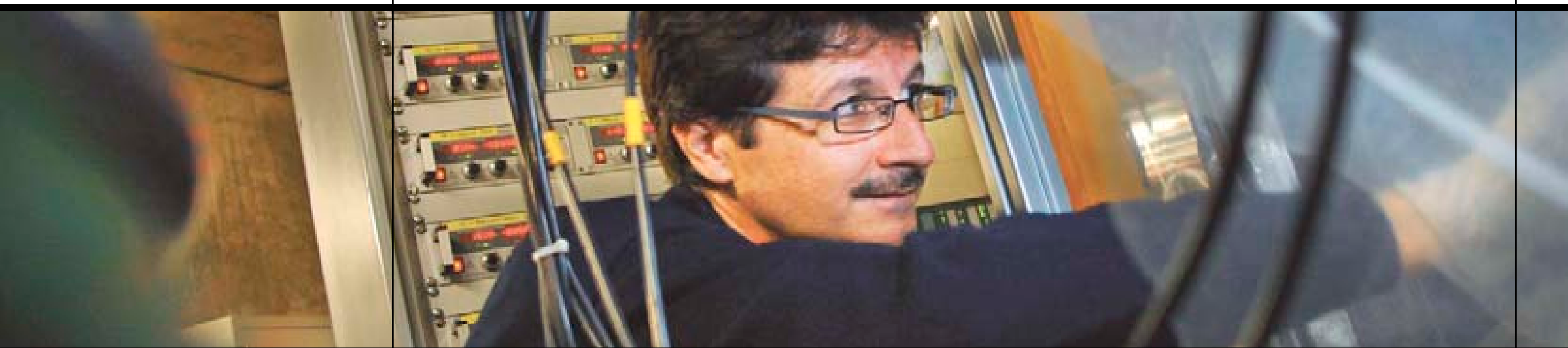
PAUL SCHERRER INSTITUT

PSI Scientific Report 2007

Cover photo:
Elvezio Morenzoni, PSI research group leader and associate physics professor at ETH Zurich, is proud of his unique investigative methods that use muons. These short-lived particles enter special materials where they are affected by phenomena such as superconductivity and magnetism.



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Bring on the future

PSI is celebrating its 20th anniversary in 2008. Since its inception on January 1, 1988, it has developed into one the most successful international research centres for natural and engineering sciences. This success story is due to the creativity, the know-how and the drive of its employees. The support the institute has received from the board of the Federal Institutes, the federal government and parliament has also played a vital role.

Unique research facilities

PSI's research interests have developed significantly over the past 20 years: born from the merger of two institutes that focused primarily on atomic energy and nuclear research, it has become a centre where work is now also carried out in the fields of physics, materials science, chemistry, biology and medicine, as well as energy technologies and their environmental impact. Much of the research undertaken at PSI is carried out with a long-term outlook, and is both fundamental and highly relevant to today's society.
PSI is in a unique position in the Swiss scientific landscape. Firstly because it encourages a strong multidisciplinary approach to research, bringing together engineering and natural science. And then because of the complex facilities the institute develops, builds and manages. These facilities are available to the scientific community working either in our universities or for firms with their own projects. Facilities such as the synchrotron light source SLS, the spallation neutron source SINQ and the muon source µSR are currently among the best anywhere in the scientific world. Around 20,000 visiting researchers have benefited from these unique facilities since PSI's foundation.

A pupil laboratory

Research and innovation at PSI owe much to young up-and-coming scientists. More than 1,500 doctoral theses have been completed at the institute since 1988. The specific infrastructure and the interdisciplinary character of the projects undertaken at PSI have played an essential role in this success.
Training and further education will continue to be a central mission for PSI in the future – especially now with a shortfall of well-trained engineers and scientists. The Swiss economy has huge needs. But too few youngsters are prepared to follow this career path. PSI wants to change this and will focus on this issue: for its 20th anniversary, we will open the institute's pupil laboratory, a place where we hope to convince youngsters that engineering and natural sciences are attractive career choices. Students aged from 12 to 14 will be able to experience research first-hand and carry out scientific experiments under the guidance of seasoned professionals. We hope to make such an impression during their visit to this laboratory that they will opt later for careers in engineering or science.
PSI has made a name for itself both at home and abroad in many fields of research. Fuel-cell technology is just one, de-

◀ **"Flexibility at all levels and a positive attitude towards change are necessary," says interim PSI director Martin Jermann.**

veloping clean motors for vehicles. In physics and chemistry, we are probing the structure of materials, compounds or biological molecules such as proteins. We are gaining knowledge that will serve later as the basis for new products and for the development of more effective pharmaceuticals. Proton therapy is another field where PSI is carrying out pioneering work. Tumours are targeted precisely with a tightly focused radiation beam, preserving healthy tissue. These projects are just a small selection of the research carried out at PSI.

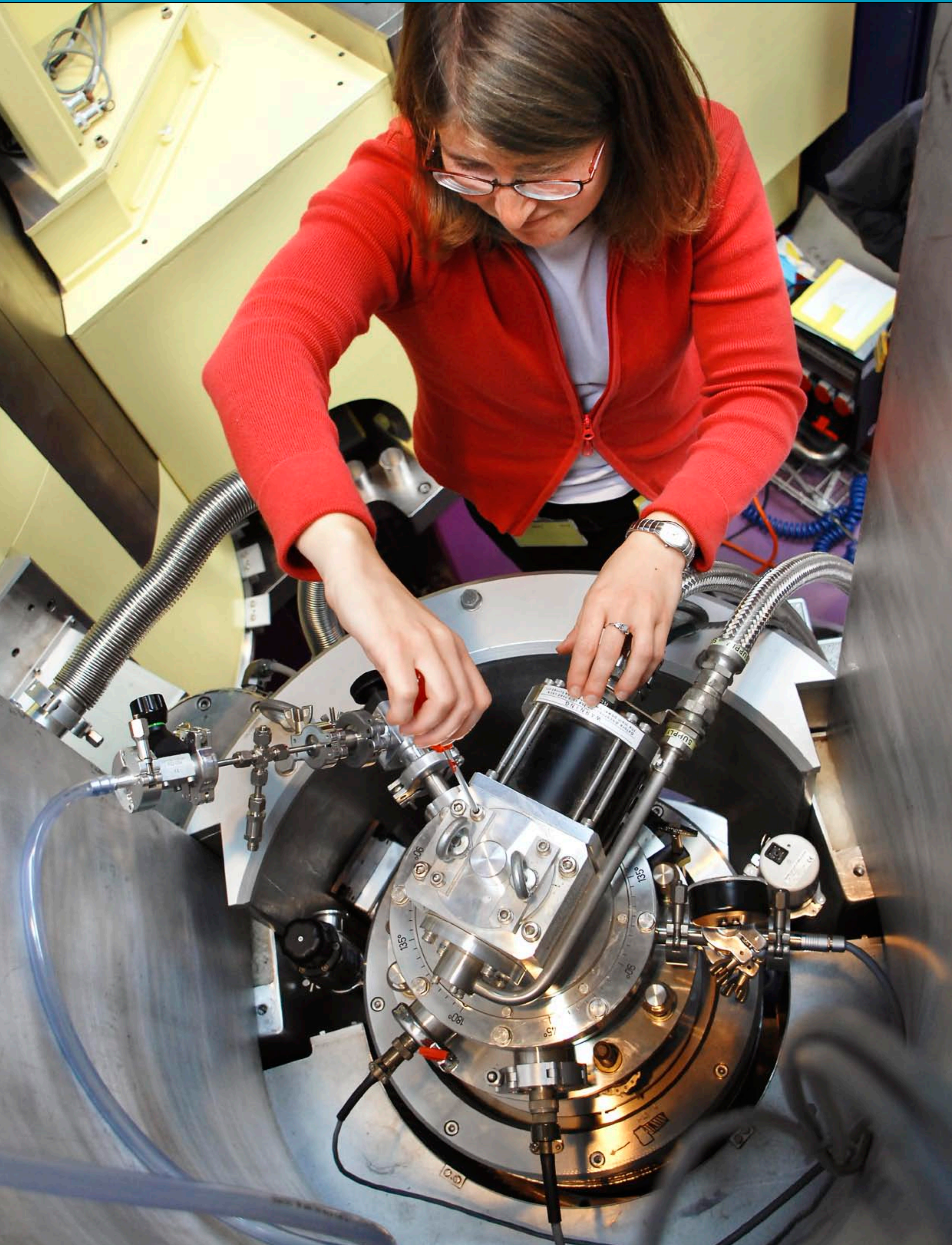
A pioneering role thanks to major projects

Major projects such as the SLS take ten years to complete from the planning phase all the way through to the operational phase. If PSI is to remain among the world's leading research institutions over the next ten to 15 years, we must start planning for the future now. This means in particular completing one trailblazing project: a new research facility that would produce coherent x-ray light one million times more brilliant than the one currently emitted by the SLS. If the project is considered feasible and results in the development of a compact X-Ray Free Electron Laser (PSI-XFEL), PSI will posses a machine capable of a literally filming changes in the structures of biological, chemical and physical samples as they happen, at unprecedented resolutions. This would open new perspectives for researchers, who know from experience that this can lead to unexpected discoveries. A preliminary study over the next three years will tell us if the project is feasible. If this is the case, the facility could go online in 2016, making PSI an international pioneer in the development of a new generation of research facilities.

PSI has some exciting perspectives. New initiatives such as the proposed PSI-XFEL project imply change for research and to some extent, push it in a new direction. As additional funding is unlikely, we will have to set priorities. Flexibility at all levels and a positive attitude towards change will also be necessary, something that is perfectly normal though at centres such as PSI. My own experience has convinced me that we can handle these challenges.

Finally, I wish to thank the staff, who through their commitment have all contributed to our many successes during the year. I would also like to thank in particular the ETH board, our two federal institutes of technology, and the other research institutes as well as the many enthusiastic university and industry scientists who have given us long-term support.

Martin Jermann, Director a.i.
(Contact: martin.jermann@psi.ch)



Research focus and highlights

Research in brief

Selected highlights in this year's report include the tenth anniversary of operations at the Spallation Neutron Source SINQ and the completion of the pixel barrel detector for the Large Hadron Collider at CERN.

In 2007, the Swiss Light Source also pursued its successful international career as a user facility. New beamlines were built and existing ones were upgraded to meet heavy demand. The SLS produced many highlights in the areas of structural biology – for example determining the make-up of a virus – X-ray imaging, surface science and magnetism.

In energy research, as petrol prices soar, progress was made towards improving the combustion of so-called syngas while a process to validate industrial conversion of wood to natural gas was successfully tested. Important work into the reactivity loss of nuclear fuels – knowledge that is vital if we are to overcome a future energy gap – was also carried out, comparing theoretical models with experimental data.

Environmental research plugged a hole in our knowledge of climate change thanks a novel technique that helps determine temperature variations in regions where no records exist. The hunt for sources of fine particles in the atmosphere also took a turn for the better with the combination of two distinct techniques.

PSI's innovative health work continued in 2007. A new cyclotron was successfully commissioned for proton therapy and the first patients have undergone therapy, pursuing a tradition of medical excellence at the institute.

The reports in this volume are only a fraction of the varied research undertaken at PSI in the past year; for more information visit our website – www.psi.ch

◀ **Fanni Jurányi is a physicist with a PhD who holds joint responsibility for the new MARS backscattering spectrometer. The 33-year-old Hungarian is investigating neutron scattering with the SINQ spallation neutron source.**

Driving atoms with light

Gerhard Ingold, Steve Johnson, Paul Beaud, Faton Krasniqi, Ekaterina Vorobeva, Rafael Abela, *Swiss Light Source, PSI, Switzerland*; Camelia Borca, Daniel Grolimund, *Research Department Nuclear Energy and Safety, PSI*; Chris Milne, Van-Thai Pham, Amal El Nahhas, Renske van der Veen, Wojciech Gawelda, Christian Bressler, Majed Chergui, *Laboratoire de Spectroscopie Ultrarapide, EPFL*

Under intense optical excitation, matter rearranges at atomic length scales in less than one picosecond. Femtosecond x-ray pump-probe experiments can capture electron, phonon and spin dynamics directly in the time domain. In crystalline systems Bragg diffraction provides information about coherent transient changes of the long-range order. X-ray absorption spectroscopy (XAS) is a complementary technique that measures the local electronic and structural changes in solvated molecular systems.

Two experiments were performed in 2007 at the FEMTO slicing source: (1) the search for coherent phonon coupling in bismuth with grazing incidence diffraction; and (2) the investigation of electron dynamics during the femtosecond magnetization of an iron-based metal-ligand complex with X-ray absorption spectroscopy. The FEMTO source installed at the µXAS-beamline delivers 2 kHz temporally and spatially stable X-ray pulses tunable from 4–12 keV with a duration of 140 ± 30 fs FWHM and low timing drifts of 30 fs rms over several days [1].

Phonon-phonon interactions

In crystalline systems intense optical excitation can cause remarkable changes in the atomic arrangement within a unit cell. In bismuth, large amplitude A_{1g} optical phonons along the body diagonal of the rhombohedral unit cell are excited by ultrashort laser pulses. Density functional theory predicts [2] that coherent E_g optical phonons in the plane perpendicular to the A_{1g} motion as well as a significant $A_{1g} – E_g$ coupling are induced at high excitation fluences (see Figure 1).
Our experiment's goal was to investigate the atomic motion induced by optical excitation in directions perpendicular to the [111] direction in bismuth as well as any relationship of this motion to the coherent A_{1g} population. To accomplish this we performed femtosecond time resolved measurements of diffracted intensity from the (1–21) lattice planes while applying a sequence of two laser pulses to control the population of the A_{1g} phonon mode. In this double-pump control experiment, the amplitude of the coherent atomic motion was manipulated through the delay of the second pulse while keeping the electronic excitation constant [1]. Significant coupling between the A_{1g} mode and the atomic motion in the [1–21] direction should lead to a change of the corresponding Bragg diffraction signal when the pulse sequence is adjusted to either maximize or to cancel the amplitude of the coherent A_{1g} phonon. Figure 2 demonstrates successful control of the A_{1g} amplitude. Within the sensitivity of our experiment we did not observe any change in the dynamics of the (1–21)-diffraction. The observed drop in diffraction efficiency appears instead to be a direct consequence of electronic excitation of the crystal, which results in a nearly instantaneous change in the frequency of phonon modes that involve atomic motion perpendicular to the [111] direction. The observed drop of the (1–21)

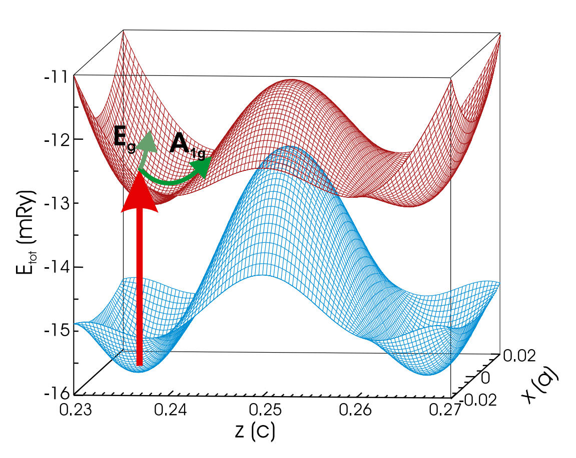


Figure 1: **Computed potential energy surface for the ground (blue) and for the excited electronic state (red) [2]. The arrows indicate the optical excitation and the A1g and Eg optical phonon modes.**

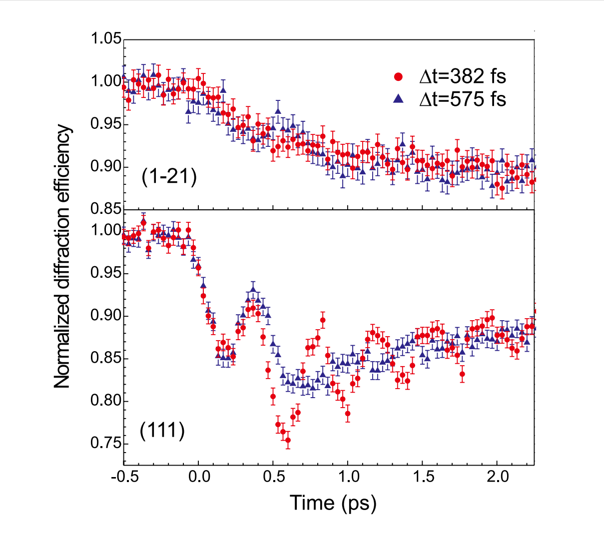


Figure 2: **Measured response of the (111) and (1–21) diffraction signals at 7.15 keV controlled by a 2-pulse excitation scheme for two delay settings of the pump pulse pair. The absorbed energy density was 1.09 mJ/cm² for the first and 0.77 mJ/cm² for the second pulse, respectively.**

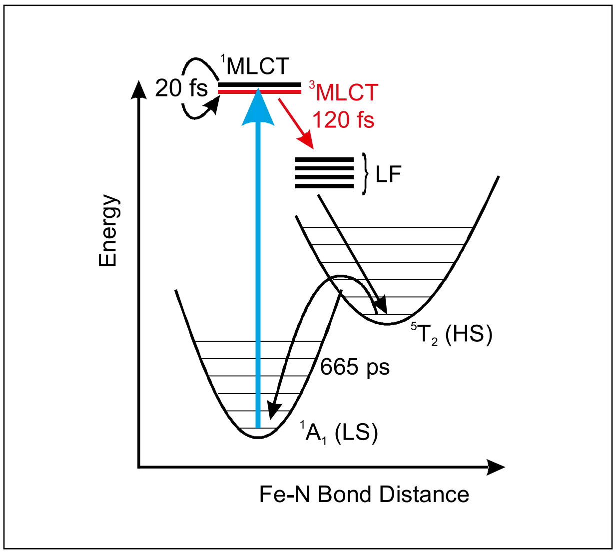


Figure 3: **Photochemical cycle of aqueous [Fe^{II}(bpy)$_3$]$^{2+}$ after excitation at 400 nm.**

intensities are due rather to larger atom displacements (via the Debye-Waller factor) caused by the flattening of the parabolic potential energy surface upon carrier excitation.

Light-driven spin crossover in solution

Ferrous molecular complexes have been studied for a long time due to their intriguing electronic and magnetic switching properties. Of particular interest are the dynamics of the spin-cross-over process itself, where an electron in a low-spin (LS) ground-state is excited by a resonant laser photon, and eventually joins with another metal-centered electron to generate a paramagnetic high-spin (HS) excited state. While the electronic relaxation back to the LS ground-state has been extensively studied in aqueous solutions of iron trisbipyridine ([Fe^{II}(bpy)$_3$]$^{2+}$) using ultrafast optical techniques [3], we have recently added picosecond X-ray absorption spectroscopy to monitor structural changes [4]. Figure 3 summarizes the dynamics of the energy relaxation pathway obtained from these studies. After excitation to the ^{1}MLCT (singlet metal-to-ligand charge transfer) state the molecule relaxes through a ^{3}MLCT state and, presumably, a sequence of ligand field (LF) states into the longer lived (665 ps) high spin quintet state ($^5T_2$). Analysis of the transient EXAFS spectrum of the system in the $^5T_2$ state, shown in the inset of Figure 4, indicates an increase in the metal-to-ligand (Fe-N) bond distance of 0.2 Å [4].

The femtosecond experiment was carried out by exciting the flowing liquid sample with a 110 fs pulse of 400 nm light. The X-rays were spectrally tuned to 7,126 eV, the energy of the maximum transient absorption signal in the ps experiment (see inset, Figure 4). Preliminary analysis indicates the arrival of the system in the high-spin $^5T_2$ state in < 300 fs. To our knowledge the results in Figure 4 are the first femtosecond hard-X-ray absorption measurements on a molecular system. The results of these experiments illustrate that ultrafast X-ray absorption spectroscopy is a powerful technique that allows access to otherwise unobtainable structural and dynamical information.

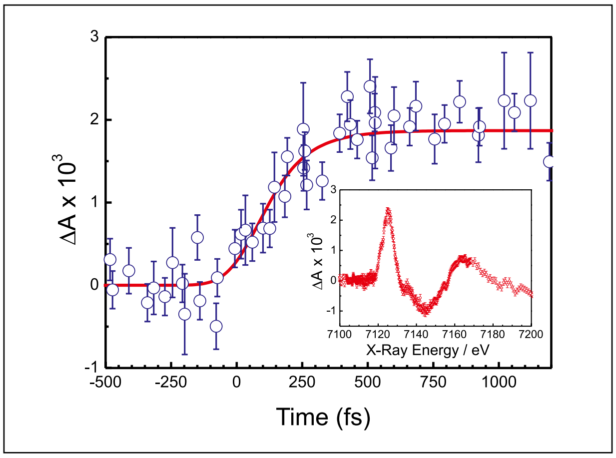


Figure 4: **Femtosecond X-ray absorption time scan performed at 7126 eV. Red line: a fit using a model taking into account the energy pathway shown in Figure 3. Inset: Transient X-ray absorption measured at 50 ps after excitation [4].**

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The conducting meat in the insulating sandwich

Philip R. Willmott, Stephan A. Pauli, Roger Herger, Christian Schlepütz, Domenico Martoccia, Bruce D. Patterson, *SLS, PSI*; B. Delley, *Condensed Matter Theory Group, PSI*; R. Clarke, D. Kumah, C. Cionca, *Randall Laboratory of Physics and FOCUS Center, University of Michigan, Ann Arbor, Michigan, USA*; Y. Yacoby, *Racah Institute of Physics, Hebrew University, Jerusalem, Israel*

In 2004, it was discovered that when a layer of $LaAlO_3$ (LAO) is in contact with a layer of $SrTiO_3$ (STO), an ultrathin layer of highly conducting material is formed where they touch one another, despite the fact that both are insulators. The underlying physics responsible for this phenomenon is still disputed, despite a concerted worldwide research effort to explain it. Using x-rays, the atomic structure of this interface between LAO and STO has been revealed with unparalleled resolution. For the first time, the exact positions and chemical compositions of each atomic layer were determined. Using simple arguments based on electrostatic energy minimization and the known sizes of the contributing ions, it was shown that the conducting layer consists of about three monolayers of a graded mixture of STO and LAO, which is predicted to be conducting. A fascinating and potentially technologically important phenomenon could therefore be explained on the basis of structural arguments alone.

The physical mechanisms behind the unexpected formation of an ultrathin conducting layer at the interface between the band insulators $SrTiO_3$ (STO) and $LaAlO_3$ (LAO) have been the subject of considerable controversy since its discovery in 2004 [1] (see Fig. 1).

Both STO and LAO belong to a technologically important family of materials called perovskites. In many of these materials, very small movements in the positions of the constituent atoms can have profound effects on their electronic properties, due mainly to the fact that the electrons involved in the bonds are strongly influenced by one another. On one hand, this makes the perovskites a very interesting class of materials for tailor-made use of novel physical properties, but on the other, these properties seem difficult to predict with the current level of modeling sophistication.

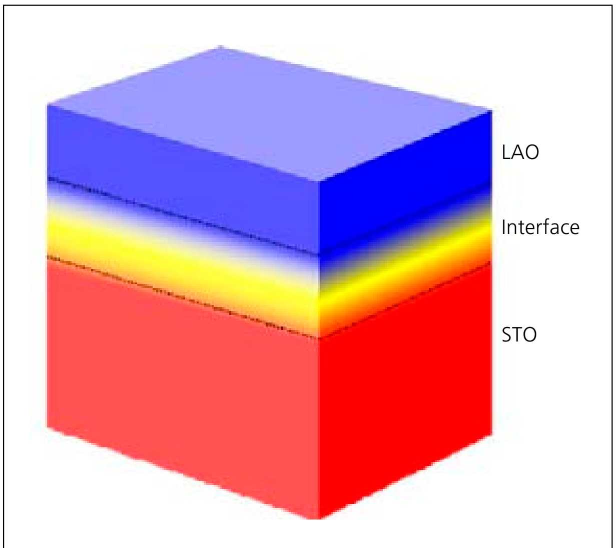

Figure 1: **Schematic of the ultrathin conducting interfacial sheet in between the insulating materials $LaAlO_3$ and $SrTiO_3$.**

In the case of the LAO/STO interface, the situation is further complicated by the fact that LAO consists of a stacking of alternating oppositely charged atomic sheets (LaO^+ and AlO_2^-), while the equivalent layers in STO (SrO^0) and TiO_2^0) are neutral. This stacking of charged layers in LAO causes an electric field to form at the interface, which can be neutralized either by the rearrangement of electrons (i.e., a local change in ion valence), or by the rearrangement or removal of atoms. Exactly which mechanism plays the most important role is the essence of the controversy.

SXRD – a unique structural technique

A common conclusion of investigations so far is that these mechanisms would be better understood if a comprehensive description of the interface with sub-Angstrom resolution was made available. The synchrotron technique of surface x-ray diffraction (SXRD) is ideally suited for this. Put simply, the presence of well-defined and atomically flat interfaces and/

or surfaces in crystalline structures results in the generation of a weak but highly predictable signal in between "normal" diffraction peaks. A very precise picture of the interfacial and surface structure can thus be gleaned from the intensity distribution of this signal.

Using a novel x-ray photon-counting area detector, a large SXRD data set of a five-monolayer film of LAO grown on STO was recorded, and analyzed with phase-retrieval methods as well as subsequent structural refinement techniques [2].

The interface structure

From the SXRD analysis, it was found that the interface between STO and LAO is not abrupt, but forms a graded layer of approximately a three unit-cell thickness [see Fig. 2(a)]. Importantly, this layer contains a significant fraction of Ti^{3+} incorporated into $La_{1-x}Sr_xTiO_3$ (LSTO), a conducting material in bulk form. The Ti-ions in pure STO are tetravalent (Ti^{4+}), hence the Ti^{3+} ions in LSTO contain one more electron, making their ionic radius significantly larger. This explains why, at the interface, the structure becomes dilated [see Fig. 2(b)].

In this interfacial layer, LSTO is forced by the underlying STO substrate to assume the latter's more symmetrical structure rather than the orthorhombic shape of LSTO in bulk form. It is known that this should further enhance the conductivity of LSTO.

With this technique, the formation of the conducting layer has been explained based only on simple structural considerations.

The electronic properties of this model were also investigated using theoretical (density functional theory) calculations, which confirmed the experimental findings [2].

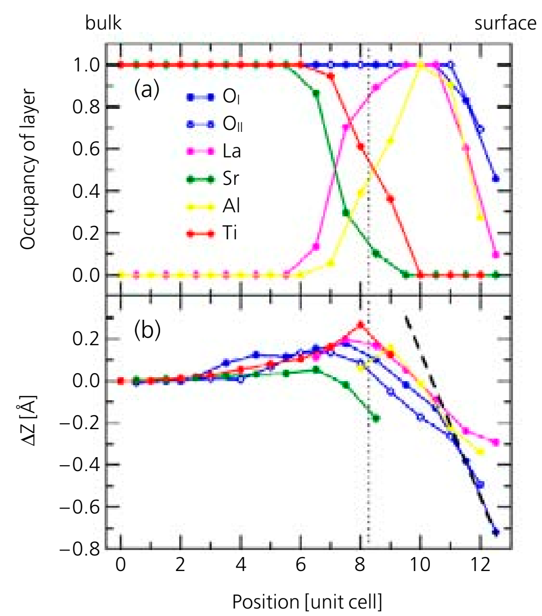

Figure 2: **(a) The chemical composition of the STO/LAO structure across the interface. The transition from STO to LAO is not abrupt, but extends over approximately three monolayers. (b) The positions of the atoms in the direction perpendicular to the interface z relative to the positions of atoms in bulk STO. Note the dilation as the nominal interface (dotted vertical line) is approached.**

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It's a matter of cores

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Using time-resolved X-ray microscopy, it is possible to get an insight into the dynamics of magnetic micro- and nano-structures. A fascinating property of micro-magnetism comes from the possibility to control the domain and vortex configuration through the sample's shape and size. For instance, in a rectangular platelet a configuration containing a stable combination of vortices and an antivortex can be created. Such a single crosstie wall contains three vortex cores that can each point either up or down resulting in a total of 2^3 (= eight) configurations only distinguishable when their dynamics are investigated.

The Surface and Interface Microscopy (SIM) beamline of the Swiss Light Source (SLS) is a versatile tool for studying micron-sized magnetic objects. It is equipped with a Photo Emission Electron Microscope (PEEM). The sample is illuminated with X-rays. The secondary electrons generated by the absorption of the X-rays are imaged on a two-dimensional detector. Magnetic contrast is obtained via XMCD, the dependency of the x-ray absorption on the relative orientation of x-ray polarization $\vec{P}$ and direction of the magnetization $\vec{M}(\vec{r})$.
Figure 1 shows the typical magnetization pattern of a ferromagnetic square, a so-called Landau pattern [1]. Both components of $\vec{M}(\vec{r})$ can be measured when rotating the polarization direction of the x-rays with respect to the sample. They can be combined to a single image containing all the information by using a colour code as shown in Figure 1c).

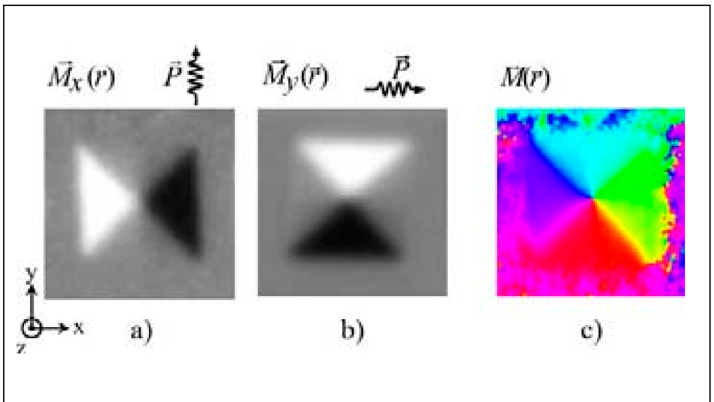

Figure 1: **Magnetization of a permalloy square. The intensity is proportional to the projection of the magnetization M onto the polarization P. The two in-plane components M_x(r) a) and M_y(r) b) are measured by rotating the sample around the surface normal (z) in the PEEM. The vector of the in-plane magnetization is shown in c) using colour coding.**

Dynamic studies

To study the dynamic properties of magnetic objects we excite them with an ultra-short magnetic field pulse of typically 200 ps rise time and several ten Oersted. By varying the time delay Δt between the magnetic field pulse and the x-ray probe pulse we measure the time evolution of the magnetization [2].
The samples are thin film permalloy ($Ni_{81}Fe_{19}$) objects with lateral dimensions of 10 µm x 6 µm and a thickness of 20 nm. Such objects are known to form a domain configuration called the crosstie wall [1].
Figure 2 shows the temporal evolution of a crosstie wall after excitation by a magnetic field pulse. The first row shows the experimental data. The third row emphasizes the changes over time by subtracting the image before excitation from each of the subsequent images. The second and forth row show the results of a numerical simulation [3].
The crosstie wall contains three static solitons, one antivortex in the centre and two vortices where the tips of a black and a white triangle touch each other (Figure 2). These objects have a magnetization component out of the plane (up or down), whereas the remaining parts of the structure are magnetized in the plane.
Following the field pulse several parts of the structure become excited. After 300 ps the grey domains get brighter (best seen in the difference images), while at longer delays (600 ps) the domain walls start to move. For delays of 1500 ps three spots show up in the difference images. These correspond to the three vortices having moved away from their initial position. By comparing experimental and simulation data it become obvious that the dynamics depend strongly on the relative

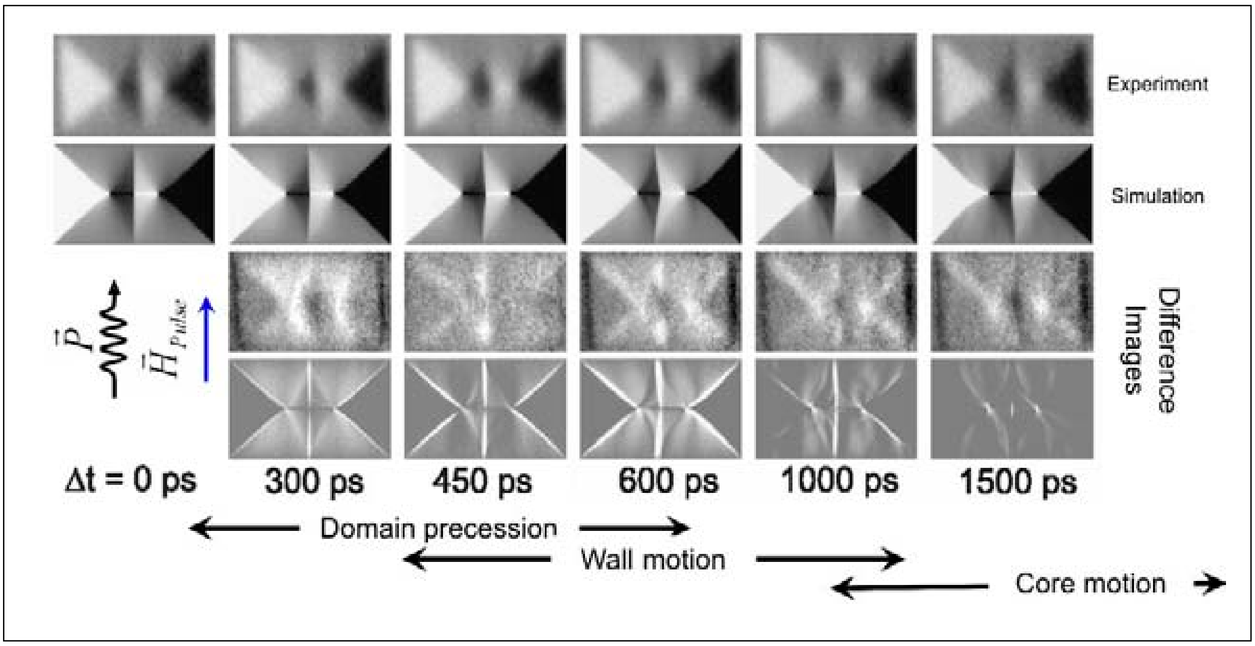

Figure 2: **Magnetization M_y(r, Δt) of a crosstie wall at characteristic delay times.**

orientation (up or down) of vortices. A detailed analysis can be found in [3].

Figure 3 shows a crosstie configuration taken from simulations. The coloured arrows indicate the calculated trajectories of all three vortices after excitation by a field pulse. Each of the vortices can point either up or down, resulting in a total of 2^3 (= eight) possible vortex configurations.

Pure static imaging does not allow us to distinguish these eight configurations, and energetically they are almost equivalent.

But following excitation the sense of rotation as well as the amplitude of the vortex trajectories is different for all eight configurations. By comparing simulation and experiment data it was possible to determine the configuration of the crosstie structure shown in Figure 2. Which is down – up –up [3].

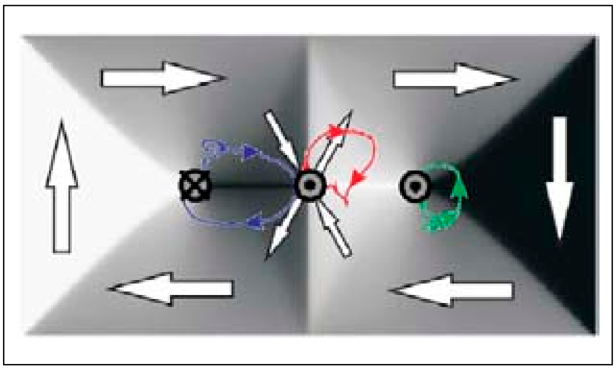

Figure 3: **Domain pattern of a platelet containing a cross tie wall taken from a simulation. The white arrows indicate the local direction of the magnetization. Coloured arrows indicate the trajectories of the three vortices following the excitation by a field pulse. The cores are oriented down – up – up (⊗ ⊙ ⊙).**

Summary

Time-resolved PEEM gives a detailed insight into the dynamic properties of micro-magnetic systems, allowing for example the determination of vortex orientations which are not detectable in static imaging. Although static properties are independent of core orientation, the cores are relevant to dynamic properties.

This is not only important for the comprehension of fundamental properties of magnetic micro- and nanostructures, but also important for the numerous applications envisaged for these micro-magnetic objects.

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Manipulating magnetic moments with electric fields

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The search is on for materials that become magnets simply by applying an electrical signal. A small group of materials with unusual spin arrangements, so-called multiferroics, show coupling and coexistence of magnetism and ferroelectricity. The interest in these materials is due to the fact that they may enable the electric control of magnetic states. Our experiments demonstrate the possibility of manipulating magnetism and imprinting a magnetic response with electric fields in multiferroic $ErMn_2O_5$.

In 1865 Maxwell established four well-known equations describing the dependencies between magnetic interactions and the motion of electric charges. A changing magnetic field produces an electric field (electromagnetic induction), whereas the motion of electric charges generates a magnetic field (Biot-Savart law). A typical application is the electromagnet, which usually consists of wire coils or loops and is big and bulky.

Multiferroics

With the need to produce smaller and faster electronic devices a group of materials that intrinsically exhibit magnetic and electric ordering attracted interest: the so-called multiferroics. In these materials magnetism and ferroelectricity coexists and are coupled. The magnetoelectric (ME) effect in a solid, the induction of a magnetization **M** by electric fields and the induction of an electric polarization **P** by magnetic fields, were first predicted by Pierre Curie [1]. Since the ME effect was first confirmed experimentally in the 1960s, many magnetic materials have been shown to produce this effect [2]. However, observed ME effects are usually too small for practical applications.

In $ErMn_2O_5$ spontaneous electric polarization **P** is induced by a non-collinear arrangement of magnetic moments leading to a magnetoelectric coupling which is gigantic. $ErMn_2O_5$ shows spontaneous electric polarization parallel to the crystallographic **b**-axis at T_{C1} = 39.1K, i.e. below the Nêel temperature of T_N=44K. Below T_N the system shows two magnetic transitions; the transition between incommensurate and commensurate magnetic order at T_{CM} and between two different incommensurate magnetic structures at the transition temperature T_D [3].

Experiment

We used resonant soft x-ray magnetic diffraction to demonstrate that ferroelectricity in $ErMn_2O_5$ can be modulated, excited and switched by applying a static electric field [4]. The experiments were carried out at the RESOXS station at the SIM beamline of the Swiss Light Source (SLS).

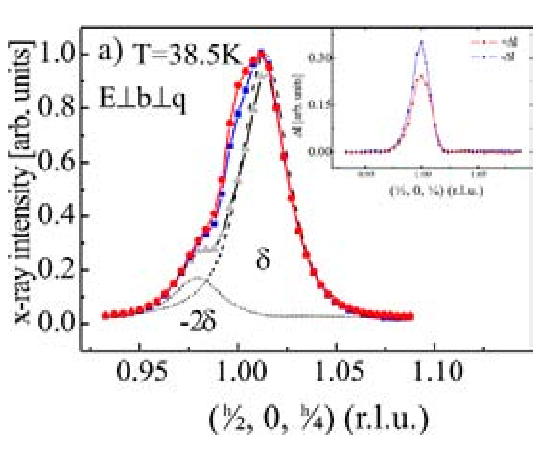

Figure 1: **The (½ 0 ¼)-reflection of $ErMn_2O_5$ taken at the Mn L_3-edge above T_{CM}. δ corresponds to a magnetic reflection, -2δ to an induced aspheric charge reflection. The inset shows the intensity difference ΔI.**

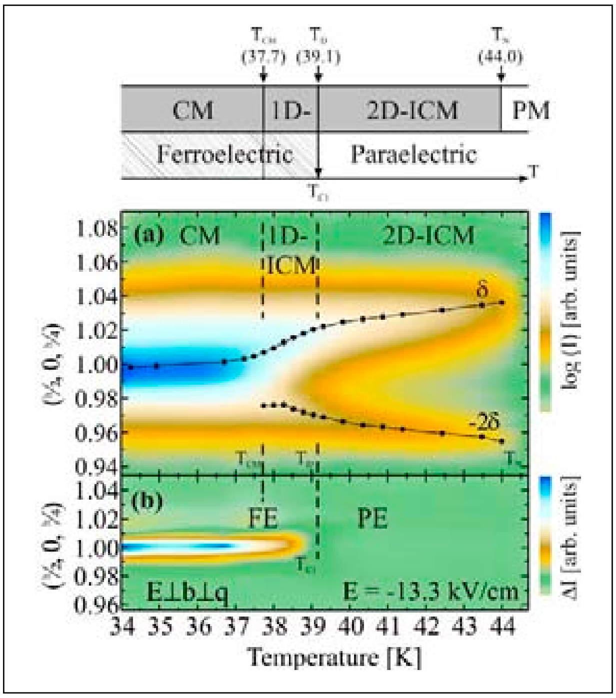

Figure 2: **top: Phase diagram of $ErMn_2O_5$.**
(a): Temperature dependence of the magnetic (½ 0 ¼)-reflection.
(b): Intensity difference $\Delta I(T)$ due to the electric field.

In Figure 1 we present a momentum scan at the Mn L_3-edge (E=643.75 eV) across the magnetic (1/2 0 1/4)-reflection. At this energy we probe only the Mn magnetic moments. Magnetic Bragg scattering appeared at **q** = (1/2 0 1/4) below T_{CM}, whereas above T_{CM} two satellite reflections δ and –2δ exist. δ represents the initial magnetic scattering, whereas the –2δ satellite corresponds to orbital scattering and describes the magnetically induced aspheric charge distribution of Mn. Applying an electric field of E = ± 13.3kV/cm perpendicular to both **q** and the spontaneous electric polarization (**E** ⊥ **b** ⊥ **q**) leads to a pronounced increase of the scattered magnetic intensity. The insets highlight the intensity difference $\Delta I^{\pm} = I(\pm E) - I(E{=}0V)$. These findings show that a magnetic structure can be directly manipulated with an electric field applied in-situ.

To obtain further insight, the detailed temperature dependence of the reflection was measured (Figure 2a). The Néel-temperature at T_N = 44 K was observed by the onset of magnetic scattering. When lowering the temperature the positions of δ and –2δ changed slightly (black dots). The magnetic phase transition at T_D lead to a significant change in the slope of δ(T) and –2δ(T). After further decreasing the temperature, $ErMn_2O_5$ entered the commensurate magnetic phase (CM) at T_{CM}. At this point δ(T) and –2δ(T) merged into the commensurate reflection. Simultaneously, we observed the influence of the applied electric field on magnetic scattering. Figure 2b presents the intensity difference ΔI(T). The onset of ΔI(T) was coupled to the magnetic transition at T_D. Moreover, ΔI(T) appeared at the commensurate peak position and was stable in **q**. Since the **E** field was applied in-situ, these results represent direct proof of a coupling between ferroelectric and magnetic order.

The intensity difference ΔI(E) as function of the applied electric field is shown in Figure 3. The data were taken after field cooling the sample, resulting in positive ΔI at 0V and a negative field bias (dotted line). We observed an increase of ΔI when increasing E up to ~9 kV/cm, followed by a decrease upon a further increase of E. Similar behavior could be observed by applying E in the opposite direction. A second remarkable finding was the difference in the slope of the hysteresis when crossing E = 0. It shows that the system is in a different magnetic state because the magnetic signal depends significantly on history.

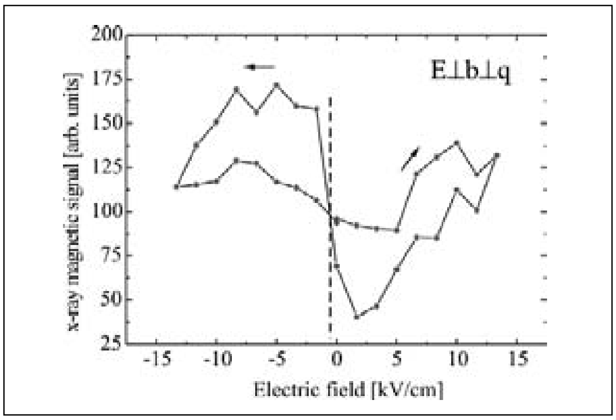

Figure 3: **X-ray difference intensity ΔI as function of the applied electric field at T = 38.5K, showing its hysteretic behavior.**

Conclusions

Applying a static electric field on $ErMn_2O_5$ leads to a significant increase of magnetic scattering. The difference in intensity clearly demonstrates the generation of magnetic scattering intensity at the commensurate (1/2 0 1/4)-position that is stable in **q**. The temperature dependence of ΔI reveals the coupling of magnetic and electric transitions. In the ferroelectric phase, an applied electric field perpendicular to **q** and **b** pushes the system into the commensurate magnetic phase by changing the direction of the magnetic moments. The hysteresis loop reveals that it is possible to imprint a magnetic response with an electric field.

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Virus in a nutshell

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Only a few proteins appear in their crystalline form in living cells. One of them is polyhedrin, a protein encoded by cypoviruses (CPV), a widespread insect pathogen. Polyhedrin forms ultra-stable, micron-sized crystals to protect viral particles from harsh environmental conditions. The structure of these crystalline containers was determined by X-ray diffraction analysis. Understanding the molecular organization of *in-vivo* crystallized polyhedrin might pave the way for the development of new, easy-to-manipulate nano-containers that could accommodate a wide range of cargos and deliver them to specific places.

Cypoviruses and polyhedra

Together with nuclear polyhedrosis virus (NPV) and granulosis virus (GV), the cytoplasmic polyhedrosis virus (CPV) belongs to the family of *Reoviridae* and infects insect larvae [1]. As an infection progresses, viral particles are embedded into small particles called polyhedra, which are micron-sized crystals formed by the crystallization of a viral-encoded protein called polyhedrin (figure 1) in the cytoplasm of the insect cell. Polyhedra act as very stable containers for the viruses and protect their sensitive cargo against any loss of infectivity.
As CPV infection (polyhedrosis) is located in the midgut, affected insect larvae rapidly spread the disease by spoiling plants and soil with their faeces. CPV polyhedra are stable enough to persist in the soil for years, making them difficult to eradicate. As insect colonies are particularly vulnerable to polyhedrosis, the disease causes significant losses in silkworm cocoon harvests [2]. But the extraordinary stability of polyhedra has been exploited in the development of biological alternatives to chemical insecticides [3].

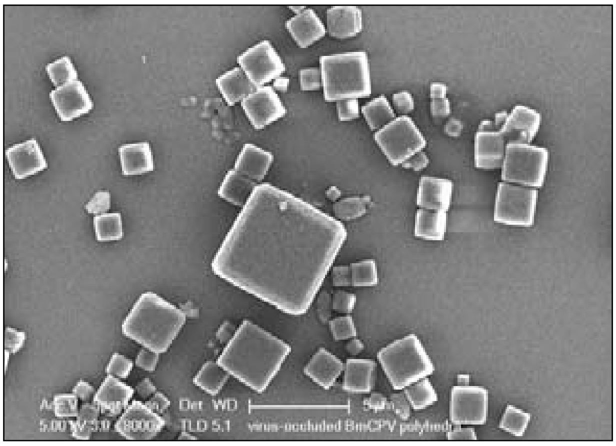

Figure 1: **Scanning electron micrograph of virus occluded polyhedra (Elaine Chiu). White bar indicates 5 μm.**

The molecular organization of cypovirus polyhedra

Methods for purification and X-ray analysis of *in vivo* grown, infectious CPV polyhedra were developed that allowed its structure to be determined to 2 Å resolution [4]. The crystals studied had dimensions of 5–12 microns and are the smallest yet used for *de novo* protein X-ray structure solution. Crystals were spread onto micro-fabricated mounts and illuminated at 100 K by the X-ray beam at the micro-diffractometer (MD2) station of the Swiss Light Source's X06SA beamline. Data were processed in the cubic space group I23 and structure factor phases were obtained from four different isomorphous heavy atom derivatives. The structure of infectious polyhedra was refined to 2 Å with R = 9.3 % and R_{free} = 15.4 %.
Figure 2 depicts the ribbon diagram presentation of the 28 kDa CPV polyhedrin. The structure of the polyhedrin monomer is formed by two central β-sheets, which are surrounded by α-helices H1, H4, H5 and the clamp. The basic building block of polyhedra consists of a trimer of polyhedrin molecules (Figure 3). The trimer is mainly formed through hydrophobic interactions and its 3-fold symmetry axes coincide with the cubic lattice's crystallographic three-folds in such a way that a single polyhedrin protein constitutes the asymmetric unit of the crystal.

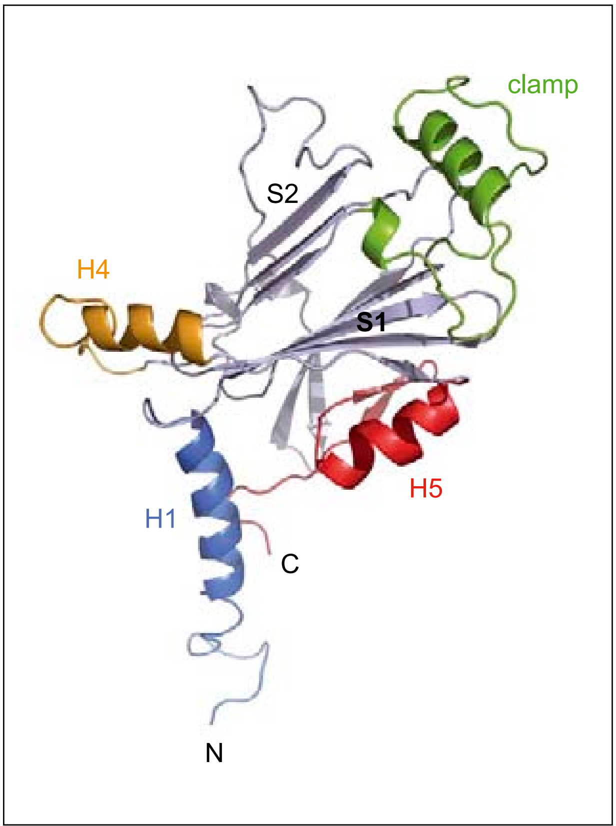

Figure 2: **Ribbon diagram of the CPV polyhedrin monomer.**

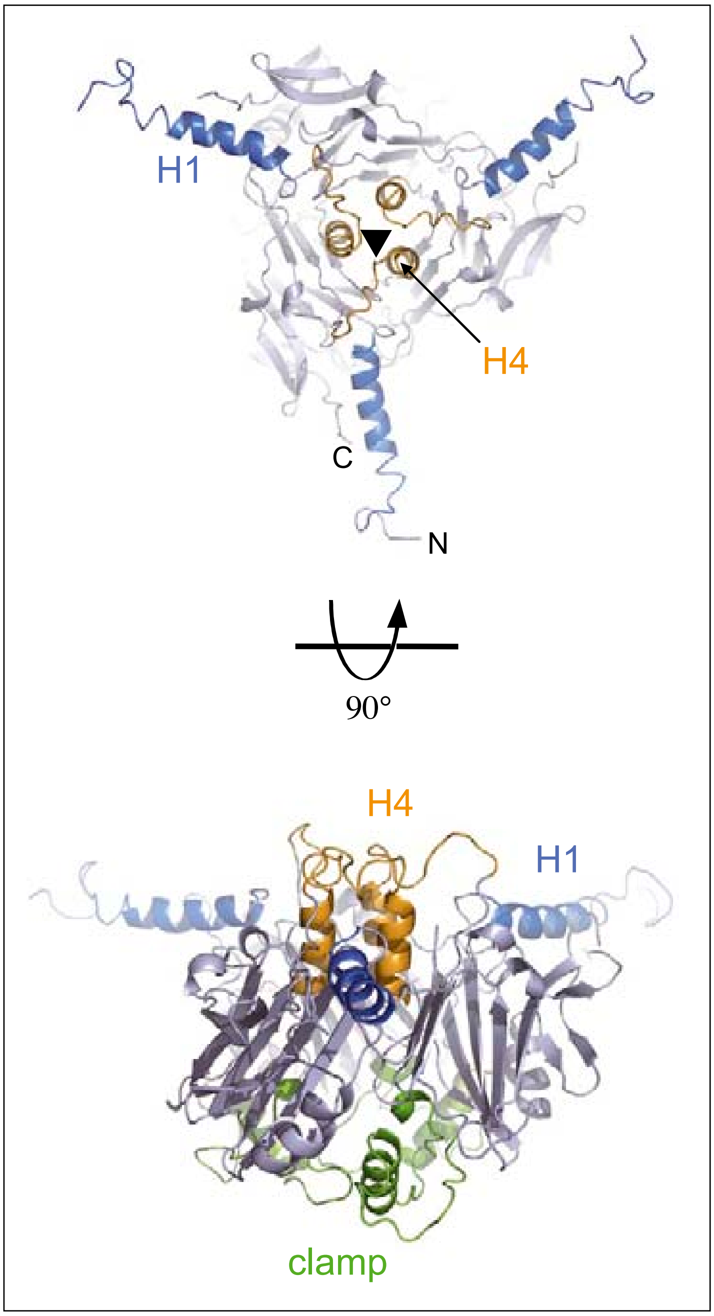

Figure 3: **Polyhedrin trimers are essential building blocks of polyhedra. They are formed through hydrophobic interactions between residues of helices H4 and the clamps. The three-fold symmetry axis of the trimer coincides with the crystallographic three-fold (triangle).**

A tetrahedral cluster of four trimers forms the next level of organization in polyhedra. Two of these tetrahedral clusters constitute the crystal's unit cell, which is repeated a few hundred times along each axis to form micron-sized cubic polyhedra. The interconnected trimers form an extensive, tightly packed network that shields over 70 % of the polyhedrin surface from solvent. Remarkably, the dense packing is interrupted only by narrow channels between unit cells and by closed cavities at the centre of the tetrahedral clusters. Polyhedra are tightly sealed containers of extraordinary chemical and physical stability that shield embedded virus particles from the external environment. Based on this structure we are also able to propose a mechanism for virus release at high pH values in the insect's midgut: crystals dissolve readily at pH 10 – 11, presumably due to deprotonation of a particular group of amino acids essential for the stability of the tetrahedral clusters.

Due to their robustness and size CPV polyhedra are easy to manipulate and could possibly accommodate a wide range of cargos [4]. The structural characterization of polyhedra provides a sound basis for structure-based engineering of polyhedrin to create variants that, for example, release their cargo at less extreme pH values. Such an approach would certainly open the road for the development of a new generation of nano-containers.

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Near-surface hydrogen impurity states in semiconductors and insulators

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Hydrogen impurity states are of fundamental and technological interest due to their influence on electrical and optical properties, particularly in semiconductors. Muon Spin Spectroscopy (μSR) has been shown to be a powerful tool for the investigation of the formation, structure and electrical activity of isolated hydrogen-like states, where a stopping μ^+ may capture an electron to form the hydrogen-like, bound state muonium (Mu). Using the unique low-energy muon source (LEM) at PSI we studied for the first time the formation of Mu states as a function of implantation energy in a near-surface region up to 150 nm depth.

The implantation of energetic (MeV) μ^+ in insulators and semiconductors commonly results in the formation of hydrogen-like muonium, with different final charge states (Mu^+, Mu^0, Mu^-). μSR probes H states at infinite dilution, while other spectroscopic techniques for the study of H states usually require high H concentrations. μSR has played a pioneering role in identifying and characterizing isolated hydrogen-like states in technologically relevant semiconductors [1,2]. Mu_T with isotropic hyperfine interaction (HFI) at a tetrahedral interstitial site and Mu_{BC} with anisotropic HFI at a bond-center between two host atoms with a much weaker HFI have been identified in diamond, Si, Ge and III-V semiconductors. In covalent semiconductors, Mu_T represents an acceptor and Mu_{BC} a donor state. Recently, novel very weakly bound states (*shallow* Mu) were established in a number of II-VI and III-V (nitrides) compounds [3-5]. *Shallow* donor hydrogen states were also predicted theoretically in InN and ZnO from a universal alignment of hydrogen levels in semiconductors and insulators [6]. Using μSR, these states were confirmed experimentally [4,5].

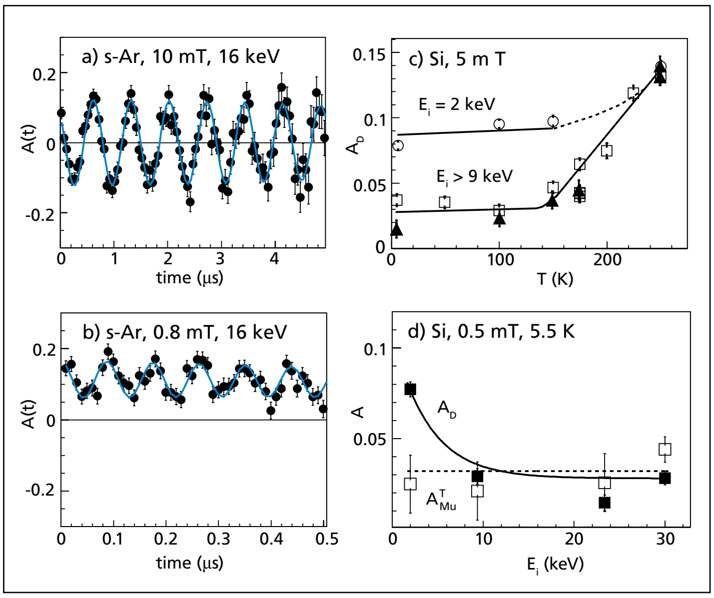

Figure 1: **a) Typical LE-μSR asymmetry A(t) of Mu^+ (diamagnetic signal) in solid Argon, and b), corresponding low-field Mu^0 precession which is 103 times faster. c) Undoped Si <100>, Mu^+ asymmetry A_D as a function of temperature and energy. d) Mu^+ and Mu^0_T asymmetries versus energy. The lines in a) and b) are fits, and in c) and d) guides to the eye.**

The use of MeV μ^+ leads to the generation of a large number N_{eh} ($10^5 - 10^6$) of electron-hole pairs during the stopping process of the incident μ^+ (other techniques using protons also start with energetic protons of comparable energy). A sizable fraction of these electron-hole pairs escapes prompt recombination and may interact with the thermalized impurity: electrons from the ionization track may recombine with the stopped μ^+. It has been shown experimentally by applying electric fields to the sample, that a significant fraction of Mu is formed this way [7]. The question arises whether and how the final H-like states are influenced by the formation process, which is essential for studies on semiconductors and insulators.

The low-energy μ^+ (LEM) facility at PSI allows examination of this issue. With its variable implantation energy between 1 and 30 keV, the formation of hydrogen-like Mu impurity states can be studied as a function of energy, i.e. as a function of depth and N_{eh}. Due to the low implantation energy, N_{eh} can be tuned between a few and several thousand electron-hole pairs, which is orders of magnitude less than for MeV-muon beams. Figure 1 shows μSR data and deduced results for undoped Si <100>. The Mu^+ (Mu^-) signals can be distinguished from the Mu^0 signals by the different muon precession frequencies due to the hyperfine coupling between μ^+ and e^- in Mu^0. In Si at energies greater than 9 keV (corresponding to a mean depth <d>=65nm) the temperature dependence of the Mu^+ signal is the same as in the bulk. The increase of A_D (which is proportional to the Mu^+ fraction) above 150 K is attributed to the thermal ionization of Mu^0_{BC}. At 2 keV (<d>=18nm) and T < 150 K A_D is clearly larger. As shown in Fig. 1d) the behaviour of A_D is not related to a change of the Mu^0_T fraction, which does not depend on energy. Rather it reflects the unobserved (due to the limited time resolution of the LEM spectrometer) Mu^0_{BC} fraction that decreases in parallel with decreasing energy and number of available track e^-. The differentiated dependence on the availability of track e^- indicates that Mu^0_{BC} is mainly formed by capture of a track e^- after μ^+ thermalisation (*delayed* formation), whereas Mu^0_T forms during the stopping process in charge-exchange collisions (*prompt* formation). This has been inferred more indirectly in bulk μSR studies [7].

As a second example we present a study on ZnO, which is a wide band-gap semiconductor and has recently attracted interest due to its potential application in optoelectronic devices. Figure 2 shows a Maximum Entropy analysis of energy scan data of ZnO at T = 10 K. At energies > 15 keV (<d>=70nm) about 50% of the muons are in the Mu^+ state (central peak at 10 mT). The other 50% form the shallow donor state with 10^4 times smaller hyperfine coupling (compared to vacuum Mu) so that the Mu^0 states are in the Paschen-Back region at 10 mT, i.e. they appear as broad peaks symmetrically located below and above 10 mT. This is in agreement with previous bulk μSR studies [3,4]. When the energy is lowered (reducing N_{eh}), the intensity of the Mu^+ signal clearly increases while the weight of the broad side peaks decreases correspondingly, which demonstrates that shallow Mu states form mainly by *delayed* e^- capture.

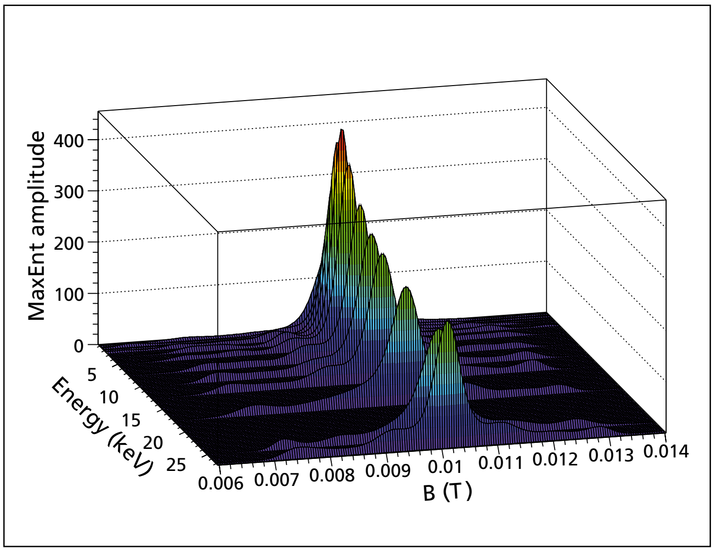

Figure 2: **Undoped ZnO, <0001> oriented, energy scan at 10 K, 10 mT applied parallel to <0001>. Maximum Entropy analysis.**

Conclusions

These results are examples of a general trend found in other materials: in simple insulators (solid van der Waals gases, SiO_2, Al_2O_3) and semiconductors (Si, Ge, CdS, ZnO) the observed energy dependence of Mu states shows that *delayed* Mu formation processes require the presence of thousands of track electron-hole pairs [8]. From the corresponding implantation energies we estimate that about 100 nm of the ionization track are involved in *delayed* Mu formation. Below 3 keV this formation process is nearly absent. This suggests that the formation of those hydrogen impurity states which strongly depend on the availability of excess charge carriers is suppressed in cases where the H isotope is inserted in the solid without the presence of a sizeable number of excess charge carriers. It could also imply that the role of H-impurity states in determining electric properties depends on how the H isotope is incorporated into the material. So far, the question of the relative importance of different possible H states and their occurrence as native impurity states has not been generally addressed. The LEM facility at PSI could obtain new insights in this field, particularly for new, thin-film materials that are potential candidates for electronic/optoelectronic devices.

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Charge fractionalization without breaking time-reversal symmetry

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In condensed matter physics, the electron is not fundamental in the sense that it may have little relation to low-lying charge excitations due to strong interaction effects. In the fractional quantum Hall effect, for example, a very strong magnetic field enhances dramatically the importance of Coulomb interactions among electrons over their kinetic energy; so much so that elementary charge excitations carry a fraction of the electron charge. Here we show that the fractionalization of charge in graphene-like systems is possible without breaking time-reversal symmetry.

The discovery of the electron was made in 1897 by Thomson. Millikan and Fletcher demonstrated the quantization of the electron charge *e* with their oil-drop experiment in 1909. Both experiments can be understood within the framework of classical mechanics and electrostatics by postulating that the electron is a point-like particle carrying a quantized electric charge. Neither classical physics nor quantum mechanics explain the origin of the electron and its quantized electric charge. Grand unified theories (GUT) of strong, weak, and electromagnetic interactions lead to the quantization of the electron charge at low energies as a result of spontaneous symmetry breaking below the energy scale 10^{14} *GeV*. However, this scenario has not been tested experimentally.

In condensed matter physics, electrical transport can be understood by assuming that the charge carriers are electrons, point-like particles with a quantized mass and electric charge that interact with each other and with a periodic ionic background following the rules of quantum mechanics. Ignoring electron-electron interactions, the interaction between an ionic crystalline background and electrons leads to two well-known phases of matter. There is the metallic state for which any applied voltage drives an electric current. Then there is the insulating state for which a sufficiently large applied voltage is required to drive an electric current (provided the sample survives the applied voltage). The metallic and insulating states of matter have no classical counterparts; they are quantum mechanical objects.

The discovery of the integer quantum Hall effect (IQHE) in 1980 ushered an era in which the quantization of the electron charge has been tied to purely quantum mechanical signatures of the metallic and insulating states. The IQHE manifests itself by a vanishing longitudinal conductivity and by a Hall conductivity that is quantized in integer units of e^2/h (*h* the Planck constant) for a gas of free electrons confined to a two-dimensional interface (by a band structure effect) and subject to a strong magnetic field perpendicular to the interface. A prerequisite for observing the IQHE is that the temperature is sufficiently low and the sample is sufficiently clean for the existence of a mobility gap in the electronic spectrum.

Neither the metallic nor the insulating states of non-interacting electrons need to be robust to interactions. The metallic phase in alkali metals is unstable to the superconducting phase at sufficiently low temperatures because of electron-phonon interactions. The 1983 discovery of the fractional quantum Hall effect (FQHE) in which the Hall conductivity of two-dimensional electrons is quantized in units of rational fractions of e^2/h is now understood to be a dramatic manifestation of the combined effect of a strong magnetic field and of electron-electron interactions. Laughlin's theory for the Hall plateau at 1/3 filling fraction ν of the first Landau level suggests that electrons are not elementary excitations in the $\nu=1/3$ FQHE. They are replaced by collective excitations carrying a fractional charge $e/3$. A direct measurement of the fractional charge of these excitations in the $\nu=1/3$ FQHE came from the 1997 shot-noise experiments in Saclay and at the Weizmann Institut.

The discovery of the FQHE has motivated a search for unusual quantum numbers without breaking time-reversal symmetry. Candidate systems are mostly quasi-two-dimensional, high-temperature superconductors. A notable exception is graphene, an isolated layer of graphite studied for the first time in 2004 by the Manchester group. In a collaboration between the condensed matter theory groups at PSI and Boston University [1] it was shown that an insulating state of graphene characterized by a bond ordering that extends the Kekulé pattern of weak and strong bonds in the benzene

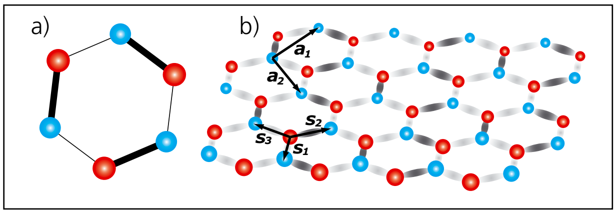

Figure 1: **Kekulé pattern for strong and weak bonds for (a) the benzene molecule and (b) graphene.**

molecule [Figure 1(a)] to the honeycomb lattice [Figure 1 (b)] can support charge excitations that carry a fraction of the electron charge *e*.

In 1947 Wallace calculated the electronic dispersion of graphene, demonstrating thereby the potential for graphene to realize relativistic quantum field theory in the tip of a pencil. The band theory of graphene can be explained by assuming that one carbon ion is localized on the honeycomb lattice and that there is one valence electron per ion in a π orbital. The resulting band structure consists of two Bloch bands that touch at the six corners of the first Brillouin zone. The energy at which the valence and conduction bands meet is called the charge neutral Dirac point as linearization of the dispersion around it creates the cones depicted in Figure 2(a). The non-equivalent cones of the wave vectors K_- and K_+ mimic the massless relativistic spectrum of two flavors of fermions in the lowest spin or representation of the Lorentz group in (2+1) space and time. Hence, the density of states vanishes at the charge neutral Dirac point. The Kekulé pattern of strong and weak bonds illustrated in Figure 1(b) opens a gap in the spectrum of graphene [Figure 2(b)].

Finally, a point-defect in the Kekulé pattern of Figure 1(b) pulls from the continuum a midgap eigenstate with a wave function that decays exponentially fast away from the defect. This mid-gap eigenstate carries the electric charge $\mp e/2$ depending on whether it is occupied or not. Remarkably, by breaking the particle-hole symmetry between the conduction and valence bands as could happen if graphene were deposited on a substrate that favors electrons sitting on top of the red sites in Figure 1, the mid-gap state can be made to move away from the charge neutral Dirac point smoothly. Correspondingly, the fractional charge deviates smoothly from $\mp e/2$, i.e., the fractional charge can be tuned continuously and take irrational values. This physics of fractionalization is not limited to graphene but can also be realized for electrons hopping on the square lattice as is shown in Figure 3.

In summary, the principle of fractionalization of the electron charge due to many-body interactions without the breaking of time-reversal symmetry has been demonstrated theoretically for graphene-like systems. As in GUT – and unlike in the FQHE – spontaneous symmetry breaking plays a crucial role. Unlike in GUT, the symmetry that is broken is not fundamental but an emerging one in the low-energy and long wavelength limit of a graphene-like system.

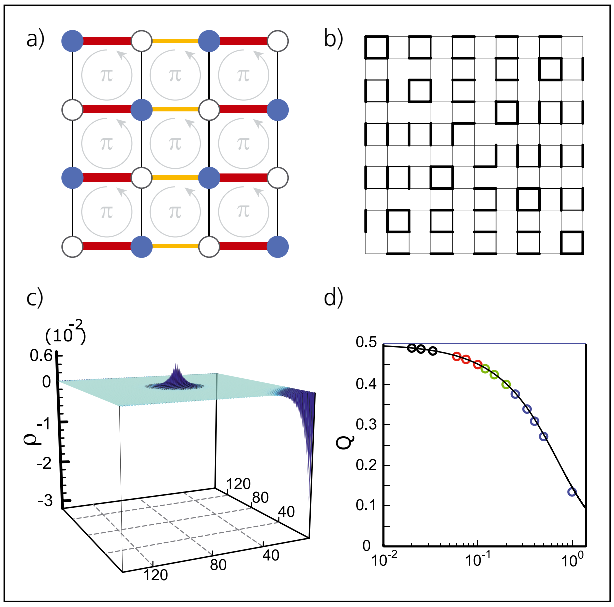

Figure 3: **(a) The columnar dimerization is the counterpart to the Kekulé dimerization for the square lattice threaded by a magnetic flux of π per plaquette. A point defect (b) in the columnar pattern that nucleates a mid gap state (c) at the origin. The fractional charge induced by the point defect as a function of the ratio between the energy scale that breaks the sublattice symmetry and the energy gap at the charge neutral Dirac point.**

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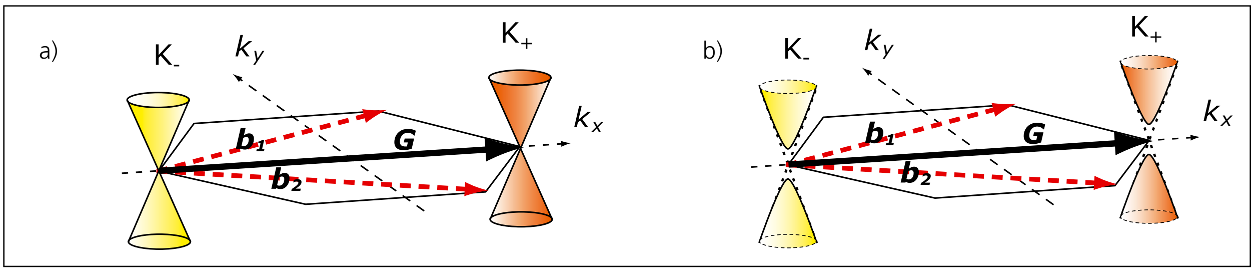

Figure 2: **Linearized energy dispersion of grapheme without (a) and with (b) the Kekulé dimerization.**

Direct link between low temperature magnetism and high temperature sodium order in Na_xCoO_2

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We prove the direct link between low temperature magnetism and high temperature Na^+ ordering in Na_xCoO_2 by characterizing a magnetic transition at 8 K and demonstrating its dependence on a diffusive Na^+ rearrangement around 200 K. Applying muons as local probes this process is shown to result in a reversible phase separation into distinct magnetic phases that can be controlled by specific cooling protocols. Thus the impact of ordered Na^+ Coulomb potential on CoO_2 physics is demonstrated, opening new paths to experimentally revisit the Na_xCoO_2 phase diagram.

The layered transition metal oxide Na_xCoO_2 combines high thermopower and metallic conductivity, making it a promising candidate for thermoelectric energy conversion [1,2]. Superconductivity [3] as a prototypical Fermi surface instability in hydrated $Na_{0.3}CoO_2$ and charge or spin-ordered electronic ground states for higher sodium content ($x > 0.75$) [4] reflect the richness of sodium cobaltate physics.

The susceptibility of the CoO_2 electronic system to a number of instabilities was revealed by theoretical studies assuming a homogeneous electronic structure [5]. However, Na ions (whose apparent main role is to donate electrons to the Co-O derived states) create local electronic inhomogeneity through their Coulomb potential, seen for example with NMR in the form of inequivalent Co sites [6]. It was suggested from a theoretical point of view that sodium ordering at high temperatures [7] influences the electronic structure of the CoO_2 layers through Coulomb potential wells [8]. By combining the results of specific heat, muon spin rotation (μSR) and neutron diffraction we were able to establish a direct link between high T sodium ordering and the low T magnetic properties by characterizing a new low temperature magnetic instability in $Na_{0.8}CoO_2$.

Figure 2 shows specific heat data taken in a zero field. In addition to the well-known transition to an antiferromagnetically ordered state at 22 K [9-11] there is another lambda-shaped anomaly at 8 K associated with a distinct second phase whose formation is dependent on the sample's cooling protocol [12]. The second transition only develops if the sample is cooled sufficiently slowly (at a rate < 10 K / min) through a narrow temperature range around 200 K. This points to diffusive sodium rearrangement as a driving force of magnetic order possibly due to the patterned sodium Coulomb potential breaking the crystal symmetry.

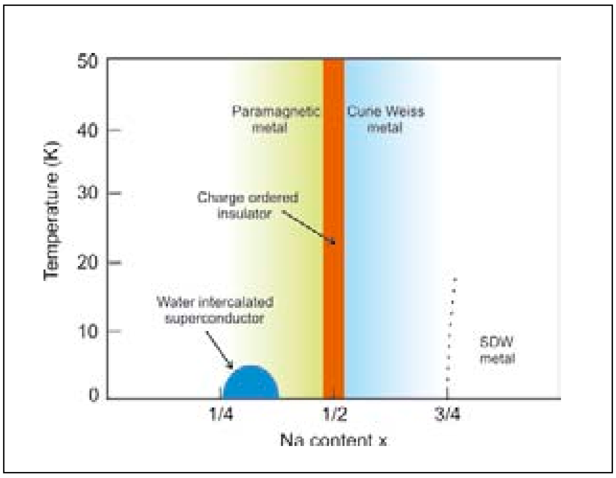

Figure 1: **Na_xCoO_2 phase diagram (after Foo et al. [4])**

In light of the small entropies associated with the anomalies in the specific heat data it is worth applying a technique that probes the bulk of the sample magnetically and allows one to determine the volume fractions involved in the two transitions. To achieve this, we performed μSR measurements using the general purpose GPS spectrometer on the πM3 beamline. The results indicate that both cooling procedures result in a fully ordered sample volume at 5 K. However, the microscopic magnetic state of the sample is distinctly different depending on the cooling protocol. 'Fast cooling' results in a magnetic state that is closely similar to that previously reported for x = 0.82 [9]. The entire sample volume is in this particular state, and it remains essentially unchanged upon cooling from 10 K

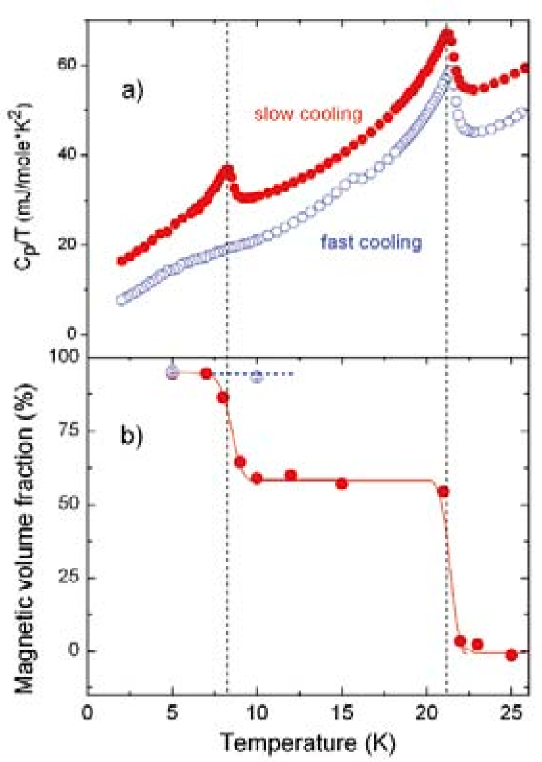

Figure 2: **a) Specific heat data showing the presence of the magnetic phase with T_N = 8 K in the 'slowly cooled' state, and its absence in the 'fast cooled' state. (b) Magnetic volume fraction determined by µSR showing two successive ordering transitions when the sample was slowly cooled through 200 K.**

to 5 K. When the very same crystal is 'slowly cooled', two distinct magnetic phases are sensed by the muons. The first one develops at 22 K, involves approximately 65 % of the sample volume and the details of the frequency distribution are slightly different from the 'fast cooled' 22 K phase. The comparison with previous detailed µSR studies on 'fast cooled' samples implies a Na content of x = 0.75 to 0.8 for this phase [13]. Below 8 K, magnetic order develops in the remainder of the sample volume causing a prominent change of the frequency distribution. The data suggest that two distinct magnetically ordered phases with slightly different Na content coexist at 5 K in the 'slowly cooled' state. Since the magnetic inter-plane coupling J_c is determined by superexchange processes involving Na orbitals [14], minute and subtle changes in the Na arrangement can have a dramatic effect on the magnetic properties.

In order to examine structural properties, we performed neutron diffraction experiments on the High-resolution powder diffractometer for thermal neutrons (HRPT). We did not observe any significant anomaly in the temperature dependence of the lattice parameters. However, the increase of micro-strain

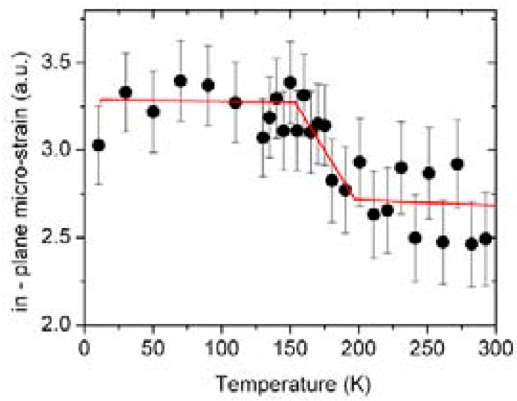

Figure 3: **Temperature dependence of the in-plane micro strain in $Na_{0.8}CoO_2$ as determined by high resolution neutron diffraction experiments. The increase below 200 K can be related to the sodium ordering.**

(dispersion of the lattice parameters) within the hexagonal plane below 200 K can be related to the sodium ordering, which can for example result in a new orthorhombic structure. Since the data are refined in a more symmetric space group this leads to a broadening of the diffraction peaks.

We have presented evidence for a new magnetic transition below 8 K in $Na_{0.8}CoO_2$ associated with the formation of two distinct magnetic phases of different Na content as implied by our µSR studies. An interesting question concerns the driving force of the phase separation: is it the Na dynamics in itself, or is the rearrangement driven by instabilities of the electrons in the adjacent CoO_2 layers?

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Novel vortex structure in superconductors

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Magnetically-induced superconductors hold the promise of truly novel applications for energy storage and transport. They may allow for superconductivity at higher temperatures than traditional superconductors that are mediated by lattice vibrations. We used $CeCoIn_5$ as a laboratory to study how magnetic fluctuations can pair electrons and give rise to superconductivity. Our small-angle neutron experiments revealed how high magnetic fields break up electron pairs in the vortex cores, leading to a novel type of vortex structure that is composed of both superconducting ring currents and magnetized states.

The first superconductor was discovered nearly a hundred years ago, and in most materials this resistance-free state arises from a phonon-mediated coupling of electrons. The electronic state of a superconducting phase consists of a single macroscopic quantum state, and so there is no resistance to transport electrons. This is similar to the Bose condensation in cold atomic gases or quantum fluids such as He^4. Most applications based on superconducting materials require superconductivity at relatively high temperatures. The present understanding of conventional, phonon mediated superconductors suggests that they cannot yield superconductivity at sufficiently high temperatures. However, magnetic fluctuations with energies much higher than those of phonons could instead provide the glue for Cooper pairs, possibly leading to superconductivity at higher temperatures.

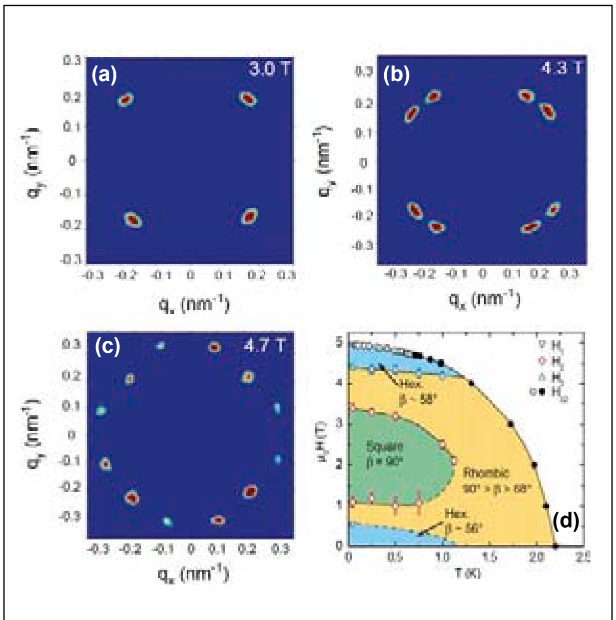

Figure 1: **(a-c) Superconducting vortices as a function of field, measured using SANS-I at PSI and an 11-Tesla horizontal field dilution cryo-magnet. (d) Field-temperature phase diagram of the vortex lattice.**

Magnetically-induced superconductivity

$CeCoIn_5$ is one of the simplest model systems of a clean magnetically induced singlet superconductor [1]. It features strong antiferromagnetic spin fluctuations that are believed to mediate superconductivity [2]. The energy of the magnetic fluctuations is relatively low, so the materials properties can be substantially tuned by magnetic fields and pressure. This means the study of the interplay between superconductivity and magnetism can be carried out in a controlled fashion.

Close to the quantum critical point

Important insights into the pairing mechanism can be obtained by studying the electron pairing process at the onset of superconductivity. We cooled the material to very low temperatures and we used magnetic fields to see how the magnetic properties change as the material crosses a phase transition from the superconducting to the insulating phase.

Uniform magnetic fields compete with superconductivity, so superconducting materials generally attempt to shield magnetic fields from their interior. If that is not entirely possible, as is the case for so-called type-II superconductors, magnetic fields enter materials in form of quantized magnetic fluxes that consist of long twister-like electromagnetic super-currents. These are called vortices and form a regular two-dimensional lattice whose symmetry depends on the details of the electronic Fermi surface. With increasing magnetic fields, the vortices move closer together until superconductivity is destroyed. A phenomenological theory for which Abrikosov and Ginzburg (AG) [3] received the Nobel Prize in 2003 accurately describes vortex lattices in all known type-II superconductors. Their theory is surprisingly simple and is based on only two parameters: the coherence length of the superconducting condensate and the field penetration depth.

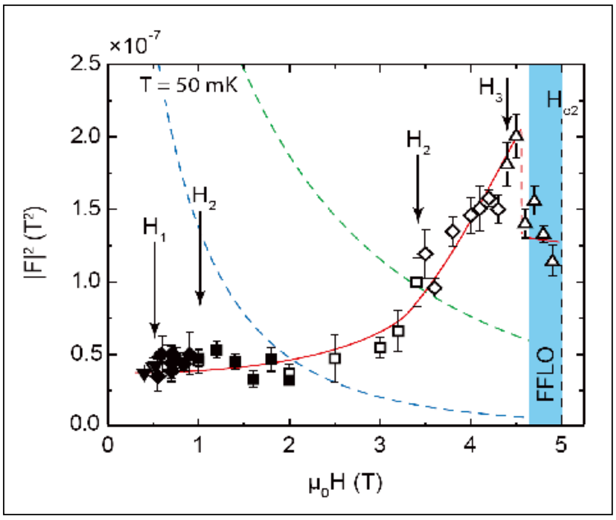

Figure 2: **Structure factor squared of the vortices in $CeCoIn_5$, demonstrating a complete departure from the AG paradigm indicated by the dashed lines.**

Departure from AG paradigm

In our experiment, we cooled a single-crystal sample of $CeCoIn_5$ down to T=50mK and applied magnetic fields along the crystallographic c-axis [4]. We observed a succession of vortex phase transitions, as shown in Figure 1, that we believe is driven, in low fields, by the symmetry of the Fermi surface and, in high fields, by the inner vortex structure. The most surprising observation was, however, that the scattering intensity of the vortex lattice increases with the field (Fig. 2), although the scattering contrast of superconducting vortices generally decreases as they move closer together with an increasing field. This stunning observation represents a complete departure from the AG paradigm, and it demonstrates that the vortex structure cannot only consist of super-currents as in all previously studied superconductors.

Novel vortex structure

To understand the field dependence of the vortex structure, it is important that $CeCoIn_5$ be a Pauli-limited superconductor. This means that superconductivity is destroyed because magnetic fields directly break up Cooper pairs and not because of super-currents [5]. As a result, the breaking of the Cooper pair singlet inside high fields must be significant, creating magnetized states in the vortice interior, as was also recently observed for the borocarbide superconductor $TmNi_2B_2C$, which has localized magnetic moments [6]. The combination of super-currents and magnetized states in $CeCoIn_5$ leads to a completely novel vortex structure that cannot be described by the AG model. Our results constitute the first experimental evidence for a novel vortex structure in a superconductor without localized magnetic moments and demonstrate that the AG model of superconducting vortices has to be extended to include the coupling of the magnetic field to the Cooper pair.

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MEG experiment – commissioning & engineering run

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One of the significant endeavours in particle physics today is the search for "new physics". The MEG experiment plans to seek such signatures in a complementary way to existing and planned TeV-scale experiments at the world's high-energy laboratories. Proof of such a signal at low-energies would be the decay of a muon into a positron and photon – the search for this decay being the goal of MEG. Using both state-of-the-art detector technology and the highest intensity surface-muon beam, commissioning of the MEG experiment was completed in late 2007 with an "engineering run"

The fascination for observing the lepton-flavour violating decay $\mu^+ \rightarrow e^+\gamma$ has existed for some 60 years now since the pioneering search using cosmic rays by Hincks and Pontecorvo [1]. Modern-day advances in theory, notably Supersymmetry (SUSY) and Grand Unification (SUSY-GUT), predict that this observation could become reality [2], due to the coupling of state-of-the-art detector technology and experimental techniques. An improvement equivalent to two orders of magnitude over the most sensitive search to date, the MEGA Collaboration $B_R(\mu^+ \rightarrow e^+\gamma) \leq 1.2 \cdot 10^{-11}$ in 1999 [3], is the goal of the MEG experiment.

Figure 1: **MEG Cockcroft-Walton accelerator post installation with a relieved team in the foreground**

Commissioning

2007 saw intense activity by the collaboration, with many aspects being undertaken in parallel. One early highlight was the completion and commissioning of the MEG Cockcroft-Walton (C-W) facility housing a 1MeV proton machine (c.f. Figure 1). The signing of the acceptance protocol in June marked the end of a series of successful tests, both at the manufacturer HVEE's facilites in Amersfoort in the Netherlands [4] and at PSI. The C-W accelerator allows essential energy and inter-timing calibrations to be performed on both the photon and positron arms of the spectrometer, by using the $^{7}Li(p,\gamma)^{8}Be$ resonant reaction at 440 keV to produce a 17.6 MeV γ-line for energy calibrations and the proton resonant reaction $^{11}B(p,\gamma)^{12}C$ at 163 keV to produce two coincident gamma-rays at 4.4 and 11.7 MeV, allowing timing measurements [5]. It is also used for monitoring purposes, e.g. the liquid Xenon purity in the calorimeter, by measuring its transparency to scintillation light. The C-W proton beamline with its remotely controllable target insertion system and beam diagnostics equipment was tested by injecting and beam tuning up to the centre of the COBRA magnet. This was completed before the upstream muon beamline had to be removed and a shielding wall built to accommodate the Lamb-shift Experiment in the front part of the πE5 area from July to September. During this period the remaining parts of the detector were assembled; the Positron Tracking System, consisting of 16 low-mass, double-layered planar drift chambers placed radially to the target and shown in Figure 2 (Left) and the Timing Counters, a set of scintillation counters with orthogonally placed scintillating fibre bundles located axially on either side of the drift chambers. The counters provide the precise timing of the positron with a 100 ps resolution (FWHM), while the

Figures 2 (Left): **– COBRA central He-volume, with the Drift Chamber Assembly including the mounted target. The beam entrance window can be seen at the far end** (Centre): **– Timing Counter assembly with scintillating fibres and APD readout exposed** (Right): **– Liquid Xenon (LXe) Calorimeter installed in the πE5 area**

fibres are used in the first-level trigger to determine the positron direction with respect to the gamma ray, c.f. Figure 2 (Centre).

Another highlight of the year was the long awaited LXe cryostat vessel, which had been delayed due to problems in construction of the thin honeycomb window. After pressure and leak tests, more than 840 photomultipliers were mounted inside the inner pressure vessel, contained in a mobile clean room, before closure and transport to the πE5 area. Figure 2 (Right) shows the calorimeter on the detector platform after liquefaction of the Xenon gas at 170 Kelvin, yielding some 900 litres of liquid Xenon inside the vessel. Thanks to this innovative technology the cryo-fluid could be purified in a liquid state at a circulation rate of ~ 70 l/hr. [6], reaching constant transparency (absorption length $\lambda > 3$m) in about 250 hrs.

Engineering run

The available beam time after re-installation of the muon beamline, closing of the COBRA end-caps and the cooling-down of the BTS solenoid was three months. The engineering run was organized in three distinct phases, with the aim of having all parts of the detector operational, the read-out/data-taking chain tested and – in a final stage – to implement the various triggers and check the rates as well as recording calibration and test data. The initial phase involved beam tuning, de-bugging and cosmic-ray calibrations, followed by low intensity Michel trigger data. Phase two concentrated on trigger tuning of the radiative muon decay and finally the $\mu \to e\gamma$ trigger, with an increased stopping-rate of about $3 \cdot 10^7 \mu^+/s$. The corresponding $\mu \to e\gamma$ trigger rate of ~ 4 Hz was found to be close to expectations. During both phases LED, alpha, and C-W calibration and monitoring data were recorded regularly. The final phase was allocated to the study of the calorimeter,

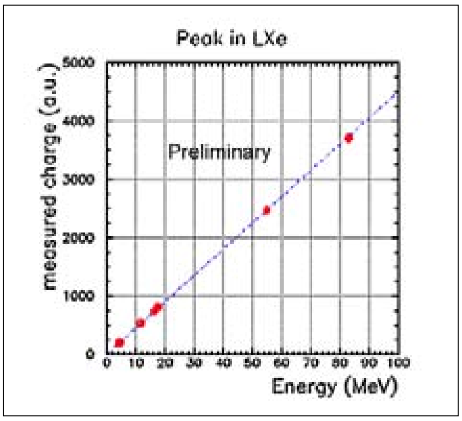

Figure 3: **Calorimeter response to different γ- lines, e.g. C-W Li & B targets: with Li at 14.6, 17.6 MeV & B at 4.4, 11.7 & 16.1 MeV as well as CEX photons at 55, 83 MeV**

using high-energy photons from pion charge-exchange (CEX) and radiative capture (RPC) reactions, $\pi^- p \to \pi^0 n$ with $\pi^0 \to \gamma\gamma$ and $\pi^- p \to \gamma n$. With a suitable selection from a NaI detector, mono-energetic photons of 55, 83 and 129 MeV could be obtained.

A total of 29 TBytes of data were accumulated during the whole period, with a mean peak rate of 1 TByte/day. Using data compression for storage, the required space was halved. Preliminary results from the various calibration sources show that the calorimeter gives a linear response to a photon energy deposition between 4–83 MeV (c.f. Figure 3). Analysis of the data is still in progress.

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Final construction of the Pixel Barrel Tracking Detector for the CMS Experiment at CERN

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The Pixel Barrel Detector for the Compact Muon Solenoid (CMS) experiment has reached the final construction and assembly phase. In Spring 2008 it will be the last detector component to be installed in the CMS Experiment at CERN before the Large Hadron Collider (LHC) accelerator begins operations at an unprecedented proton – proton collision energy of 14 TeV. The experimental search for the Higgs boson and super symmetric particles will be a major task for which the pixel device will play a vital role in detecting picosecond long-lived particles that are crucial in the search for new fundamental laws of physics.

A pixel detector for the CMS Experiment

The Compact Muon Solenoid (CMS) experiment is one of two large general-purpose particle physics detectors being built on the proton-proton Large Hadron Collider (LHC) at CERN. Its purpose is to detect, record and reconstruct unknown particle physics reactions that are expected to take place in collisions at energies of 14 TeV. The most prominent is the creation of the Higgs boson that is of crucial theoretical importance in the Standard Model of elementary particles, a relativistic quantum field theory describing the electromagnetic and nuclear forces acting on all known elementary particles and on all atoms as well. In the coming years the LHC experiments will have a unique opportunity to observe the Higgs mechanism for the first time. The CMS experiment is designed as a series of sub-detectors that are nested in an onion-like structure with a so-called pixel tracking detector as the innermost part. The barrel part of this detector was developed at PSI and entered its final construction phase in 2007. It is roughly 56 cm long, weighs about 5.5 kg and has a total of 48 million microscopically arranged silicon sensor and electronic readout channels. This microscopic detector technology is quite a contrast to the large scale of the CMS experiment with an overall volume of 3700 m^3 and a total weight of 12’800 tons.

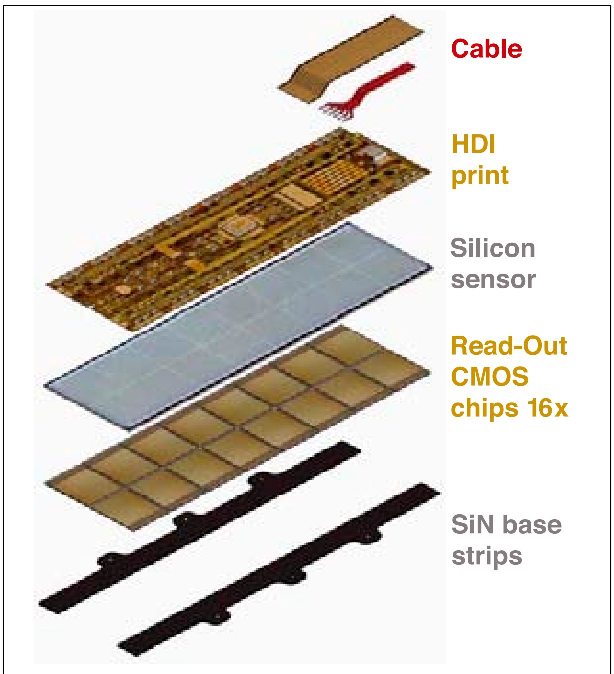

Figure 1: **Exploded view of a barrel pixel module. The silicon sensor has an approximate length of 65 mm and is 16 mm wide.**

Pixel Module Fabrication

The barrel pixel detector is built in form of three concentric cylindrical shells with radii 4 cm, 7 cm and 11 cm. Each layer is tiled together with pixel modules as shown. For the complete construction of the three barrel layers a total of 768 modules were built and thoroughly tested. This implied thermal cycling from room temperature to the final operating temperature of –10 degrees Celsius as well as a calibration with x-ray sources for signal pulse height measurements. This will be important

Figure 2: **A pixel module is mounted onto the carbon fibre mechanics with integrated cooling by use of tiny swiss watch screws.**

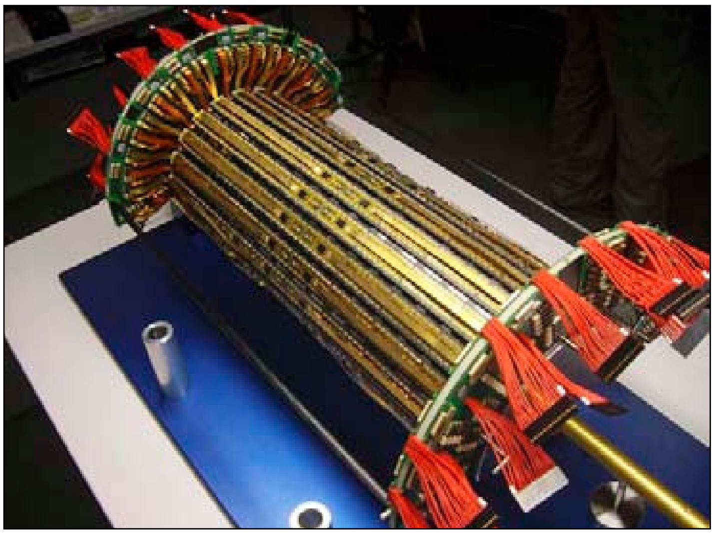

Figure 3: **View of one of the two completed half barrel pixel detectors.**

for a precise interpolation of measured particle track coordinates that should be measured at the 15 μm level. A crucial step in the fabrication of the pixel modules is the micro-bump bonding of the pixel segmented silicon sensor to each of the 16 pixel Read-Out Chips (ROC). These electronic chips were assembled using 250 nm CMOS technology and can be exposed to irradiations at the 400 KGy level without significant degradation. Each pixel ROC – 8 mm by 9.8 mm – can read out 4,160 pixels and contains about 1.3 million transistors. For the three-layer barrel this results in about 15 Giga transistors that need to work flawlessly for data collection that is expected to start in 2008. The micro-bump-bonding connection of the pixel sensor elements to the corresponding pixel signal amplifiers in the ROCs is done with small Indium balls of 16 μm diameter. They were fabricated following special processing steps at the wafer level in the Laboratory for Micro- and Nanotechnology The actual merging between sensor and ROCs is carried out by a very precise chip placement machine developed at PSI and that has since been transferred to industry for commercialisation.

Detector assembly

The challenging task of assembling the pixel modules in complete detector shells proceeded rather smoothly and is now complete. The pixel modules are fixed onto the carbon fibre structure with tiny screws from the Swiss watch industry. After thorough testing at PSI the pixel detector will be shipped in spring 2008 directly to the CMS experiment near Cessy in France. According to the CMS installation plan it will be the last sub-detector to be inserted before the experiment is sealed and the LHC starts operations.

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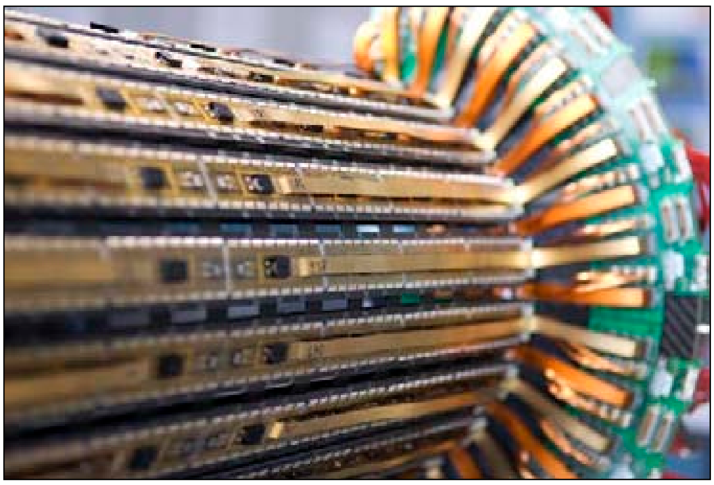

Figure 4: **Details of the mounted pixel modules with the high density cabling.**

^{60}Fe at PSI and in stars – a nuclear connection

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A target containing $1.2 \cdot 10^{16}$ atoms of ^{60}Fe was prepared by radiochemical separation from a copper beam dump used at the 590-MeV ring cyclotron at PSI. The target was deployed at FZ Karlsruhe to study the nuclear reaction $^{60}Fe(n,\gamma)^{61}Fe$, a key element in understanding the composition of the Early Solar System.

Introduction

The isotope ^{60}Fe, with a half-life of $1.5 \cdot 10^6$ years, plays a key role in tracing the history of the Early Solar System (ESS). Current attempts to reconstruct the inventory of short-lived radioactivity between Fe and Pb that were present in the ESS [1,2] show that ^{60}Fe (together with ^{107}Pd, ^{41}Ca, ^{36}Cl, ^{26}Al, and ^{10}Be) must be considered a late addition to the protosolar nebula. Whether this material stems from a supernova or a nearby asymptotic giant branch (AGB) star is still an open question.

Neutron capture cross sections are required for calculating the s-process production of ^{60}Fe. The stellar (n, γ) rates for the unstable isotopes, ^{59}Fe and ^{60}Fe, which govern stellar production and destruction of ^{60}Fe, are currently obtained by theoretical calculations using the Hauser-Feshbach statistical model, with typical uncertainties of 30 to 50% for the resonance dominated cross sections in the mass region around Fe [3]. But the results from calculations of the ^{60}Fe cross section with the statistical model codes NON-SMOKER [4] and MOST [5] differ by a factor of three. Because the s-process abundances are directly determined by the respective stellar (n, γ) rates, the present cross section uncertainties translate into uncertainties in the calculated ^{60}Fe yields of more than a factor of two, clearly obscuring the abundance predictions of the stellar models.

Experimental solutions to this problem are therefore urgently needed. The precondition for such an experiment is the availability of a sufficient amount of ^{60}Fe as sample material. One of the very few possibilities for obtaining such rare isotopes is the exploitation of accelerator waste from PSI facilities.

Target preparation

For the separation of the ^{60}Fe sample, copper chips drilled out from a beam dump irradiated with high-energy protons were used. Besides the desired iron isotope, the sample contained also about 150 MBq ^{60}Co and 2 MBq ^{44}Ti as the main contaminants, which would have impeded the envisaged neutron activation of ^{60}Fe leading to ^{61}Fe. Therefore, these impurities had to be carefully reduced to a near zero level prior to measurement. In addition to the isotope under investigation, the sample contained a comparable amount of ^{55}Fe, which is co-produced along with ^{60}Fe, as well as traces of stable iron isotopes, originating partly from nuclear reactions and partly from the drilling process.

Liquid-liquid extraction, precipitation and ion exchange were used to separate the impurities with a decontamination factor of $\sim 3 \cdot 10^8$ for ^{60}Co and $\sim 5 \cdot 10^6$ for ^{44}Ti.

The content of ^{60}Fe was determined by measuring the activity of the daughter nuclide ^{60}Co, which increased from 2.8 Bq on January 25, 2007 to 19.5 Bq on October 2, 2007.

For a small time difference $t \ll t_{1/2}$ (^{60}Co), the number N of ^{60}Fe atoms can be calculated by

$$N_{^{60}Fe} = \frac{\delta A_{^{60}Co}}{\lambda_{^{60}Fe} \cdot \lambda_{^{60}Co} \cdot t} \quad \text{with } \delta A_{^{60}Co} = 16.7 \text{ Bq}$$

where $\lambda_{^{60}Fe}$ and $\lambda_{^{60}Co}$ are the decay constants of ^{60}Fe and ^{60}Co, respectively. Taking the chemical yield into account, we obtained a total content of $1.18 \cdot 10^{16}$ atoms ^{60}Fe in diluted HCl solution. This solution was dried by evaporation on a graphite backing 6 mm in diameter, which served as a target for the neutron capture experiment.

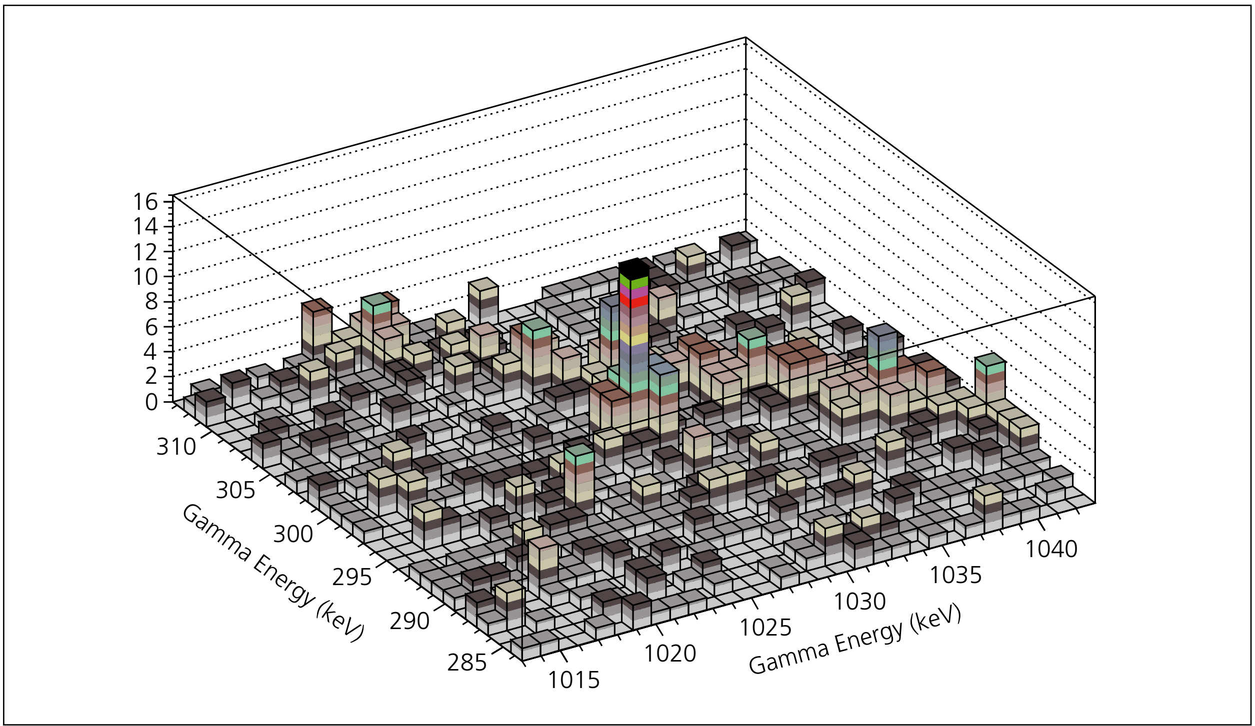

Figure 1: **γ-ray spectrum of coincident events from the activated ^{60}Fe sample. Events following cascades from the decay of ^{61}Fe consisting of the 298 and 1027 keV transitions are concentrated in the center, clearly separated from the overall background and from Compton-scattered events of the 1332 keV line from ^{60}Co, which appear as the diagonal band in the upper part.**

Experiment

The measurement was carried out using the Van-de-Graaff accelerator at FZ Karlsruhe via the neutron activation technique in a quasi-stellar spectrum, which offers the highest flux presently available, orders of magnitude higher than can be achieved by TOF methods.

During neutron activation, the sample was sandwiched between two sheets of gold foil. The induced gold activity served for the determination of the neutron flux. The sample sandwich was placed in front of the neutron production target, a metallic Li layer 6 mm in diameter evaporated onto a water-cooled 1.5 mm thick copper backing. The proton energy of E_p = 1912 keV was chosen to provide a maximum neutron energy of E_n = 106 keV. Under these conditions it was found that the neutron spectrum represents an almost perfect thermal distribution corresponding to kT = 25 keV, which matches exactly with the stellar s-process temperature.

Because of the short half-life of ^{61}Fe (6.1 minutes) and the small amount of ^{60}Fe in our sample, activation had to be repeated 70 times in order to accumulate significant statistics.

In view of the very low activity achieved during irradiation, the γ-measurements were performed with two high efficiency Ge-Clover detectors. The detectors were arranged face-to-face only 3 mm apart. The sample was exactly centered in the gap by means of a special holder. In order to significantly reduce background, it was necessary to consider only events, where 2 γ-rays out of the same ^{61}Fe-cascade could be detected in coincidence. Figure 1 shows the result of such an analysis, where the events from ^{61}Fe decays are clearly visible above the very low background.

Results

The analysis is not yet complete, but we expect a final uncertainty of about 10%. Given the very small sample and the very small neutron capture cross section, this result reflects the remarkable sensitivity that was reached in the experiment.

The final cross section will be sufficiently accurate for a quantitative discussion of the origin of ^{60}Fe that is needed to understand the pre-history of the ESS, be it connected with the outflows of a nearby Supernova or of a Red Giant.

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Advances in diffractive optics for X-ray microscopy

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The resolution of X-ray microscopy is limited by the smallest line width of the diffractive X-ray lenses used. To overcome the limitations of electron-beam nano-lithography, we have applied a novel method to double the density of structures in Fresnel zone plate lenses. This enables us to resolve 15 nm lines and spaces in the scanning transmission X-ray microscope POLLUX at the Swiss Light Source. A variety of scientific fields such as biology or materials sciences will benefit from this development, especially when combined with advanced coherent scattering techniques.

There is an intimate relation between the spatial resolution of a Fresnel zone plate (FZP) type microscope and the outermost zone width of the zone plate, the two of them being essentially comparable. This is the reason why X-ray microscopy is so dependent on nanofabrication technologies. However, electron-beam lithography, which is the technique to generate practically all FZPs worldwide, has an intrinsic limitation. While state-of-the-art electron-beam lithography tools are capable of writing with nanometer spot sizes and position accuracies, the range of secondary electrons created in the resist layer determine structure sizes. The exposed pattern is thus blurred, with particularly detrimental consequences when creating dense patterns of lines such as gratings or FZPs.

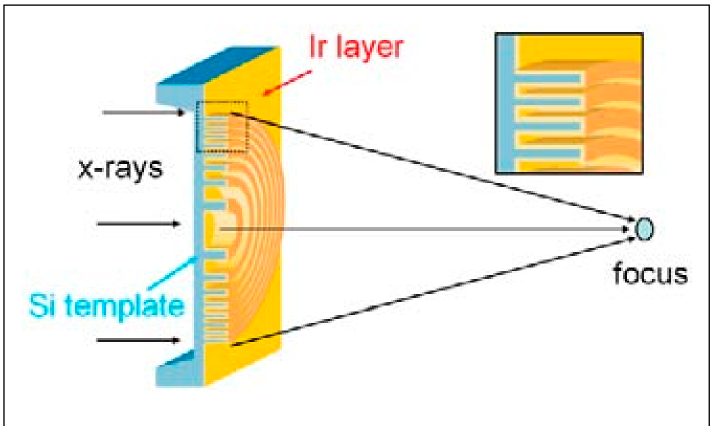

Figure 1: **Zone doubling technique to obtain ultra-high resolution X-ray lenses. A silicon template is covered with a thin layer of iridium by atomic layer deposition. The cross section through the structure reveals the 20 nm wide Ir zone plate structures.**

A zone doubling technique to reach world-record resolution

We have developed a powerful yet simple nanofabrication method, which overcomes the difficulty of high feature-density patterning [1]. It is based on a deposition of a thin layer of a material with a high X-ray-refractive index onto the sidewalls of a template structure made of a low-index material. This leads to a doubling of the effective line density of the deposited material compared to that of the template (see Figure 1). The cross section of the resulting structures reveals the uniform deposition of iridium onto the sidewalls of the silicon template structures.

The zone plates were tested at the POLLUX scanning transmission X-ray microscope (STXM). For our tests, we selected structures with periods down to 30 nm (i.e. 15 nm lines and spaces), prepared in a similar way as the zone plates. Figure 2 shows clearly resolved STXM images, representing the best resolution value achieved to date in scanning X-ray microscopy.

Nanoscale coherent X-ray phase contrast microscopy

Apart from their use as focusing optics for conventional scanning transmission X-ray microscopy applications, Fresnel Zone Plate optics can also be combined with more advanced coherent X-ray imaging methods. For example, when a coherently focused X-ray beam is used in a setup with a two-dimension-

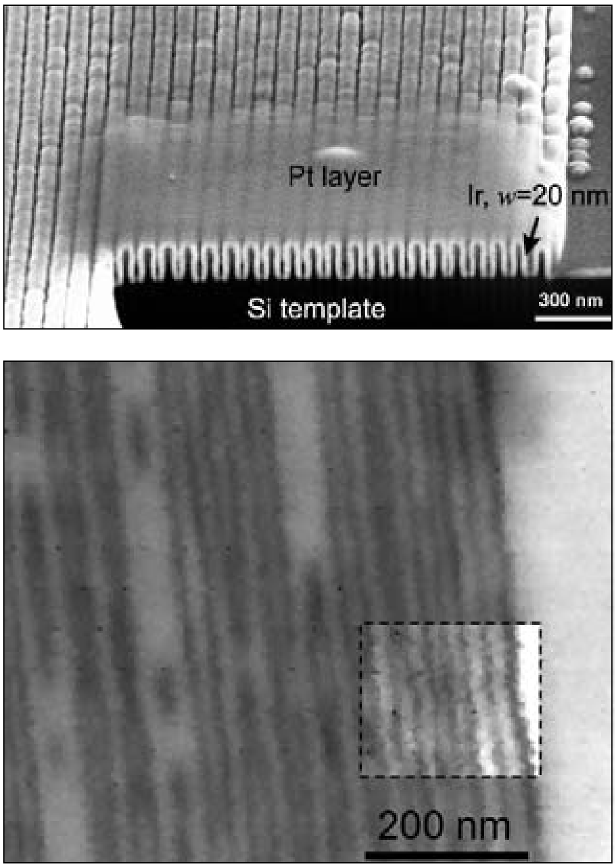

Figure 2: **Scanning X-ray microscope image of a test object consisting of lines and spaces down to 15 nm in width. Photon energy: 1 keV.**

al area detector, coherent X-ray diffraction patterns can be recorded at each point of the image while the specimen is scanned across the focus spot.

We have tested this novel approach using the fast-framing, noiseless two-dimensional pixelated PILATUS 2M detector that is installed at the coherent X-ray Scattering Beamline (cSAXS) at the SLS. Figure 3 shows an example of one of the first results obtained with hard X-rays (6.8 keV) for a biological specimen, an osmium-stained human pancreas cell. Ten thousand coherent diffraction patterns, recorded in 100 seconds, were used to process out a differential X-ray phase contrast image of the cell (right panel) – for further details see reference [2]. The clarity of some of the smaller details in the cell structure is striking, particularly if compared to the conventional scanning transmission image (left panel), which was recorded using the same exposure times.

Since these first tests in the harder X-ray regime where carried out with a relatively coarse and conventional Fresnel Zone Plate producing a focus spot hardly smaller than 300 nm, we expect a significant increase in resolution when zone-doubled FZPs, as described above, become also available in the multi-keV X-ray range. These future improvements in the hard X-ray range should ultimately allow us to achieve nanometer-resolved, three-dimensional images of cells or cellular subcomponents.

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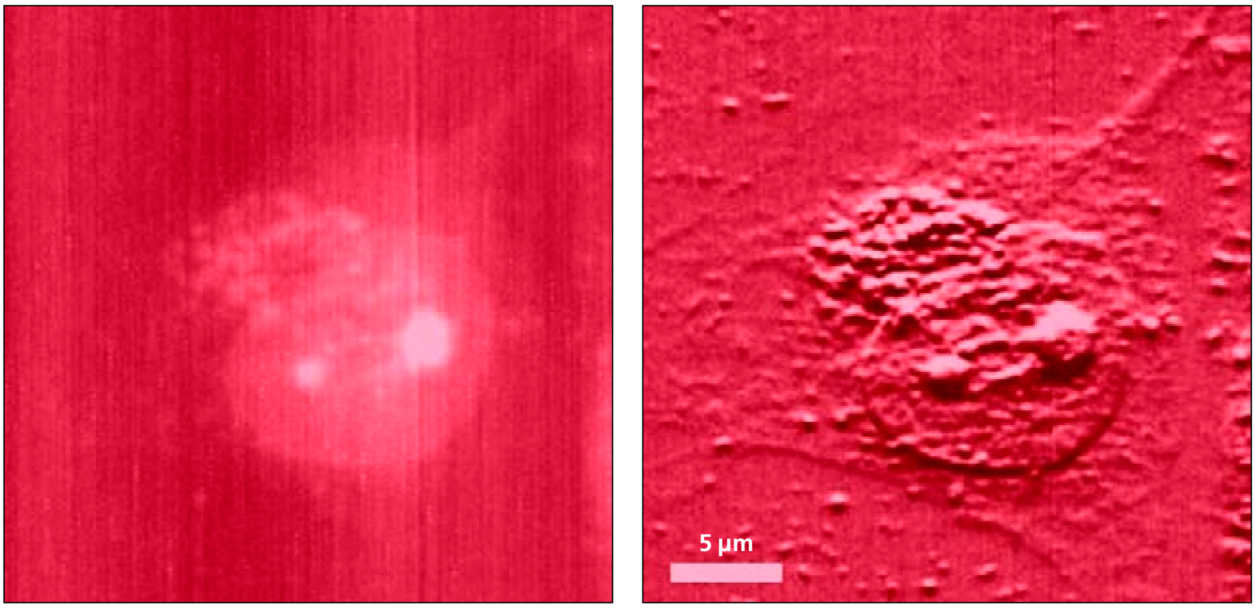

Figure 3: **Hard X-ray scanning transmission X-ray microscope images of a human pancreas cell. Left: transmission image. Right: differential phase contrast image obtained from a set of ten thousand coherent diffraction images recorded with the PILATUS 2M.**

Metallic nanowire arrays for electronics and sensors

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Wires interconnect our world. We transmit energy and information over great distances via vast networks of metal wires. In semiconductor chips microscopic wires carry out the same functions at a much smaller scale. There is intense research to scale down wire dimensions even further in future devices. The "nanowires" in these devices will enable not only higher densities but they will take on additional roles as well. Extreme ultraviolet interference lithography (EUV-IL) developed at PSI is uniquely capable of producing the required arrays for research on these systems. Novel pattern transfer methods have been developed to produce metal nanowires that are tested for their mechanical, electronic and optical properties.

A nanowire is an extremely thin wire with a diameter of only a few nanometers and with length orders of magnitude more than its diameter. At this scale physical properties of nanowires are expected to deviate significantly from bulk metal, due to confinement and surface effects. For example the conductivity of the wires changes considerably, due to the drastic increase of the surface-to-volume ratio, which can be exploited for sensing. Mechanical properties such as the yield strength are an important parameter that need to be characterized for applications like flexible circuits. In order to study nanowire properties, they must be arranged on a surface in a controlled fashion.

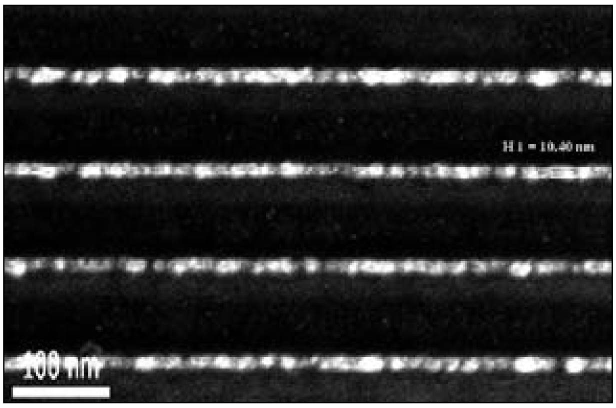

Figure 1: **SEM image of 10 nm wide Au lines obtained with EUV-IL and novel lift-off processes.**

Fabrication of nanowires

The goal of our manufacturing effort is to produce nanowire arrays with periods of less than 100 nm over areas of several square millimeters. It is important to be able to produce a substantial number of samples for experimental purposes. The EUV-IL method is a suitable technique with a demonstrated resolution of 12.5 nm in terms of the half-pitch of the periodic structures [1]. Fabrication with this method starts by coating the substrate with a radiation sensitive film (photoresist), which is exposed to an EUV intereference field at the XIL beamline of the SLS. The photoresist is then developed to produce an array of parallel lines. To produce metal nanowires, this pattern has to be transferred into a metal film.

For the first fabrication approach we developed a number of modified lift-off processes such as the use of two photoresists in a dual-layer stack and shadow evaporation of metal layers to modify the width and the profile of photoresist lines [2]. Dense 10 nm wide and 10 nm thick gold nanowires obtained with these processes are shown in Figure 1. At this scale, the metal's grain structure and growth properties during deposition become critical, causing roughness and ultimately continuity problems. Control of parameters such as substrate surface chemistry, deposition rate, pressure, temperature and the metal (or alloy) type are important in obtaining high-quality nanowires.

Using another approach. we produced nanowires via guided self-assembly of Au colloids. A chemical pattern of PLL-g-PEG/biotin was prepared on a Nb_2O_5-coated substrate following EUV-IL exposure of a sacrificial photoresist film. Single-strand DNA was then attached to the biotin molecules that were arranged on 100-nm period lines. 20-nm diameter Au colloids

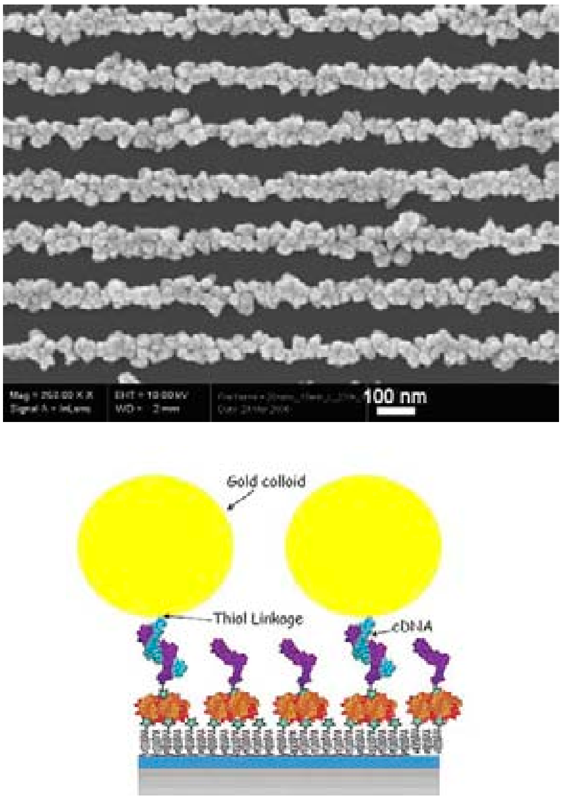

Figure 2: **Gold colloid nanowires were formed on a Nb_2O_5 substrate: DNA-tagged gold particles were linked to the PLL-g-PEG/PEG biotin surface by neutravidin/biotin linkage.**

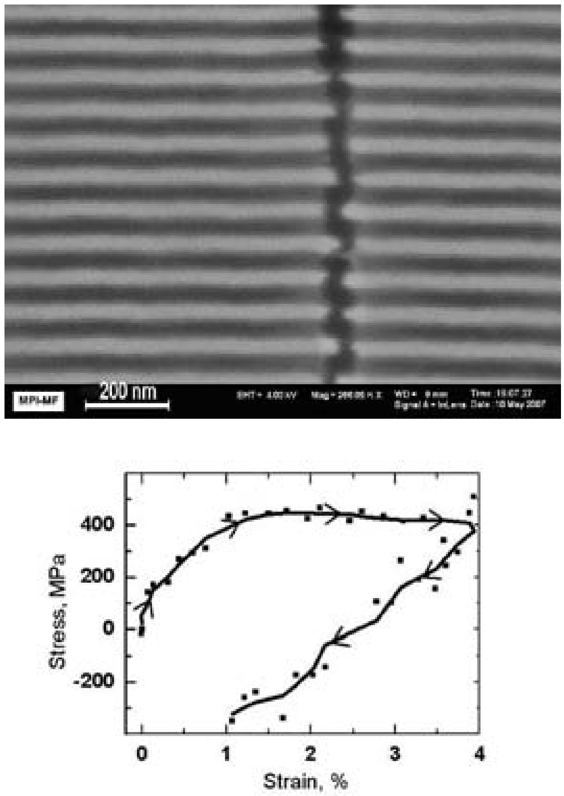

Figure 3: **a) SEM image of Au nanowires on polyimide substrate. First cracks perpendicular to the loading direction appear at a strain of 2.4%, b) Stress/strain curve of Au nanowires with 20 nm height and 50 nm width in loading direction. The arrows show the strain change direction. The yield stress averages approximately 400 MPa which is one order of magnitude higher compared to the yield stress of bulk gold and the same as in a corresponding thin film.**

tagged with the complementary DNA strand were then selectively attached to the surface (Figure 2). The SEM image in Figure 2 demonstrates the selectivity of this chemical recognition process, i.e Au colloids were only found along the molecularly patterned lines. The lines can be used as a sensitive biosensor for label-free electrical and/or optical detection based on surface plasmons [3].

Strength of nanowires

Novel devices, such as flexible displays and solar cells, usually consist of a thick compliant substrate (polymer, flexible glass) and several layers of patterned lines and thin films that are ductile or brittle. During normal use the patterned layers on such substrates are expected to withstand significant mechanical loads due to the bending of the substrate, for example in electronic paper. We have made arrays of Au nanowires using EUV-IL exposures and a dual-layer lift-off process on polyimide substrates to test the mechanical limits of a model system subjected to a tensile load. The samples were tensile tested at the MS beamline of SLS using an *in situ* X-ray diffraction (XRD) technique. The nanowires were strain-pulled along the direction of their length while XRD data were acquired to determine the stress in the metal. When the strain is low, they stretch and prolong. With more strain they start to deform and crack (Figure 3a). The strain-stress curve in Figure 3b shows how the nanowires stress the more they are strained. This unique experiment showed that nanowires can be strained ten times the critical strain of bulk gold before actual deformation [4].

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Biological membranes on nanostructured chips

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Life – from a chemical point of view – is the separation of aqueous micro-chambers by lipid bilayers to enable complex concerted (bio)chemical reactions. Proteins integrated in biological membranes act as selective ion transporters, while others regulate metabolic reactions or communicate with the outside world. In life sciences, elucidating the structure and predicting the function of membrane proteins using synchrotron facilities is given high priority. At the same time, we are attempting to establish assay systems allowing us to measure the function of reconstituted membrane proteins at predefined conditions.

In the past there have been many attempts to generate stable and functional lipid bilayers allowing us to investigate the function of membrane proteins. Major limitations are the poor stability of the fragile bilayers and the difficulty of accessing both sides if the bilayers are immobilized on a solid surface. Recently it was suggested [1] (Fig. 1) and also demonstrated [2] that lipid bilayer stability can be enhanced if they are suspended in nanopores.

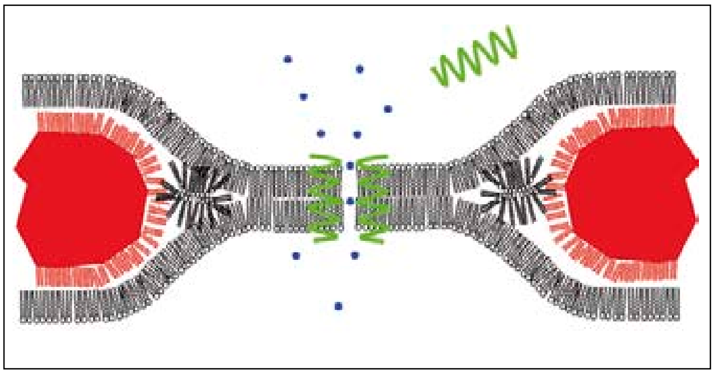

Figure 1: **Side view of a nanopore in the silicon nitride membrane (red) used as a support for stable and functional lipid bilayers, self-assembled from lipid molecules (black). Insertion of peptide and protein (green) can result in pore formation and allows diffusion of ions (blue) across the bilayers.**

Based on a previous TopNano21 project in collaboration with an industrial partner, 300 nm thick silicon nitride membranes with regularly arranged nanopores were produced (Fig. 2). We created bilayer membranes on these nanoporous supports and measured their stability over time using electrochemical impedance spectroscopy. This method is very sensitive and allows to determine the sealing (membrane resistance) and the quality of the lipid bilayers (membrane capacitance). We found that the specific capacitance of bilayers, produced with various compositions and by different methods, is slightly higher than reported by other groups [3].

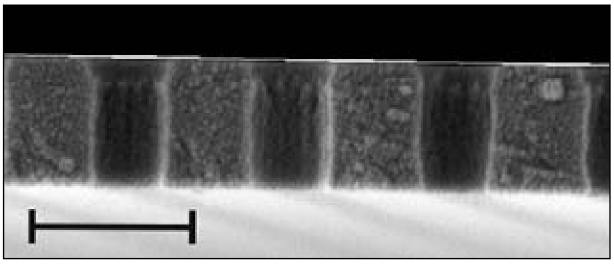

Figure 2: **Silicon nitride nanopore membrane as support for lipid bilayers (white line), shown in detail in Fig.1. Side view, scale bar is 400 nm.**

Stability has been defined as membrane resistance with a very high threshold of 1 GΩ and 1 MΩ allowing for the comparison of the stability of bilayers consisting of various lipids. We found that bilayers composed of naturally occurring lipid soy phosphatidylcholine are stable for days in pores of 200 nm diameters, whereas they were stable for only a few hours in 800 nm pores (Fig.3). Furthermore, bilayer stability depends on the lipid used (Fig. 4). The unprecedented stability found allowed us to investigate the interaction of peptides and proteins with bilayer membranes consisting of the lipids needed to keep membrane proteins in a functional state.
The insertion of the ion transporter valinomycin was investigated first, which resulted in a change of bilayer resistance when transporting K^+ ions across the bilayer membrane

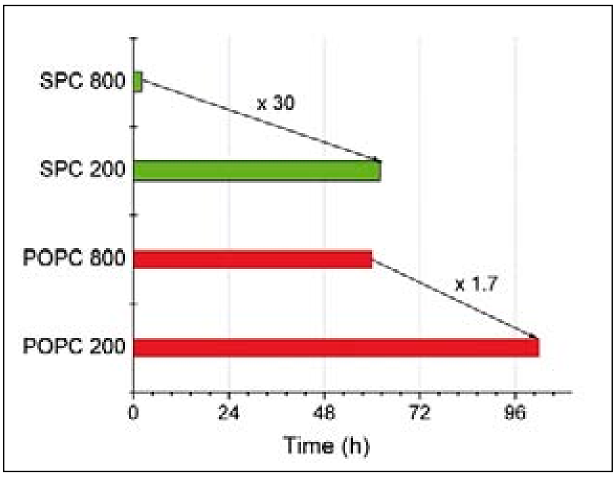

Figure 3: **Time of soy phosphatidylcholine (SPC) and palmitoyl-oleoyl-PC (POPC) bilayers in 200 nm and 800 nm pores evincing a membrane resistance >1GΩ.**

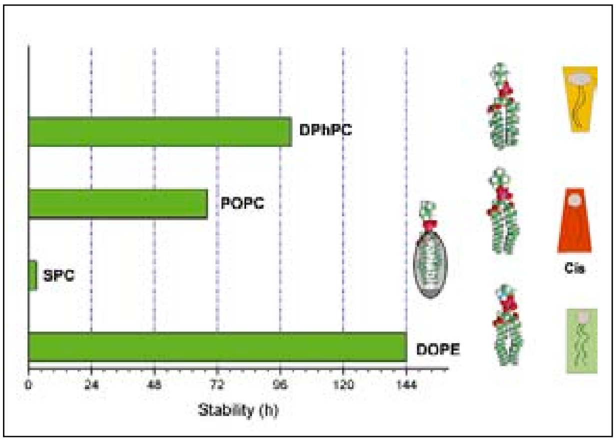

Figure 4: **Stability of bilayers of different compositions on 800 nm pores. The space filling models of the lipid molecules Di-phytanoyl- phosphatidycholine (DPhPC), POPC, SPC and Di-oleoyl-PC (DOPE) and their shapes (side view) are shown. Threshold was set to 1 MΩ.**

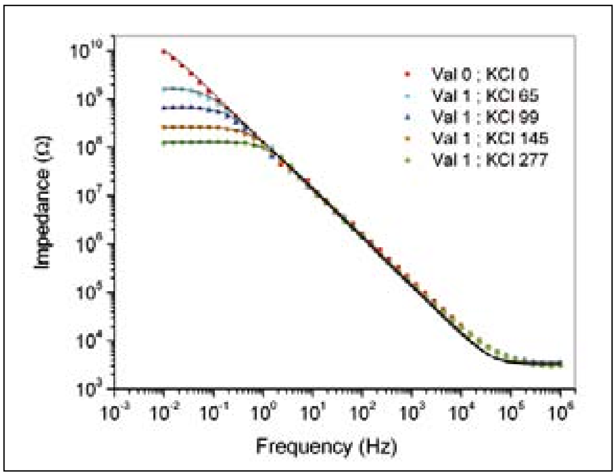

Figure 5: **K^+-transport across membranes by valinomycin (Val). Concentrations of Val and KCl in mM.**

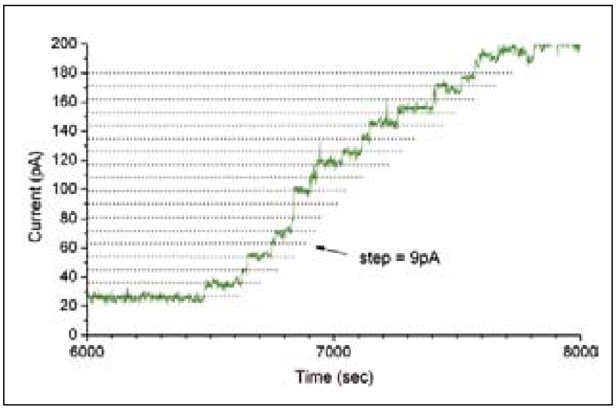

Figure 6: **Insertion of hemolysin molecules results in the formation of protein pores, detected as step-wise increase of the current.**

(Fig. 5). A concentration-dependent decrease of the impedance by two orders of magnitudes was observed.

Monitoring the incorporation of a membrane protein in pre-formed freestanding lipid bilayers (Fig. 6) is more demanding. Seven hemolysin molecules spontaneously form a protein pore within lipid bilayers and diffusion of ions across such pores can be recorded by measuring the incremental increase of the current at a constant potential (50 mV). The process of channel formation is dependent on the hemolysin concentration used and the diameter of the pore.

The results show that nanopore array supports are useful for generating stable lipid bilayers and the function of integrated peptides and proteins can be quantitatively determined. We are now developing functional assay systems for other membrane proteins of interest. The aim of a dedicated EU project within the 7^{th} framework programme with our partners is to understand further the factors influencing stability and functionality and to achieve bilayer formation using liposomes with integrated proteins. Our goal is the application of patented technology for drug screening with membrane proteins as the drug target.

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Bacteria shed light on human Rhesus protein

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Rhesus (Rh) proteins are the most significant blood group antigens next to the AB0 system in human blood transfusion. Sequence analysis and genetic complementation experiments in yeast showed that Rh proteins are homologs of the Amt (ammonium transporter) family of transmembrane proteins and mediate ammonium transport. Transmembrane ammonium transport is essential for the regulation of acid-base homeostasis in humans. The structure of a bacterial Rhesus homolog observed at atomic resolution sheds light on the structure and function of mammalian Rhesus proteins.

Ammonium is the preferred nitrogen source for bacteria, fungi and plants. Its uptake into the cells is managed by polytopic membrane proteins and is highly regulated. These proteins belong to the extended family of ammonium transporters (Amt), whose human homologs are represented by Rhesus proteins. Several tissue-specific Rhesus proteins, which are involved in acid base balance [1], are expressed in humans. The Rhesus protein complexes embedded in red blood cell membranes constitute the second most important antigens after the AB0-system [2], and play a crucial role in transfusion medicine, but can also lead to lethal haemolytic diseases. These complexes were assumed to be hetero-tetramers of Rh30 and Rh50 proteins. Phylogenetically, Rh proteins are found predominantly in animals.They also occur more rarely in lower eukaryotes and very rarely in prokaryotes. *Nitrosomonas europaea* encodes a single Rh gene. The structure of the corresponding NeRh50 protein was visualised at a resolution of 1.3 Å and is representative for the Rh family including human erythrocyte Rh proteins [3].

Analysis of its trimer interface [3] strongly suggests that all Rh proteins are likely to be trimers and that Rh30 group antigens are unlikely to form complexes with the erythrocyte Rh50 protein (RhAG). When compared with structures of bacterial Amt proteins, NeRh50 shows several distinctive features of the substrate conduction pathway that support the theory that Rh proteins have much lower ammonium affinities than Amt proteins and could function bi-directionally.

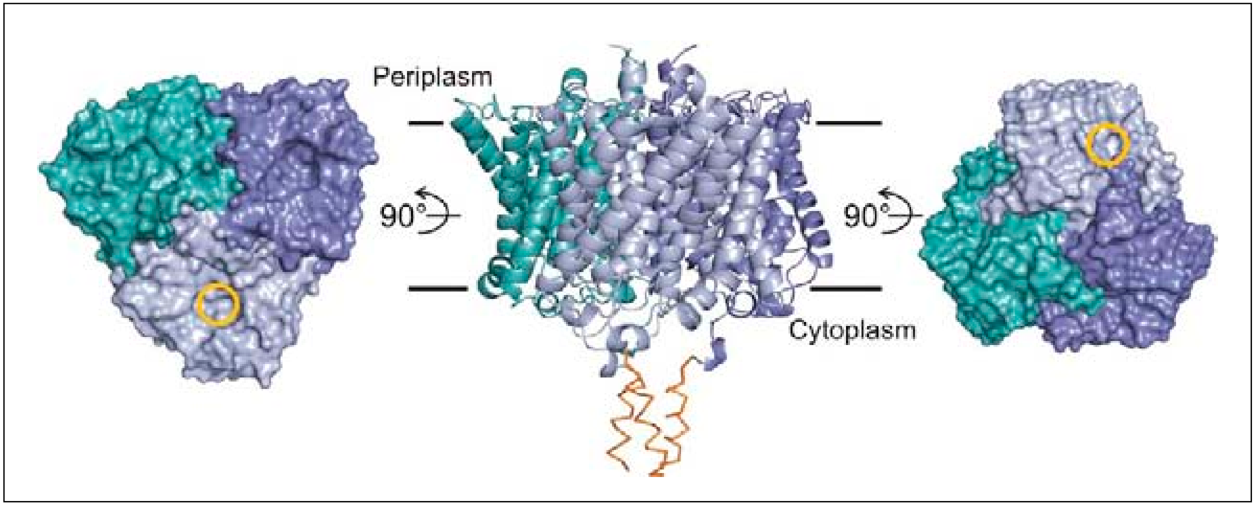

Figure 1: **The NeRh50 trimer structure. Periplasmic and cytoplasmic faces of the trimer are shown in surface representation on the left and right respectively, with the pore entry marked by a yellow circle in one monomer. A side view (ribbons) is shown in the middle with the approximate bilayer boundaries indicated by lines.**

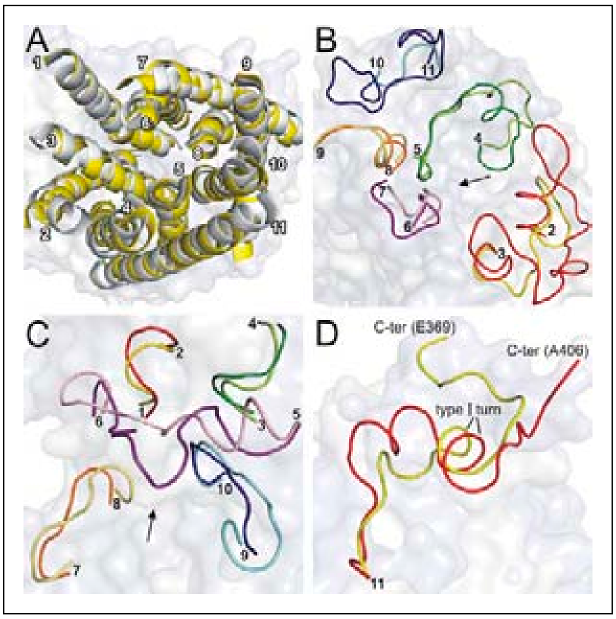

Figure 2: **Comparison of the monomer structure of NeRh50 and EcAmtB. Superposition based on 268 C_α atoms of NeRh50 and EcAmtB (A) Transmembrane segments (white numbers) represented as yellow (NeRh50) and grey (EcAmtB) helices. (B) The periplasmic loops depicted in lighter and darker colours for NeRh50 and EcAmtB, respectively. Arrow points towards the pore entrance. (C) The cytoplasmic loops (same colours as in B). Arrow points towards the pore exit. (D) The C-terminal region depicted in yellow and red for NeRh50 and EcAmtB respectively.**

Overall structure of the NeRh50 protein

High-resolution data were collected at the SLS beamline X06SA and the structure was observed using molecular refinement methods. The quaternary structure of NeRh50 from the ammonia-oxidizing bacterium *N. europaea* is a homotrimer (Figure 1) similar to that of the structure of AmtB from *Escherichia coli* (EcAmtB) (Figure 2) [4]. The monomer fold includes 11 transmembrane spanning α-helices (TM) corresponding exactly to the Amt proteins (Figure 2A).

The substrate conduction pathway

Rhesus proteins mediate net transport of the uncharged ammonia molecule. This is still controversial for Amt proteins and net transport of the ammonium ion remains only a possibility. The comparison of the two substrate conduction pathways is therefore of great interest. In Amts four distinct regions are distinguishable along this path (Figure 3). The periplasmic vestibule contains a highly conserved ammonium-ion binding site that is absent in Rh proteins. This is in accordance with the lower affinity transport characteristics of Rh proteins. Interesting differences are observed for the second region,

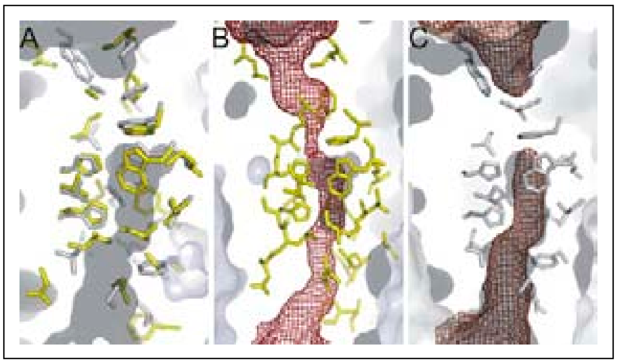

Figure 3: **The substrate conduction pathway of NeRh50 and EcAmtB. Cross-section perpendicular to the membrane through the pores of NeRh50 and EcAmtB. (A) Overlay of both proteins shown in surface representation. The darker areas represent the cavities and pores. Side chains of conserved pore residues in NeRh50 and EcAmtB are shown as yellow and grey sticks respectively. Substrate path in red mesh for NeRh50 (B) and in brown mesh for EcAmtB (C).**

the so-called phenylalanine gate. Although both phenylalanines can be seen in the two subfamilies, the constriction is less severe in the Rh protein structure (Figure 3B). The central, mainly hydrophobic, pore region with its conserved twin-His motif and essential for substrate conduction [5], is very similar in both compared structures. Finally, the cytoplasmic vestibules leading towards the cell interior differ in detail but we have no indication that these differences are functionally very important.

Conclusions

The high-resolution structure of NeRh50 strongly suggests that all Rh family membrane proteins are trimers. Analysis of the conservation of trimer interface residues in human erythrocyte RhAG and RhC/DE proteins speaks against the formation of mixed trimers. If the difference between the substrate conduction mechanisms of Amt and Rh proteins is confirmed, this is probably due to structural differences observed around the phenylalanine gate region.

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Disulphide bond formation by wild type DsbB

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Disulphide bonds are essential for the stabilisation of many proteins' three-dimensional structure. In bacteria, disulphide bonds are introduced by DsbA and the transmembrane protein DsbB. We have determined the crystal structure of a catalytic intermediate of the transmembrane redox protein wild-type DsbB in covalent disulphide complex with DsbA, providing insight into the mechanisms of *de novo* protein disulphide generation.

The formation of disulphide bonds is a critical step in the folding of many secretory proteins, with failure to form correct disulphide bonds resulting in increased susceptibility to degradation [1 and references therein]. In bacteria, the proteins DsbA and DsbB govern disulphide bond formation. DsbA is an extremely reactive dithiol oxidase that rapidly introduces a disulphide bond into periplasmic proteins by disulphide exchange; following this exchange DsbA is re-oxidised by ubiquinone-Q8. The transmembrane protein DsbB catalyses this entire reaction. We have elucidated the crystal structure of the wild-type membrane protein DsbB in complex with DsbA and ubiquinone-Q8 at 3.7 Å resolution [2], providing new insight into its active site and reaction mechanism.

Structure of the DsbA-DsbB-Q8 complex

Crystals of the purified DsbA-DsbB-Q8 complex from *E. coli* were obtained via sitting-drop vapour diffusion (figure 1), and cooled to 100 K prior to data collection. Diffraction data to 3.7 Å resolution were collected at the SLS beamline X06SA, and the DsbA-DsbB-Q8 structure solved by molecular replacement using a catalytically inactive variant of DsbA-DsbB-Q8 as the search model [3].

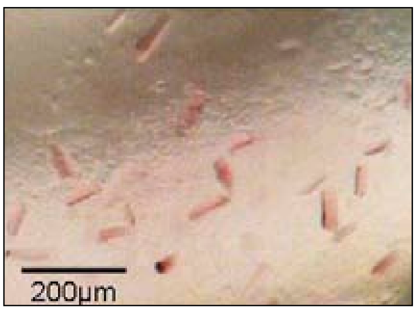

Figure 1: **DsbA-DsbB-Q8 crystals. The pink colour arises from the charge transfer interaction between DsbB and ubiquinone-Q8.**

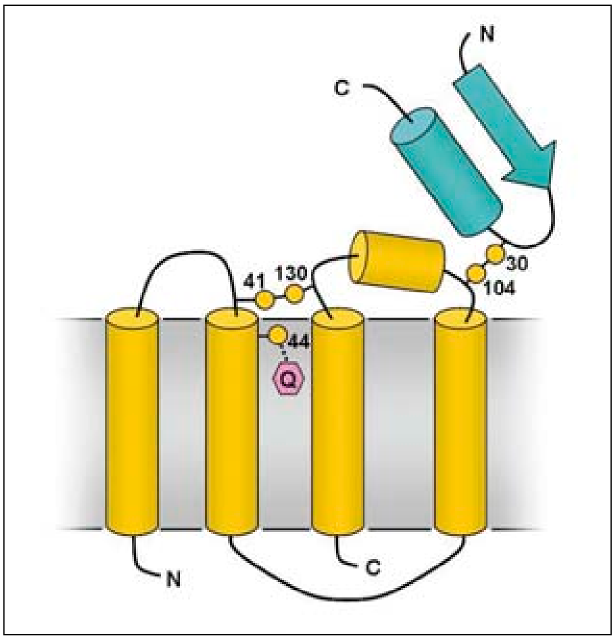

Figure 2: **Topology diagram of DsbA (cyan) in complex with DsbB (yellow). DsbB forms a charge transfer interaction with ubiquinone-Q8 (pink).**

The crystal structure of wild-type DsbB reveals four transmembrane helices and a short periplasmic helix (shown schematically in figure 2). In the complex, an intermolecular disulphide bond is formed between DsbA and DsbB, as previously observed in the inactive variant [3]. However, significant structural differences between the wild type and inactive variants are observed in the region of cysteine44 of DsbB and ubiquinone-Q8 (figure 3).

The active site architecture of the wild-type DsbB-DsbA-Q8 complex reveals a charge transfer interaction between a cysteine residue and the ubiquinone ring which, together with

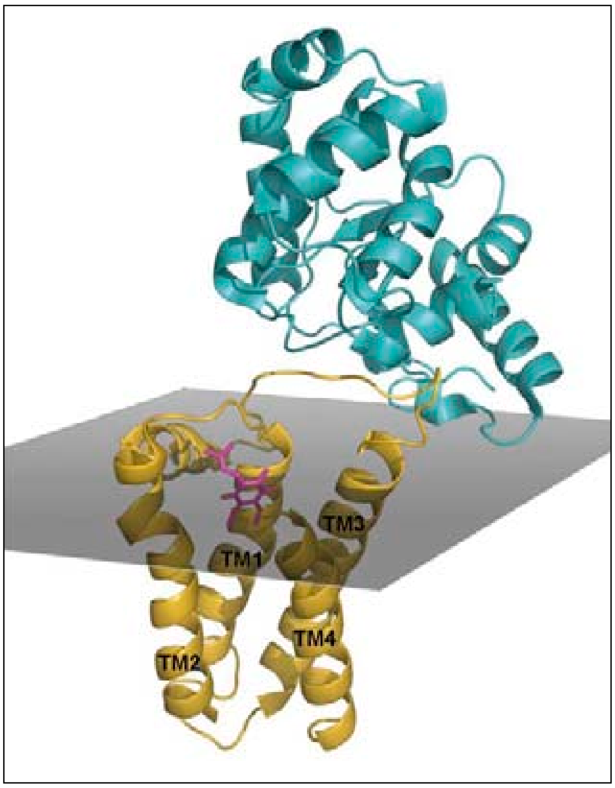

Figure 3: **Crystal structure of dsbA (cyan), DsbB (yellow) and Q8 (pink). The periplasmic membrane is shown schematically.**

the established redox chemistry of quinones, provides strong experimental support for the generally assumed mechanism of *de novo* disulphide bond formation.

Formation of a disulphide bond in a periplasmic protein by DsbA results in electron transfer to DsbB. During disulphide bond formation, the charge-transfer interaction between the cysteine44 thiolate of DsbB and the quinone ring is disrupted by the nucleophilic attack of the quinone by this cysteine.

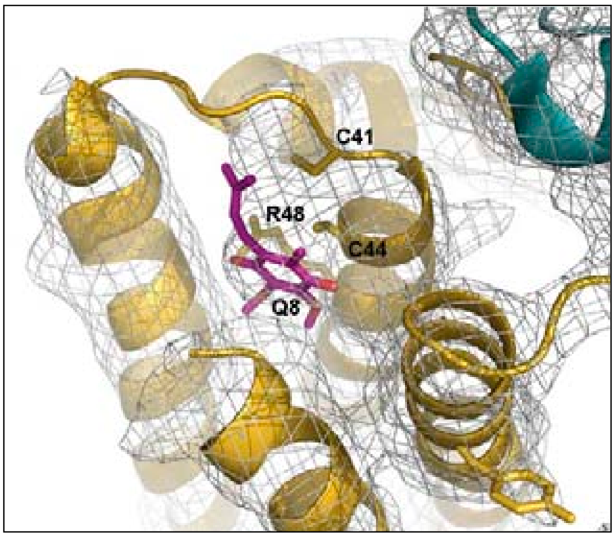

Figure 4: **A novel charge transfer complex architecture is observed in the region of ubiquinone-Q8 (pink and red).**

Subsequently, the neighbouring residue cysteine41 attacks cysteine44, producing an intra-molecular DsbB disulphide bond and reduced quinone (shown in figure 2). The second step of this reaction requires the presence of unpaired, reduced cysteine41 of DsbB, which is only formed when wild-type DsbA is present. In this case, cysteine33 of DsbA attacks the intermolecular cysteine30 (DsbA) – cysteine104 (DsbB) disulphide bond (shown in figure 2), regenerating oxidised DsbA and producing semi-reduced DsbB. Within semi-reduced DsbB, inter-loop disulphide exchange creates the reduced cysteine41 / cysteine44 pair and the cysteine104-cysteine130 intra-molecular disulphide bond.

Thus, following the formation of a disulphide bond in a periplasmic protein, DsbA oxidation by ubiquinone-Q8 is catalysed by DsbB.

Conclusions

Structural studies of complexes of wild-type DsbB have revealed a possible charge transfer mechanism underlying the formation of disulphide bonds in proteins. Further crystallographic and biochemical work is underway to enhance our understanding of the mechanisms of disulphide formation.

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A seed of knowledge

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The discovery over the past three decades of small, charcoalified plant fossils from the Cretaceous period has radically improved our understanding of the diversification of flowering plants, also known as angiosperms. Recent study of small charcoalified seeds using phase-contrast enhanced X-ray tomographic microscopy reveals details that link these fossils to extant Gnetales as well as extinct Bennettitales and Erdtmanithecales. This has consequences for understanding angiosperm origin and revives the controversial anthophyte hypothesis, which proposes that the closest living relatives of flowering plants are the bizarre Gnetales.

Angiosperms are the most disparate and species-rich group of land plants that exist on Earth. They are also the youngest major group of plants to have emerged in geological history, with the first unequivocal records dating from the Early Cretaceous period, 130 million years ago. Despite their enormous diversity and importance in the present-day ecosystem, the origin of angiosperms is still open to debate. The anthophyte theory, based on structural comparisons among extinct and extant seed plants, considers angiosperms as most closely related to the Gnetales, a small group of seed plants with a relictual occurrence in present flora, and to the Bennettitales, a group of extinct seed plants that flourished in Jurassic and Cretaceous forests [1]. The anthophyte hypothesis has been challenged by studies of DNA sequences in seed plants that place Gnetales with conifers, separate from angiosperms. DNA studies can be applied exclusively to living plants, but living seed plants constitute only a small fraction of the total seed plant diversity. New information on the structure of Mesozoic seed plants is therefore vital to help resolve the apparent impasse between morphology-based and molecular assessments of seed plant relationships.

The charcoalified seeds that we investigated using phase-contrast enhanced X-ray tomographic microscopy (PCXTM) at the TOMCAT beamline of the Swiss Light Source (SLS) have yielded exciting new structural information that supports and revives the anthophyte hypothesis. This technology provides higher resolution at the cellular level as well as enhanced contrast, the latter being no longer dependant on simple attenuation but generated by the phase shift induced in the X-ray wave as it passes through the sample. The method that we used [2] couples high resolution and sensitivity with speed: it yields the three-dimensional distribution of the phase (refractive index) of a sample with weak absorption from a single tomographic scan. Even though the underlying numerical approach is based on an assumption of low and homogeneous absorption, the quality of the resulting images is more than sufficient to perform optimal segmentation and further post-processing. The major advantage of tomographic analysis is that it is completely non-destructive, i.e. the sample remains intact after the experiment and can be further investigated with other methods. This is an unconditional prerequisite when dealing with unique fossil specimens.

The seeds were retrieved from soft sediments of Early Cretaceous age discovered in Portugal and eastern North America. They are preserved in charcoal form as the result of natural fires. Charring has preserved the three-dimensional morphology as well as histological detail to the sub-cellular level. The seeds are about 1 mm long, elliptical in longitudinal outline and clearly four-angled in transverse section (Fig. 1a). Four apical extensions make them superficially resemble an angiosperm flower [3], but the seeds have also been compared with seeds of Gnetales [4]. PCXTM analyses establish unambiguously that the fossils are small gymnospermous seeds. Their most distinctive features are the presence of an additional seed envelope surrounding the integument and nucellus, and a long narrow micropylar tube. The outer envelope is robust, formed from thick sclerenchyma cells, while the integument is membranous, formed by thin-walled cells. The

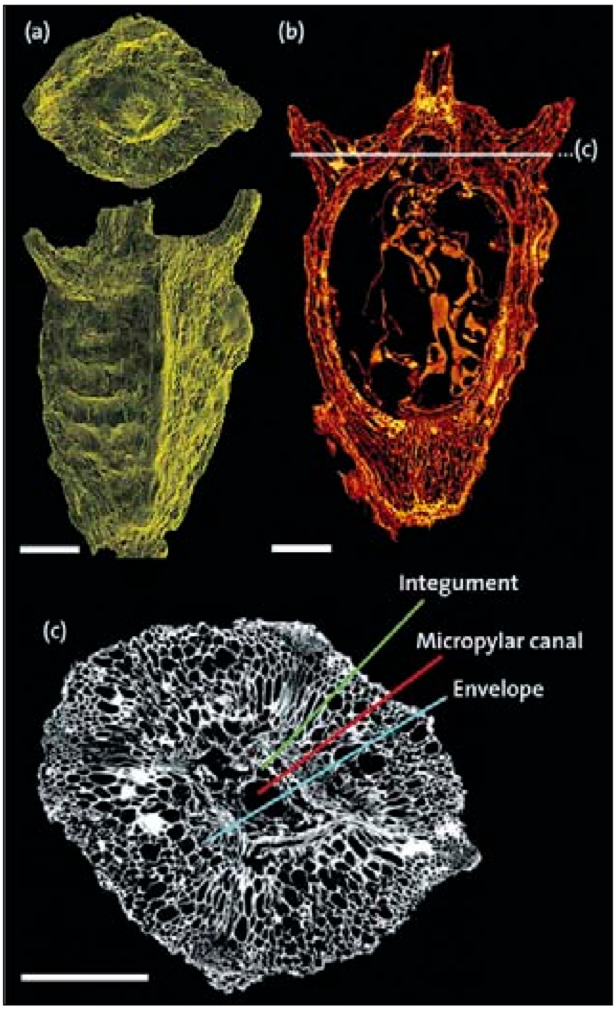

Figure 1: **Charcoalified seeds from the Early Cretaceous in Portugal. (a) 3D rendering of seed showing the four-angled outer shape in apical and lateral view, with micropylar protrusion and the four apical extensions of the outer seed envelope. (b) PCXTM longitudinal virtual slice showing the robust outer envelope and the membranous inner tissues. (c) PCXTM transverse section showing the base of the micropylar region. Scale bar in all figures 200 microns.**

PCXTM also revealed an intriguing construction of the micropylar tube: towards the apex of the tube the micropylar canal is open, while it is closed in the middle section and towards the base. The closure is distinct and caused by expanded tissue of the integument; in particular the cells of their inner epidermis expand radially to form a prominent ring that contributes to the closure in the middle part of the tube. The micropylar canal opens again towards the base of the tube, but the inner lining is here irregular and the radial cells have disappeared (Fig. 1c).

Among seed plants as a whole, the architecture of our charcoalified seeds is unusual and comparable only to extant and fossil Gnetales, and extinct Erdtmanithecales and Bennettitales.

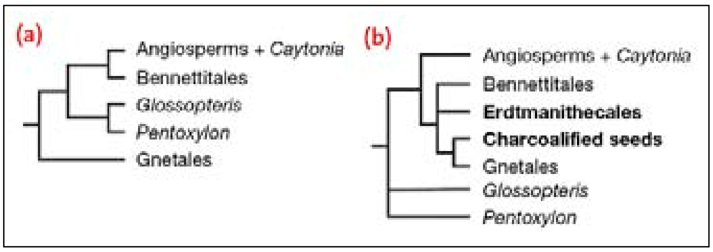

Figure 2: **Phylogenetic analyses showing relationships between anthophytes. (a) The analysis of Hilton and Bateman [6] places Gnetales as sister clade to the "higher" seed ferns, Bennettitales and angiosperms. (b) The expanded analysis of our studies place the charcoalified seeds together with Bennettitales, Erdtmanithecales and Gnetales as a sister clade to angiosperms and *Caytonia*.**

The link between these lineages, termed BEG lineages [5], was further corroborated by performing a phylogenetic analysis using the data matrix from Hilton and Bateman [6], expanded and revised based on our new observations (Fig. 2). This analysis also places the BEG lineages as closely related to angiosperms and thus supports the anthophyte theory.

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Microscopic understanding of the dynamics of "living" polymers

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How scattering techniques can help to make the link between micro-structural and macroscopic rheological properties.

Rheology is the study of matter's mechanical response to an applied deformation or stress. This macroscopic response can be predicted if the micro-structural response to shear is known, for example the molecular size and architecture of polymers in solution or the particle size distribution in a colloidal suspension. Rheological response functions reflect these changes in sheared complex fluids. However, the direct link between the observed macroscopic rheological response and the underlying morphological changes is inconclusive and hampered by several facts: (i) complex fluids such as suspensions, emulsions, foams as well as molecular suspensions of surfactants, macromolecules, proteins and polysaccharides may exhibit the same rheological response function even though (ii) the molecular, colloidal, and non-colloidal aggregation are controlled by different forces acting on different length scales, and (iii) probing of the local microstructure under flow must be *in situ*, to provide sufficient spatial and temporal resolution, and to probe the right length scale [1]. Since complex fluids are often engineered in industry (chemical, pharmaceutical, food, and cosmetic sectors) and the quality characteristics as well as the processing behavior are determined by their microstructure, it is important to understand the structure-flow relationship.

An inherent problem in rheological research is the fact that shear-induced micro-structures cannot be resolved by using standard equilibrium techniques such as electron microscopy or other imaging techniques. Only very few imaging techniques probing the systems in situ under shear have been developed, e.g. a fluorescence microscopy setup at the IFF in Jülich. Another technique combined with a sophisticated rheometer is Small-Angle Neutron Scattering (SANS). These setups, which combine a rheometer with a scattering technique such as SANS or fluorescence microscopy can access simultaneously flow behavior and morphological properties, providing the missing link between flow and structure. They allow the investigation of complex rheological flows and their microstructural origin, in particular when focusing on the evolution over time and the transient coupling of micro-structural and macroscopic rheological properties.

A common rheological technique besides applying steady shear is the use of an oscillatory shear strain. The stress response with in-phase and out-of-phase components gives access to the mechanical excitations (storage modulus $G'(\omega)$ and loss modulus $G''(\omega)$).The applied frequencies of such measurements are typically in the range of 10^{-3} to 10Hz and therefore also accessible with time-resolved cyclic SANS. The synchronization of oscillating shear and time-resolved SANS means the structural response of the material can be followed with a time resolution as small as a few ms. Up to now Rheo-SANS experiments have only been carried out under steady shear but not oscillating shear. All technical requirements for cyclic SANS experiments are fulfilled at the SANS-1 experiment [2] and its combination with an oscillatory rheometer is unique.

The method of simple oscillatory tests can be extended into a non-linear regime [3,4]. Mechanical harmonics are generated under oscillatory shear at odd multiples of the fundamental excitation frequency. These harmonics are analyzed as spectra after a Fourier transformation of the time-dependant torque. This method is called "FT-rheology". We have combined FT-rheology with cyclic SANS experiments for the study of polybutadiene-poly(ethylene oxide) (2.5 kd:2.5 kd) diblock copolymers. They form wormlike micelles and are known to undergo an isotropic to nematic phase transition at 5% w/w [5,6]. The rheological properties of the system display similarities to surfactant wormlike micelles, with the advantage that this system can be directly observed with fluorescence microscopy, which is carried out in Jülich. The theory describing this type of "living" polymers uses the concept of reptation in combination with the breaking and re-formation

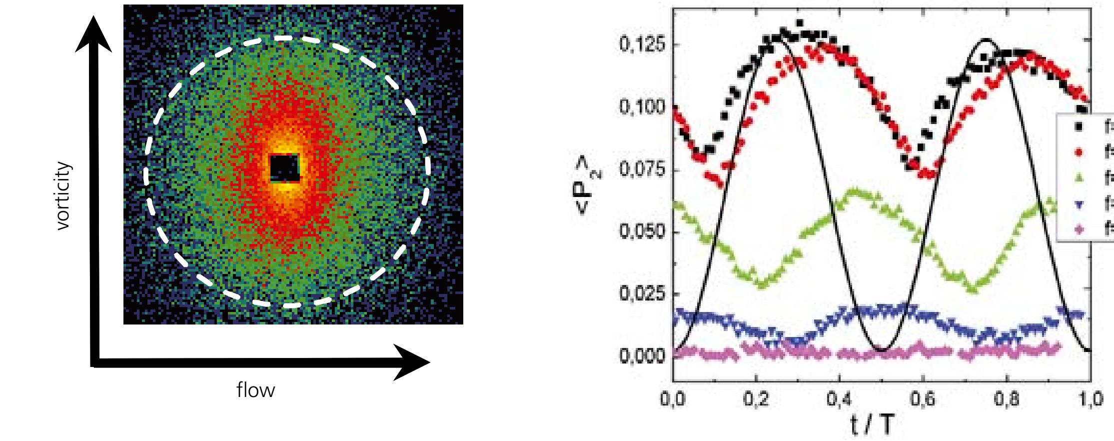

Figure 1: **On the left a typical SANS pattern like the 100 taken during the cyclic experiment. From the anisotropic scattering an order parameter <P_2> for the wormlike structures can be determined. The time dependent order parameter <P_2> for different shear frequencies is shown on the right. The solid line represents the amplitude of the oscillating shear in a.u..**

kinetics of the micelles to predict the dynamical response of such systems. In practice dynamical characterization is limited to the determination of the crossover point between the storage and loss moduli and therfore to the linear properties of the system. We have studied in situ the response of PB-PEO to an oscillatory shear field in the vicinity of the isotropic-nematic transition. We could determine the (non-)linear response of the Kuhn-segments using high time-resolution cyclic SANS (τ >= 5 ms) to obtain a microscopic understanding of the dynamics of "living'" polymers. A first successful experiment using this system is shown in Figure 1.

In this figure we observed how the structural response moves out of phase with the increasing frequency of the applied field. For a self-organised surfactant system the intersect between the elastic modulis and loss modulus, obtained from rheological measurements under oscillating shear flow, is related to the typical relaxation time for self-organised structures. To understand the structural response to shear, the steady state was not the only important factor, but also the rate at which it was reached. The latter depends on the typical relaxation time of the system. For oscillating shear flow at low frequencies the system is always close to a steady state with the actual applied shear and the time dependent scattering patterns similiar to those measured at the corresponding shear in a steady state shear experiment. However, at higher frequencies the change of shear rate becomes comparable to the typical relaxation time of the system and the structural response gets more and more out of phase with the applied oscillating shear flow. In our experiment this behaviour was observed for the first time successfully as shown in Figure 1. From the anisotropy of the SANS pattern one can draw conslusions about the allignment of the micelle segments. The degree of allignement is commonly expressed in terms of an order parameter <P_2>, whose time dependency is shown on the right in Figure 1. To get the curve for the different applied shear frequencies from all 100 SANS patterns, an order parameter <P_2> was extracted during the cyclic data acquisition. The higher the frequency, the more the structural response moves out of phase with the oscillating shear (shown as a black line). At frequencies of 2Hz the system can no longer follow the oscillating shear and the scattering pattern becomes isotropic and shows no further anisotropic scattering behavior.

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Combination therapy of Genistein with growth inhibition for consolidation after RIT

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The L1 cell adhesion protein (L1-CAM) has emerged as a potential target for therapeutic intervention in ovarian cancer. Antibodies directed against L1 were found to inhibit proliferation of SKOV3ip human ovarian cancer cells in vitro and the growth of SKOV3ip metastases in vivo in nude mice [1]. We investigated the possibility of increasing the effectiveness of anti-L1 antibody mediated growth inhibition by co-administration of the soybean-derived isoflavone Genistein. This antineoplastic tyrosine kinase inhibitor enhanced the anti-proliferative and pro-apoptotic (programmed cell death) effects of the anti-L1 chimeric monoclonal antibody (mAb) chCE7 in SKOV3ip cells. The observed synergy of anti-L1 antibodies with Genistein could lead to a new therapeutic option for consolidation therapy of ovarian cancer after surgery and radioimmunotherapy

Antitumour effects of ^{177}Lu-labelled chCE7agl antibody

Monoclonal antibody therapy involves the use of experimentally produced antibodies to target specific proteins on the surface of cancer cells. High-affinity chimeric mAb chCE7 binds to the human L1-CAM cell surface protein, overexpressed in tumours such as neuroblastoma, renal cell carcinoma, ovarian carcinoma and melanoma. Based on our results, which show a more favorable blood clearance and a high and persistent tumour accumulation of an aglycosylated radiometal labelled variant of chCE7 (chCE7agl) [2], we have used ^{177}Lu-labelled chCE7agl for therapy studies. Female nude mice were injected intraperitoneally with 10^7 SKOV3ip human ovarian cancer cells. Two days later animals were injected intravenously with a single low dose of 6 MBq ^{177}Lu-DOTA-chCE7agl (88 µg). Controls (n=7) and treated mice (n=7) were sacrificed after 26 days and tumour masses were removed and weighed (Figure 1). The single low dose of Lutetium-177 radioimmunotherapy (RIT) agent led to a 76% reduction in tumour burden ($p<0.008$). These results demonstrated the efficacy of RIT, but consolidation therapy strategies resulting in better survival of cancer patients after first-line treatment are still needed.

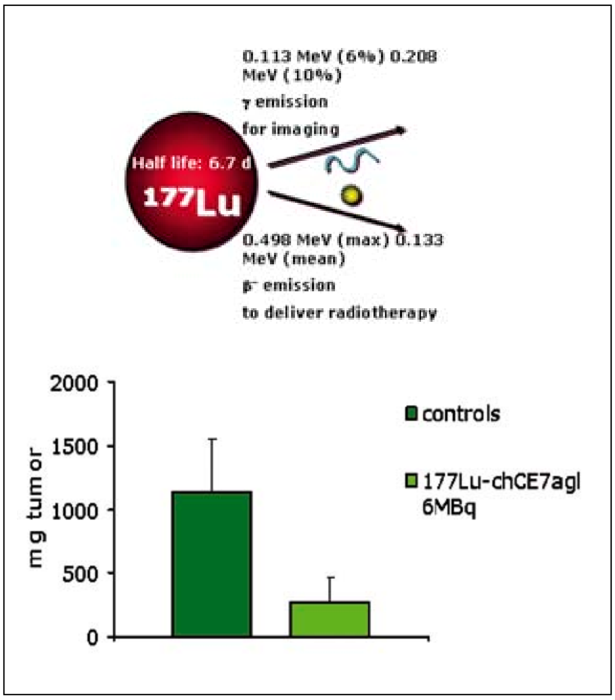

Figure 1: **Lutetium-177 radioimmunotherapy of orthotopic SKOV3ip tumours in nude mice treated with a single low dose of labelled mAb chCE7agl.**

Growth inhibition by chCE7 and Genistein

Genistein, which is commonly used as a tyrosine kinase inhibitor has many additional pharmacological activities and enhances the efficacy of a variety of cancer therapeutics [reviewed in 3]. We therefore investigated the effect of Genistein on the growth inhibition of SKOV3ip human ovarian cancer cells *in vitro* mediated by the anti-L1 antibody chCE7 (Figure 2). After 72 hours of growth in complete cell culture media supplemented with 10 µg/ml mAb chCE7 or 50 µmol/L Genistein, both agents inhibited cell growth significantly ($p<0.001$)

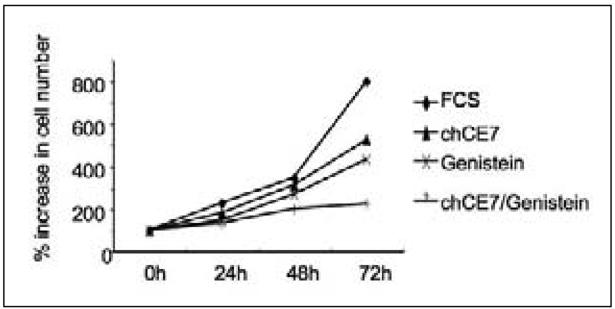

Figure 2: **Inhibition of growth of SKOV3ip human ovarian cancer cells *in vitro* by anti-L1 mAb chCE7 and by Genistein.**

in comparison to control cells (FCS). The combination of mAb chCE7 and Genistein strongly augmented the effects of the single agents (P<0.009).

Induction of apoptosis by anti-L1 mAb chCE7 and Genistein

Apoptosis is a form of programmed cell death, which is deregulated in tumour cells. One possible cancer treatment would be to overcome resistance of tumour cells towards apoptosis. We measured apoptotic responses in serum-starved SKOV3ip cells by analysis of cleaved poly(ADP-ribose) polymerase (PARP), a nuclear enzyme that is cleaved after induction of apoptosis. Cells were maintained for 72 hours in low serum (0.2% fetal calf serum) medium, and treated with mAb chCE7 (30 µg/ml) and/or Genistein (100 µmol/L) (Figure 3). MAb chCE7 and Genistein induced apoptosis (about 20% increase in cleaved PARP). A combination of the two agents led to a significant increase in the amount of cleavage product (55%, P<0.001) compared to untreated samples and to either the mAb treatment or the Genistein treatment (P<0.0002). The quantification of PARP cleavage was performed by scanning peak areas of western blots from six independent experiments (calculation with imageJ software). We also demonstrated that the combination of the two agents reduced the sensitivity of several key kinases involved in proliferation and apoptosis to extracellular stimulation with growth and survival factors (data not shown [4]).

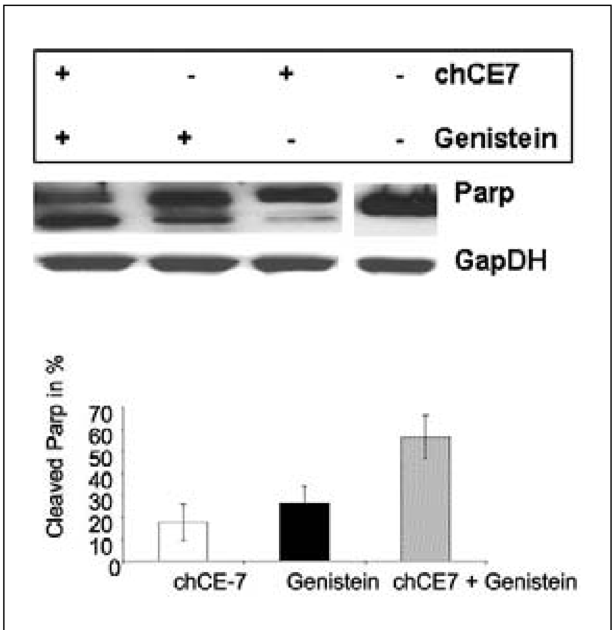

Figure 3: **Apoptosis induced by mAb chCE7 and Genistein in SKOV3ip cells as measured by cleavage of PARP. GapDH: Glycerinaldehyd-3-phosphat-Dehydrogenase, loading control**

Conclusions

We have shown that treatment of SKOV3ip ovarian cancer cells with anti-L1 mAb chCE7 induces growth inhibition and apoptotic responses, which can be increased by addition of the isoflavone Genistein. This strategy may provide an option for consolidation therapy of ovarian cancer after surgery and RIT.

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"Click" to image: a new chemical strategy for easy access to multiple imaging probes

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Non-invasive visualization of specific targets or processes is important for understanding drug-target interactions or for imaging malignant diseases. Therefore, efficient strategies for developing new and tailor-made probes applicable for different imaging modalities are needed. We have developed a procedure for the preparation of folic acid-based imaging probes useful for single photon emission computed tomography (SPECT), positron emission tomography (PET), near infrared imaging (NIR) and magnetic resonance imaging (MRI), following a single synthetic strategy involving "click chemistry".

The preparation of suitable imaging probes for the visualization of specific targets or processes frequently requires coupling a target-specific molecule with an entity suitable for imaging. This usually entails multi-step syntheses, which are often inefficient and are complicated by unwanted side-reactions during the coupling process. Therefore, novel synthetic strategies are needed to overcome these drawbacks in order to develop new probes applicable for different imaging techniques currently available.

We recently reported that "click chemistry" (the Cu(I)-catalyzed cycloaddition of alkynes and azides forming selectively 1,4 disubstituted 1,2,3 triazoles) [1] could be employed for the single-step synthesis of metal chelators in quantitative yields while *simultaneously* attaching them to (bio)molecules of interest [2]. Unlike the chemical strategies for synthesising of other chelating systems, this novel strategy avoids protective groups and provides ligands in a single step with substantial yields. They can be ready radiolabelled with $[^{99m}Tc(CO)_3(H_2O)_3]^+$ ($^{99m}Tc_{1/2}$ = 6 h, 140 keV γ-radiation), an organometallic precursor for SPECT applications developed at PSI (Figure 1) [3]. Since click chemistry has never been employed specifically for the design of metal chelators before, we called this novel approach "click-to-chelate".

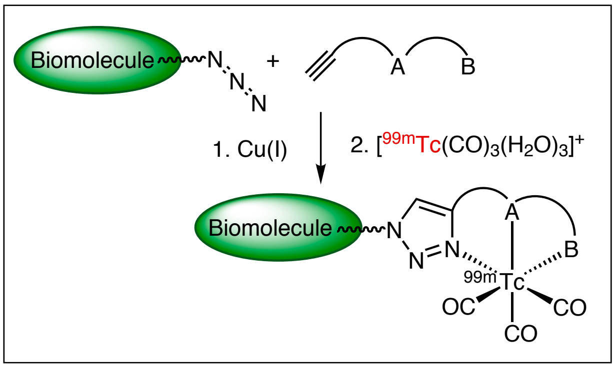

Figure 1: **General reaction scheme of the functionalization of biomolecules with a metal chelator and radiolabelling with the radionuclide ^{99m}Tc using the "click-to-chelate" approach [2].**

One precursor for multiple probes

Folic acid is an essential vitamin and as such, it is taken up by fast proliferating, folate receptor (FR) overexpressing cancers cells to a greater extent than by healthy cells.

These circumstances allow the visualization (and probably therapy) of FR-positive tumours by attaching suitable probes to folic acid. For proof of concept, we functionalized and radiolabelled (with $[^{99m}Tc(CO)_3(H_2O)_3]^+$) folic acid using the "click-to-chelate" strategy. Initially we synthesized a folic acid-γ-azide derivative (FA-γ-N_3; Figure 2). It was readily demonstrated that compared to older coupling strategies [4], the preparation of the new Tc-99m SPECT radiotracer was more efficient (Figure 2A).

At the same time, the folic acid-γ-azide derivative also provided an opportunity to apply click chemistry to the synthesis of novel folate tracers for other imaging modalities. Cu(I)-catalyzed cycloaddition employing alkyne-functionalized probes provided triazole-linked folate conjugates for PET (1-^{18}F-5-hexine; Figure 2 B) and NIR imaging (alkyne-CY5.5; Figure 2 C). The attachment of the macrocyclic alkyne-DO3A chelator (DO3A = 1,4,7,10-tetraazacyclododecane-1,4,7-triacetic acid) yielded a compound that can be employed as a probe for SPECT, PET and MRI imaging depending on the metal used (Figure 2 D).

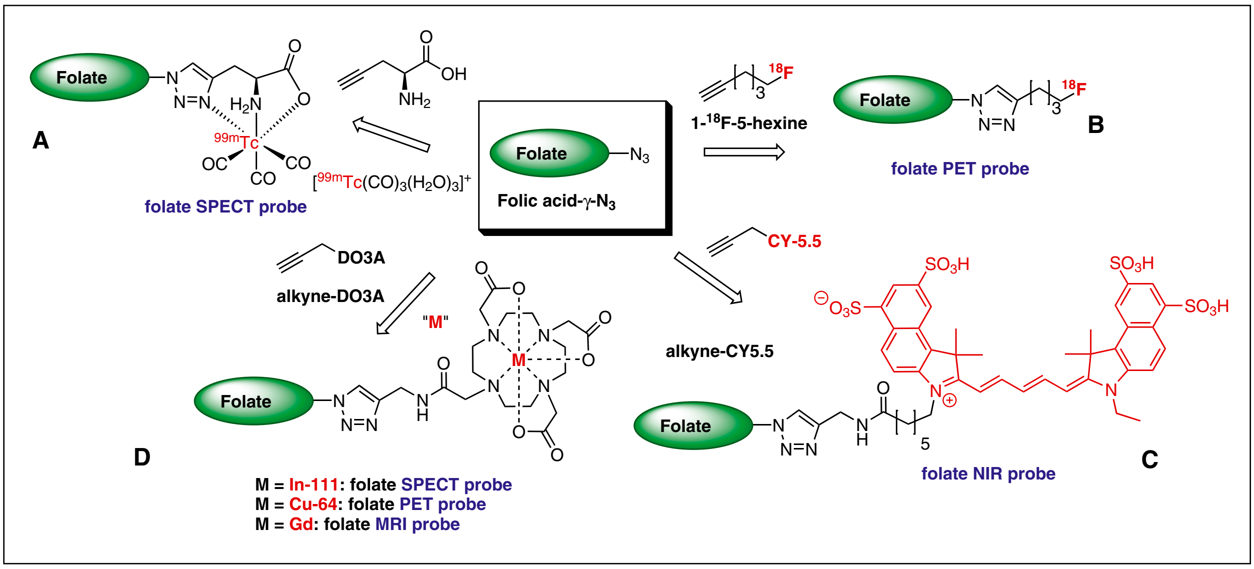

Figure 2: **Functionalization and (radio)labelling of FA-γ-N_3 using click chemistry for in vitro and in vivo imaging.**

In vitro evaluation of the novel "click" probes with folate receptor (FR) positive KB tumour cells showed in all cases a high binding affinity and unaltered cell binding and internalization properties. In vivo experiments with xenografted mice showed specific high uptake of the tracers only in tumours and FR-positive organs and tissue (Figures 3).

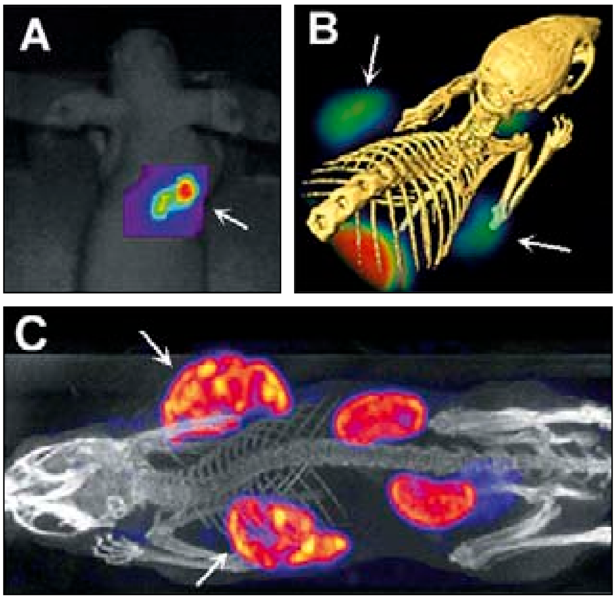

Figure 3: **(A) In vivo NIRF imaging of a xenografted mouse (arrows indicate tumour) superimposed on a white light image. Strong fluorescent signal is observed in the FR-positive tumours. (B) Small animal SPECT/CT image of a xenografted mouse post-injection of the Tc-99m folate tracer and (C) SPECT/CT image of a xenografted mouse post-injection of the In-111 folate-DO3A tracer. High specific accumulation of both radiotracers is observed in the implanted tumours and in FR-positive organs such as the kidneys and thyroid glands.**

Conclusions

We have shown that once an appropriate azide derivative of a biomolecule has been synthesized, a variety of probes suitable for different imaging techniques become available by a single, efficient and reliable coupling strategy. It is important to recognize that this approach will expedite the parallel development of new imaging probes and facilitate a comparison of different imaging modalities and thus, the selection of the optimal tracer and technique for in vitro and in vivo studies.

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Three decades of pioneering work result in an innovative year-round patient treatment facility

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Proton treatments at PSI have entered a new era and while the year 2007 represented the culmination of work for many groups, the implementation of further groundbreaking innovations still lie ahead. What follows is a "snapshot" of the facility's current status and recent accomplishments.

Introduction

The Center for Proton Radiation Therapy (CPT), whose roots go back to the pion treatments of the 1980s, the introduction of scanned proton beam treatments in the 1990s and the decision to build a patient-dedicated proton accelerator earlier this decade, began operation of a prototype cyclotron in February 2007 and moved into year-round patient treatment last August. We wish to describe the cyclotron's first performance results and the initial patient treatment delivery data. Long-term patient outcome data for proton treatments delivered since 1996 also became available for the first time last year.

First year of experience with the world's first SC cyclotron for proton therapy

At the CPT, the world's first superconducting (SC) cyclotron for proton therapy and new beamlines were commissioned as a near stand-alone proton therapy facility [1] and patient treatments started in February 2007. The heart of the new facility is a novel 250 MeV SC cyclotron [2].

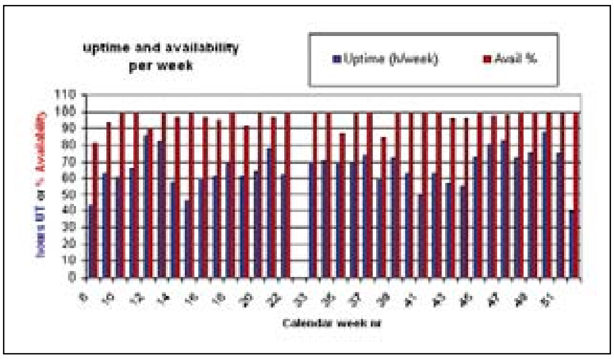

Figure 1: **Uptime and availability of cyclotron and beam lines in 2007.**

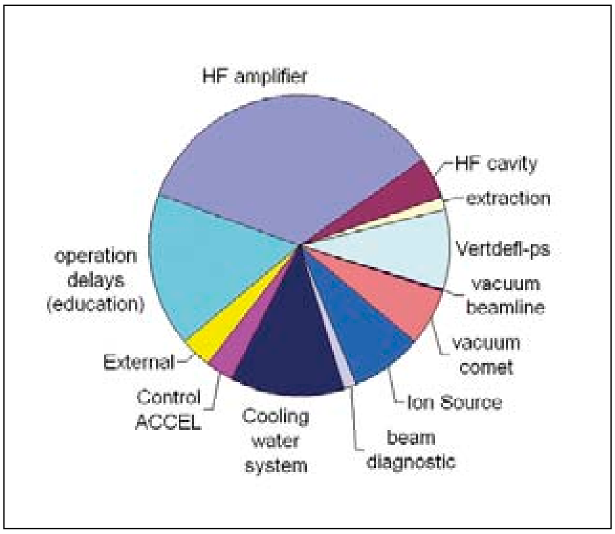

Figure 2: **The subsystems causing unscheduled down time in 2007.**

In June 2007 there was a scheduled shutdown to connect the beamlines to Gantry-2, OPTIS2 and the experimental area. During the following six weeks the extraction electrodes in the cyclotron were replaced preventively and experiments were carried out to prepare commissioning of OPTIS2. Patient treatments were resumed in the middle of August and since then no shutdown longer than three days has occurred. The number of treatments per day has been ramped up steadily to about 15 patients in a continuous five days/week treatment program. For the first time at PSI, patients were treated between Christmas and New Year, demonstrating the autonomy of the systems and infrastructure. Long beam periods with a 100–200 nA extracted beam took place during several night shifts and weekends for material irradiation experiments. Parallel to the above-mentioned programs and preparations for the other beam lines, a research project was also carried out to improve proton beam intensity stability.

Performance of cyclotron and beam lines

During the first year of clinical operation, very high system availability of 97% was reached. We define availability as: 1-UDT/UT, with UDT the unscheduled down time (no beam available, although planned) and UT (=2321 hours) is the total time that the system was "on" for beam. Figure 1 shows the uptime and availability per week and Figure 2 shows the systems that caused the 3% unavailability. Major causes were mechanical problems in a HF amplifier transformer, a problem with the power supply of the vertical deflector and cooling water issues due to parallel installation activities. Another important contribution to UDT is the learning curve of the operation crew.

It is remarkable that most of the problems occurred in the auxiliary devices and almost none in the cyclotron itself. Major problems were also always recognized early in the day, before patient treatment began.

The cyclotron is powered up over 15 to 30 minutes every day around 5 AM, allowing ample time to react to problems before the daily QA-checks at 6:30 AM. The few operator interventions during operation were related to slight corrections of the drifting magnetic field of the cyclotron, due to magnet heating by the HF. Since November this is corrected automatically.

The control systems are undergoing modifications to allow safe and easy switching between the different areas. Installation and commissioning of the other areas are in progress and should be completed by late 2008.

Achieving a high intensity stability

During the commissioning of the cyclotron the typical fluctuations of the beam intensity were often larger than 40% (σ at 10 kHz). However, for the fast pencil-beam scanning method

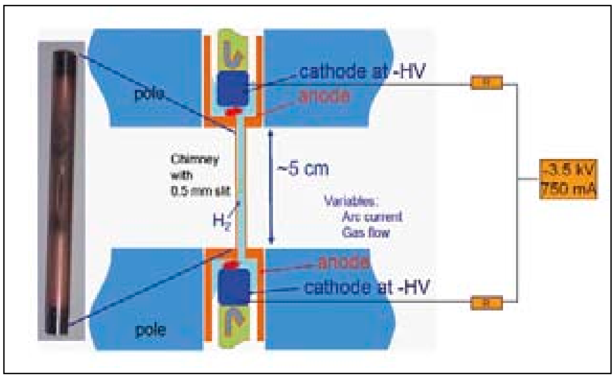

Figure 3: **Schematic view of the proton source in the cyclotron center. Free electrons, created in arcs between cathodes and anodes, are trapped in the chimney and ionize gas that is flushed into the source. The protons can leave the chimney though a slit and are pulled towards the first HF electrode.**

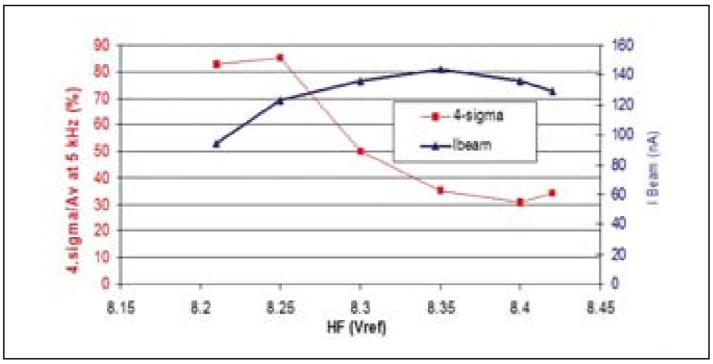

Figure 4: **HF voltage effect on intensity and stability.**

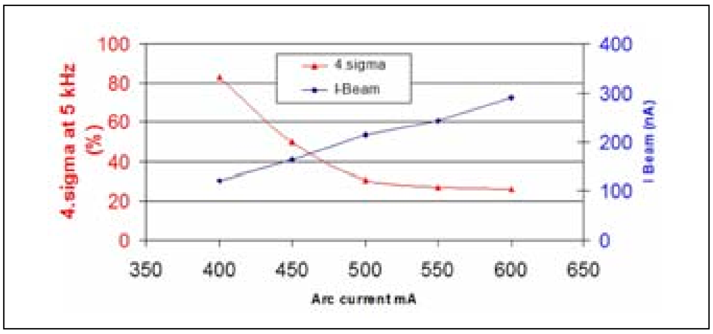

Figure 5: **Extracted beam intensity and stability as a function of arc current.**

in the new Gantry-2 setup [3], σ<2% is required. To meet this requirement, a systematic investigation was performed in collaboration with ACCEL/Varian for different settings of the cyclotron's internal "cold cathode" ion source (Figure 3) and by changing cyclotron parameters.

A model [4] was developed to explain the dependence of beam intensity and stability on several parameters. The effects of "plasma related" parameters (arc current, gas flow, gas type) as well as "acceptance related" parameters (source position, HF voltage, beam positions) were measured. As an example, the effect of HF voltage is shown in Figure 4. Chimney slit location and various aperture positions in the beam path show a similar optimal position.

As expected, arc current has a strong effect on beam intensity. Additionally, stability can improve by a factor of four by increasing the arc current (Figure 5). The importance of the electron amount in the source was confirmed by adding a few percent of helium, which improved the stability by a factor of two, with only a slight increase of beam intensity. A small mechanical modification to match the plasma shape more closely to the chimney's inner volume also improved stability considerably. Since optimal conditions always require very high beam intensities from the source, the existing vertical aperture in the first orbits (low beam energy) has been partially decreased. We now obtain σ≈1–1.5 % routinely with H2 only, without compromising the necessary extracted beam intensity.

Present clinical operation

In August 2007 proton therapy at PSI became a year-round patient operation. Patients are now usually treated Monday through to Friday, one treatment per day, five times per week. Treatment schedules are therefore similar to conventional radiation oncology centers. We try to balance patient treatment demands with the requirements of maintenance, technical improvements and innovations, and commissioning of the new OPTIS2 and Gantry-2 treatment areas. Balancing competing demands for beam time, we currently arrive at a patient volume for deep-seated tumors on Gantry-1 of 15 patients per day on a regular and ongoing basis as well as taking care of the eye program's 200 to 230 annual patients.

For deep-seated tumors we allocate presently one third, or about five patients per day, to the pediatric program. The main focus in adult patients continues to be the treatment of skull base tumors, para-spinal tumors and sarcomas in general, fields in which PSI has established itself as a European central referral center.

Long-term clinical results of proton therapy

The eye program in collaboration with the Jules Gonin Hospital in Lausanne continues to represent the world's largest number of eye tumors treated with proton therapy. Overall, local control in more than 4,800 treated patients and more than 2000 analyzed patients is around 98%. A more recent analysis of small Uveal melanomas reveals perfect 100% local tumor control in patients treated according to our standard treatment parameters.

For deep-seated tumors treated since 1996 with scanning technology, which represents the world's leading technology for proton delivery, we were able to analyze long-term success rates for the first time: for chordomas and chondrosarcomas of the skull base, 5-year actuarial local control rates were 81% and 94% (see Figure 7). How do these data compare to conventional treatment technologies and how do they compare to results of other proton and particle centers? First and foremost it means that patients with skull base tumors previously considered fatal, now have a chance of being cured. In Figure 8 we compared PSI data to historic data with conventional radiation, other proton centers and results from carbon-ion treatments. It is notable that PSI data a) confirmed the excellent results achievable with proton therapy; b) that these results are superior to conventional radiation treatment; and c) that heavy ion data do not show at present additional advantages. PSI results appear to be at least equivalent to those obtained at world-renowned cancer centers, for example at the Massachusetts General Hospital, USA.

Figure 6: **A 6-year old girl treated for a brain tumor with spot-scanning therapy at PSI.**

Proton therapy for childhood cancer

Today, the overall cure rate for pediatric cancer is about 70–80%.[5] Therefore the functional outcome after cancer is of greatest importance. However, in children growing organs are very sensitive to radiation injury. The development of secondary cancer is also of major concern [6]. With proton therapy, doses to normal tissues surrounding a target can be significantly reduced, decreasing the risk for both late toxicity and secondary cancer. [7]

In 2003 a pediatric proton therapy program was established focusing specifically on very young children. In cooperation with Zurich University's Children's Hospital, we instituted a clinical program that could meet the challenges of pediatric cancer care combining chemotherapy with proton irradiation, with general anesthesia during proton therapy at PSI. In addition, consultant services for multi-institutional European sarcoma and brain tumors groups were established. At present, more than 70 children from eight European countries have been treated at PSI with spot-scanning proton therapy (Figure 6). Approximately 50% were infants and babies requiring anesthesia. Sarcomas of the head or neck region were mostly treated, and more recently – and increasingly – brain tumors. All acute and late side-effects of proton radiation therapy were documented and quality of life investigations were carried out. So far, tumor control rates of about 80% have been achieved.

The Swiss Cancer League considered this work important enough to grant financial support. Multidisciplinary treatment protocols for child malignancies in Europe have started to implement proton radiation therapy in their treatment guidelines. The pediatric patient population will remain a major

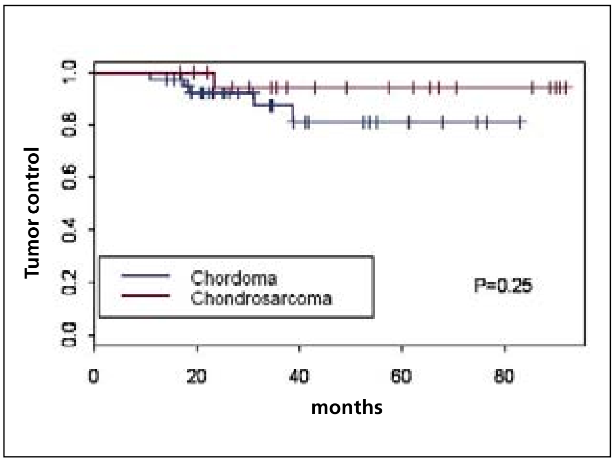

Figure 7: **Local tumor control in 64 patients with either Chordoma (42) or Chondrosarcoma (22) of the skull base treated with Proton Therapy at PSI between 1998 and 2005.**

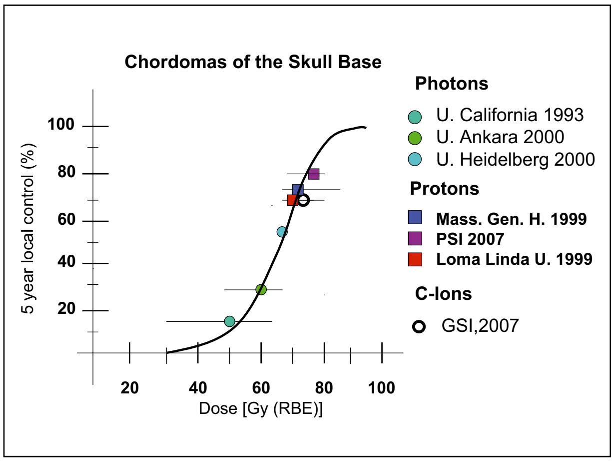

Figure 8: **Comparison of PSI's local control rates with photon-RT, other proton centers, and carbon-ions.**

focus of the CPT at PSI. Collaborations with national and international study groups are to be strengthened and expanded.

Outlook for 2008 and conclusion

On the technological side the focus will be the transition of the eye program from the OPTIS area and Injector-1 to the newly designed OPTIS2 area in connection with the COMET cyclotron. The completion of the installation of Gantry-2 will require the ongoing collaboration of various groups within PSI as will the continued development of the various controls and safety components, the new treatment planning system and the next generation scanning system.

We plan to continue treating diseases and tumors as we have successfully demonstrated in the past. However part of our focus will shift towards evaluating proton therapy for more common diseases and the application of scanning technology in mobile tumors. One example for more common diseases is the evaluation of breast cancer as part of a joint program with the Department of Radiation Oncology at Aarau's cantonal hospital. Treatment planning comparisons show that proton therapy is likely to benefit young women with loco-regional disease (that means the breast cancer involves not only the breast tissue itself but has spread to regional lymph nodes) the most. Examples of "mobile" tumors are tumors that change their position depending on the status of inspiration or expiration of the patient. These include liver tumors and some types of inoperable lung cancer.

In conclusion, 2007 was a year of marked progress and change at the CPT, thanks not only to the initiative of its team but also to the contributions from many other PSI groups as well as the continued support from the PSI management. We are aware of the importance of maintaining the balance between offering proton therapy to as many patients as possible but to also provide resources and focus on the essential mission of the Paul Scherrer Institute, which is and will remain technological innovation. The CPT is looking forward to pursuing research and development, the translation of product development into clinical practice as well as routine patient treatments, which combined help a unique department progress scientifically.

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Strategy and highlights of General Energy research

Alexander Wokaun, Samuel Stucki, Aldo Steinfeld, Peter Jansohn, Günther Scherer, Urs Baltensperger,
Research Department General Energy, PSI

The General Energy department continues to pursue three strategic lines of research. Advances in the production of energy carriers from biomass and solar energy have been achieved both at the fundamental level and at pilot plant scale. Our second focus, efficient energy utilization, promotes the use of fossil fuels with the lowest emissions (low NOx gas turbines, after-treatment for Diesel engines), and electrochemical conversion. The third line of research investigates future energy use scenarios as well as their consequences on the environment and society.

Energy carriers from renewables

Among renewable options for energy vectors that are suitable for technological applications, General Energy focused on biomass and solar energy.
An important milestone in the utilization of wood energy for methane production was reached with the start of construction of a 1 MW pilot plant in Güssing, Austria. For biomass with high water content, a breakthrough was achieved with respect to nutrient separation and recovery under hydrothermal conditions, paving the way for a new type of biogenic energy production we call the SunChem process.
The concept of storing concentrated solar energy via high-temperature endothermic processes is approaching technical realization. We are now investigating the solar upgrading of low-value carbonaceous materials of fossil or biogenic origin. Our long-term water splitting project, the solar reactor technology for the ZnO/Zn thermochemical cycle, was demonstrated experimentally at the 10 kW scale.

Energy, environment and society

The Atmospheric chemistry unit has obtained important results concerning ultrafine particles. Detailed chemical analysis by aerosol mass spectrometry has helped to attribute appropriate fractions of aerosol pollution to traffic, wood combustion, and other sources. Energy system analysis, a joint laboratory of the General Energy and Nuclear Energy and Safety departments, had a strong focus on analyzing scenarios for the development of the Swiss, European and global energy systems, including the potential role of hydrogen. Highlights from these two laboratories are found on pages 74–79.

Energy and Material Cycles

Biomass and fuel processing research activities of the Laboratory for Energy and Materials Cycles have been integrated in the framework of the Competence Center for Energy and Mobility (CCEM) during the past year.
Using our fluidized-bed catalytic methanation test rig at the Güssing plant, we have been able to show that this type of reaction can be sustained on real wood gas without deactivation if sulfur is removed from the feed.
Work on producing renewable methane using microalgae has begun. The process is based on a closed system that includes a photo-bioreactor for the growth of the algae and hydrothermal gasification as a means of recovering methane.
The super-XAS beam-line was installed and commissioned in 2007. The beam-line features infrastructure that makes it particularly suited for spectroscopic studies of catalyst materials in operando.

Solar Technology

Thermochemical production of solar fuels is the Laboratory for Solar Technology's research focus. We report on the latest developments in solar chemical reactor technology for the thermal dissociation of ZnO at 2000 K, part of a two-step water-splitting cycle for solar H_2 production. Successful tests were carried out at PSI's solar simulator with a 10 kW solar reactor prototype, with feed cycles of ZnO particles subjected to peak radiative fluxes exceeding 5800 suns. Zn(g) and O_2 products were quenched, preventing recombination and allowing the downstream collection of particles with high Zn content. The transition path to solar hydrogen is also being pursued thanks

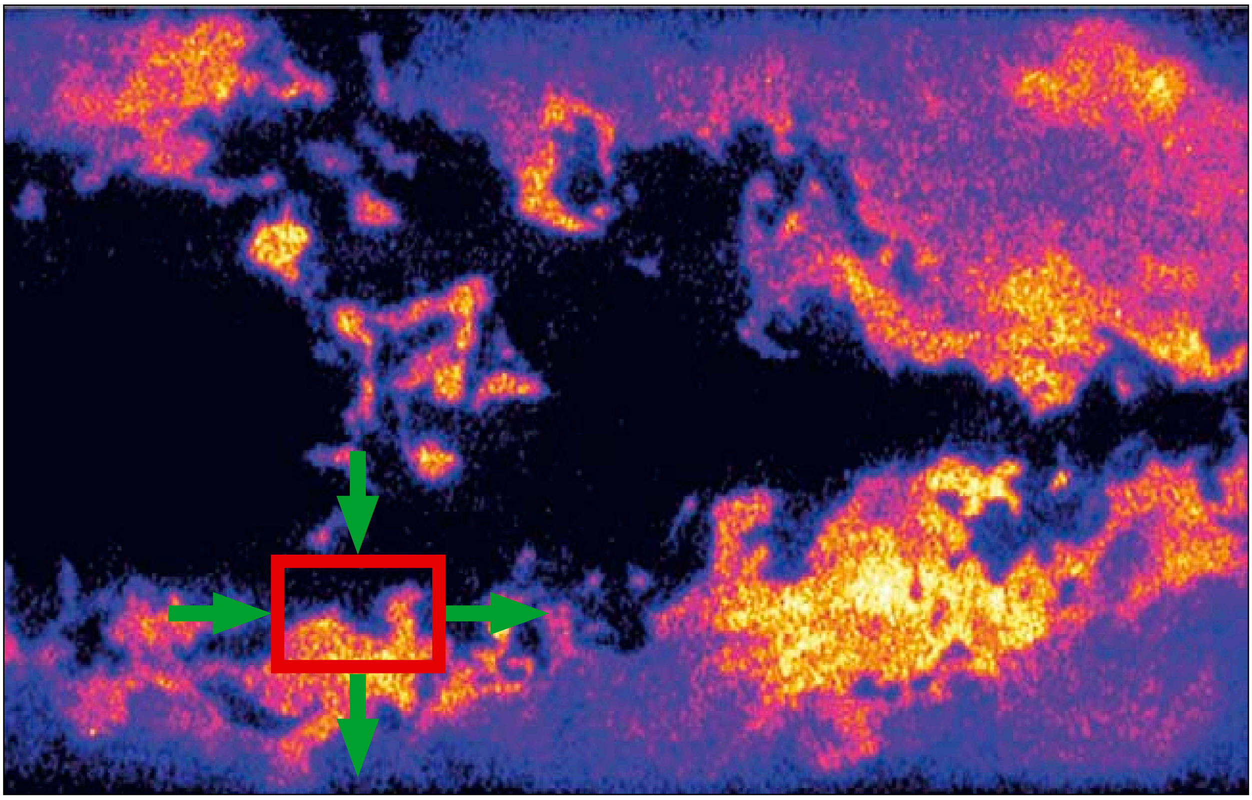

Figure 1: **The combination of laser induced fluorescence with particle induced velocimetry provides access to the local heat balance. In developing methods for the efficient, low NOx combustion of synthesis gas, this information is important to assess flame stability and to suppress thermoacoustic oscillations.**

to the solar decarbonization of fossil fuels via cracking, reforming, and gasification processes. In particular, the solar upgrade of low-value solid carbon-based materials offers a viable route for CO_2 avoidance. For solar energy conversion, research emphasis is on the analysis of radiation heat exchange in multiphase reacting flows, applied in the design and optimization of high-temperature thermochemical reactors.

Combustion Research

Our work focuses on systems that offer the highest efficiencies and lowest emissions, i.e. gas turbines and combustion engines. Besides applied research projects, the basics of physical-chemical mechanisms for "near zero emission" fuel conversion are being studied.
In 2007 the infrastructure to study dynamic molecular properties was established at the SLS. Laser diagnostics were used to study the combustion of lean premix syngas (H_2/CO) flames. New zeolite-based catalysts with high-temperature stability are also being considered to combine selective catalytic reduction of NO_x with particulate filtration. A new SCR effect on diesel soot was found in the presence of NO_2, with an enormous impact on the design of smaller catalytic systems for the next generation of diesel vehicles.

Electrochemistry

Progress in electrochemical energy conversion and storage is based on progress in electrochemical materials science. The development of electrode materials for Li batteries is progressing towards better performance without compromising safety. The fundamentals of charge storage have also been investigated in single wall carbon nanotubes for application in super capacitor electrodes.
These advances were often based on *ex situ* and *in situ* characterization of these materials at PSI's large facilities SLS and SINQ, utilizing their most advanced beam lines, and on some unique diagnostic methods available within the laboratory.

Implementing results

Many of the applied research projects are carried out in collaboration with industry, to ensure a targeted approach and efficient application of the result. The Competence Center Energy and Mobility of the ETH Domain (cf. pp. 64–65), for which PSI is the leading house, plays a crucial role in this respect. With 19 approved projects, and the laboratory hall for hosting project infrastructure approaching completion, the Center and the Department are set for a dynamic start in 2008.

In situ visualization of nutrient salt separation from biomass in supercritical water

Frédéric Vogel, *Laboratory for Energy and Materials Cycles, PSI*; Peter Vontobel, *Spallation Neutron Source, PSI*; Andrew A. Peterson, Jefferson W. Tester, *Department of Chemical Engineering, Massachusetts Institute of Technology*

Wet biomass streams (e.g. manure, sewage sludge, food wastes) could contribute ca. 4 EJ (or 6 %) to primary energy consumption in Europe if converted efficiently into methane. Because conventional technologies show low conversion efficiencies for these types of biomass streams, PSI is developing a novel process that is capable of reaching 65–70 % net efficiency. In addition, nutrient salts can be recovered as concentrated brine and used as fertilizer. Key information on salt separation was obtained recently by neutron radiography.

Introduction

One of the most challenging steps in biomass utilization for energy purposes is the separation and recovery of nutrients. Conventional thermal processes concentrate most nutrients as oxides in the ash, but nitrogen escapes into the air as N_2. Biological processes such as anaerobic digestion produce a nutrient-rich sludge or aqueous by-product stream, which is still highly loaded in organics due to an inability to digest lignocellulosic constituents. To increase the efficiency of nutrient transfer to plants, a readily available and concentrated form is needed. Catalytic hydrothermal gasification at around 400 °C and 30 MPa is one novel process being developed at PSI to efficiently convert biomass into a methane-rich gas in supercritical water [1,2]. A key step is the separation of salts from the liquid biomass stream by taking advantage of their very low solubility in supercritical water. A simplified sketch is shown in Figure 1.

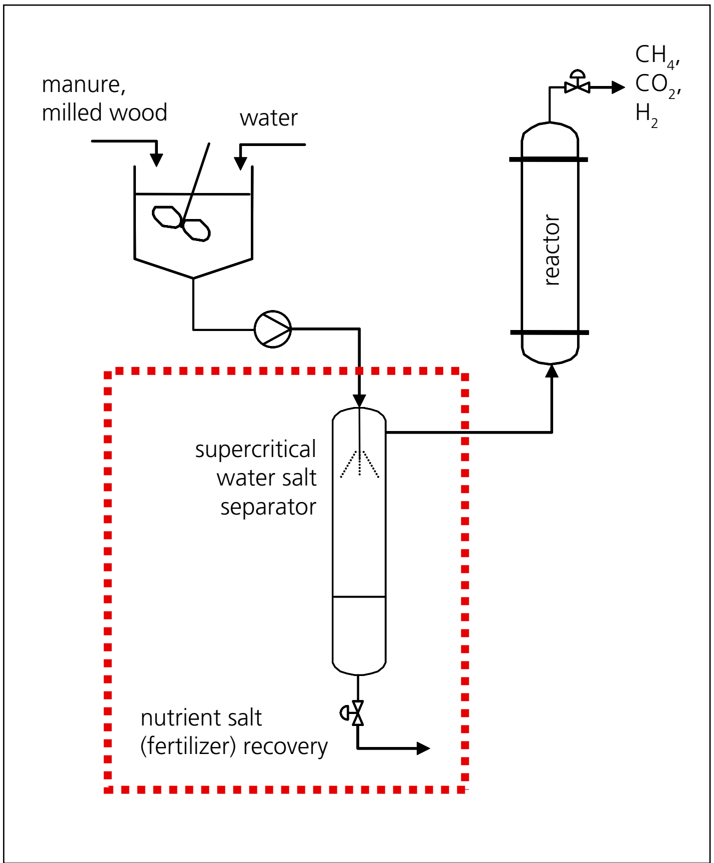

Figure 1: **Schematic representation of PSI's catalytic hydrothermal gasification process (excluding heat exchangers and gas/water separation).**

Salt precipitation

A test rig was built to study the precipitation and separation of salts from supercritical water *in situ* using PSI's neutron radiography facility NEUTRA. In two experimental campaigns both salt precipitation and flow features in the high-pressure separator were visualized. The pressure vessel was made of nuclear-grade Zircaloy-2, which is essentially transparent to neutrons. The fluid containing the dissolved salts enters the separator vessel by a dip tube at the top and leaves the vessel through the exit port on the top right-hand side. In the vessel, where it is pressurized and heated above the critical point of water (i.e. 374 °C, 22.1 MPa), the salt stream mixes with the hotter fluid, which leads to a rapid precipitation of the salt. As visualized in Figure 2, salts that form a solid phase at study conditions (e.g. Na_2SO_4) tend to stick to the dip tube and the vessel walls, which is undesirable [3].

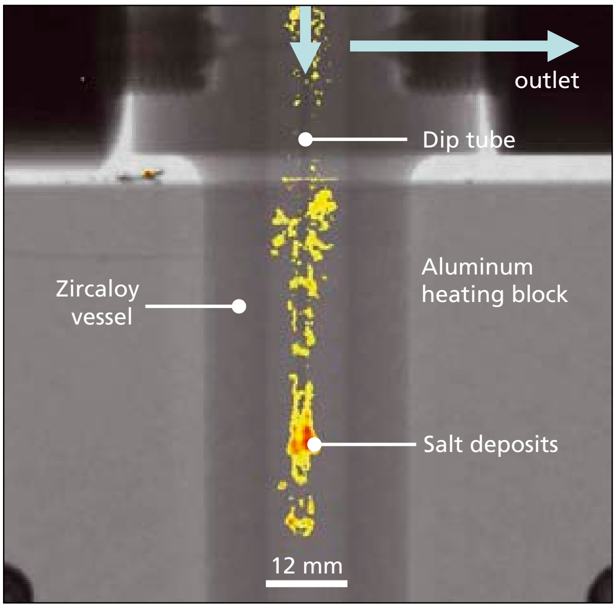

Figure 2: **Build-up of solid Na_2SO_4 around the dip tube inside the separator, finally leading to a vessel blockage (405 °C, 30 MPa; Feed: Na_2SO_4 + $Na_2B_4O_7$ in D_2O; 15 s shutter time).**

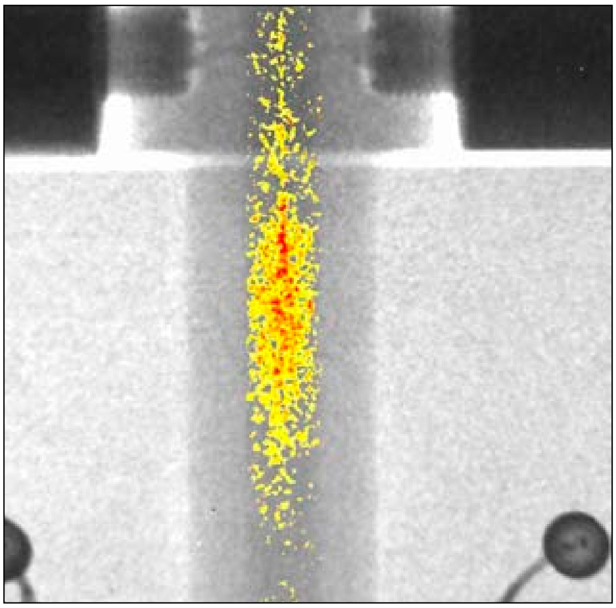

Figure 3: **Snapshot of the distribution of H_2O injected as a tracer pulse into the high pressure separator filled with D_2O (400 °C, 30 MPa; 1 s shutter time).**

Flow visualization

Important information for characterizing salt separation includes the penetration depth of the cooler salt-containing feed stream. This is visualized in Figure 3 using a fast series of images. The shorter shutter time of 1 s versus 15 s in Figure 2 leads to lower resolution in the images, but the main features can still be seen. 5 mL of salt-free H_2O were injected into the heated vessel filled with D_2O. The strong difference in neutron absorption and scattering between light water and heavy water makes it possible to visualize areas with more H_2O. The dark red area in the center is formed by the cooler and denser H_2O exiting the dip tube. In the yellow areas the H_2O has mixed with the surrounding D_2O to some extent. At this early point shown in Figure 3, the H_2O tracer had not yet traveled very far into the vessel.

These results were used to identify the best operating conditions for the salt separator, leading to precipitation free of blockages. The concentrated salt brine that accumulates at the bottom of the separator can be withdrawn continuously, and the salt-depleted stream is suitable for gasification in a catalytic reactor. Our studies have shown that sulfate ions in particular are very toxic for catalysts [4]. By separating the salts before the catalytic reactor, catalyst deactivation is less likely.

Acknowledgements

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Technological advances in the two-step H_2O-splitting thermochemical cycle

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The latest developments in solar chemical reactor technology for thermal dissociation of ZnO at 2000 K are presented here. The solar reactor features a rotating cavity-receiver lined with ZnO particles directly exposed to concentrated solar radiation. With this setup, ZnO serves simultaneously as radiant absorber, chemical reactant and thermal insulator. Experimentation was carried out at PSI's High-Flux Solar Simulator with a 10 kW reactor prototype subjected to peak radiative fluxes exceeding 5800 suns and operated over four hours in a transient ablation mode with semi-continuous feed cycles of ZnO particles. In a parallel development, Zn(g) and O_2 products were quenched at cooling rates of 120,000 K/s, preventing recombination and allowing the downstream collection of particles with 94% Zn content.

Solar-driven water-splitting thermochemical cycles offer the potential of energy efficient large-scale production of hydrogen [1]. Of special interest is the two-step cycle based on the ZnO/Zn redox reactions, comprising: (1) endothermic thermal dissociation of ZnO(s) into Zn(g) and O_2 at above 2000 K using concentrated solar energy as the source of process heat; and (2) exothermic hydrolysis of Zn to form H_2 and ZnO(s). The 2nd step of the cycle has been experimentally demonstrated using an aerosol-flow reactor for *in-situ* formation and hydrolysis of Zn nanoparticles [2]. For the 1st step, the proposed chemical reactor concept is based on a rotating cavity-receiver lined with ZnO particles that are held by centrifugal force and directly exposed to high-flux irradiation. With this arrangement, ZnO serves simultaneously as radiant absorber, chemical reactant, and thermal insulator.

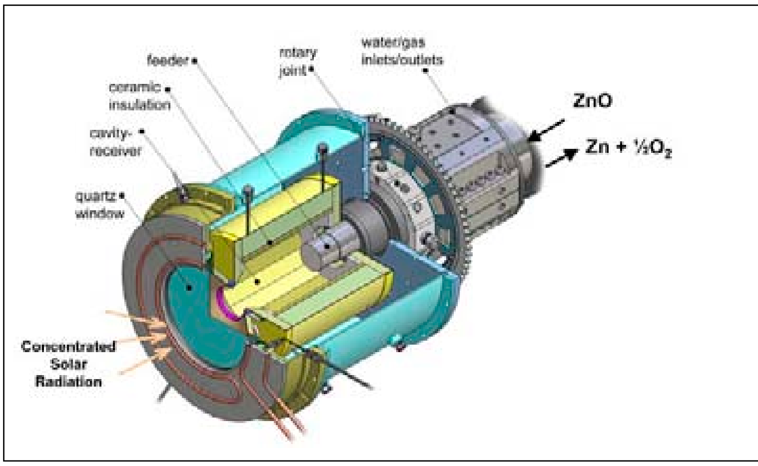

Figure 1: **Schematic of the solar chemical reactor configuration.**

Solar chemical reactor design

A schematic of the 10-kW solar reactor configuration is depicted in Figure 1 [3]. Its main component is a 160 mm-diameter rotating cylindrical cavity composed of sintered ZnO tiles on top of multi-layer Al_2O_3-SiO_2-Y_2O_3-based ceramics for thermal shock resistance, mechanical stability, gas diffusion barrier, and thermal insulation. Concentrated solar radiation enters the cavity through a 60 mm-diameter windowed aperture. The reactor has a dynamic feeder that extends and contracts within the cavity, and enables to evenly spread out a layer of ZnO particles that are held by centrifugal force. Inert gas (Ar) is injected through nozzles located around the aperture, creating an aerodynamic curtain (optimized by CFD) that protects the window from condensed Zn(g). Gaseous products Zn(g) and O_2 exit the cavity through a water-cooled annular gap, referred to as the "quench unit".

Experimentation

Experimentation was carried out at PSI's High-Flux Solar Simulator (HFSS) [4]. This unique research facility has an array of 10 Xenon arcs, each close-coupled with truncated ellipsoidal specular reflectors of common focus, and provides an external source of intense thermal radiation (radiative power > 50 kW, radiative power flux > 11,000 kW/m^2) that closely approximates the heat transfer characteristics of high-con-

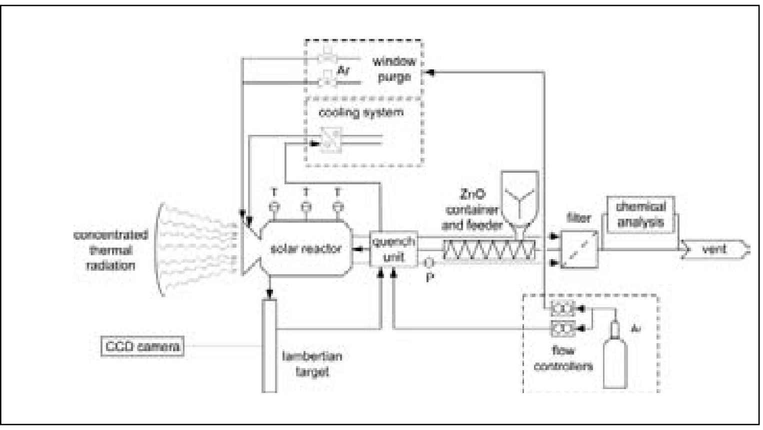

Figure 2: **Experimental set-up of the solar reactor and peripherals at PSI's High-Flux Solar Simulator.**

centration solar arrays. The experimental set-up is schematically shown in Figure 2. The radiative power input through the reactor's aperture was in the range of 1.6–9.9 kW, with a peak solar concentration ratio of 5880 suns (1 sun = 1 kW/m^2). Figure 3 shows the power input, cavity temperature (behind the ZnO tiles), and O_2 molar flow rate in the product gases measured during a four-hour experimental run with nine feed cycles of 131 g of ZnO each. To avoid feeder overheating, the power input was interrupted briefly (~50 s) during each feeding cycle. The reactor was operated under so-called "ablation" mode, where the rate of heat transfer – predominantly by radiation – to the thin layer of ZnO particles undergoing endothermic dissociation proceeds faster than the rate of heat transfer – predominantly by conduction – through the cavity walls.

Quench unit – Rapid cooling to avoid recombination of Zn(g) and O_2 exiting the solar reactor was investigated using on-line thermogravimetry coupled to a quenching apparatus, shown in Figure 4 [5]. It features three zones: 1) an inlet hot zone, incorporated at the exit of the solar reactor, where the wall temperature is kept above the ZnO dissociation temperature; 2) a transition zone still above the Zn(g) saturation temperature where an annular Ar flow (AF) impedes Zn(g)/O_2 diffusion to the walls; and 3) an outlet cold zone with water-cooled walls, where the injection of Ar quench gas (QF) sharply decreases temperatures and slows the oxidation kinetics. Measured cooling rates ranged from 20,000 to 120,000 K/s. Zinc content of the particles collected downstream varied in the range 40–94 % for Ar/Zn(g) dilutions of 170 to 1500.

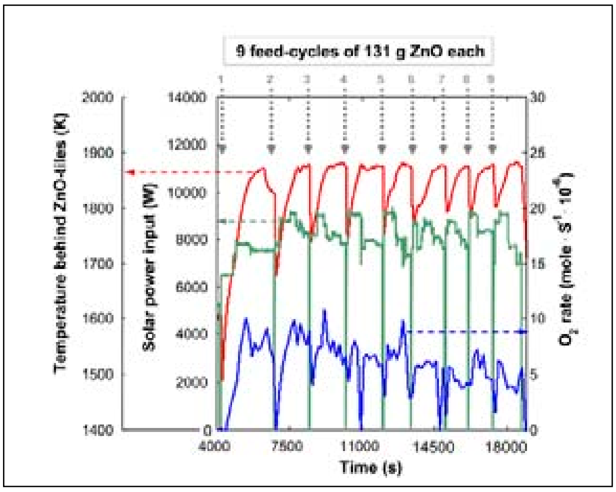

Figure 3: **Radiative power input, cavity temperature, and O_2 molar flow rate measured during a solar run with 9 feed cycles of 131 g ZnO each.**

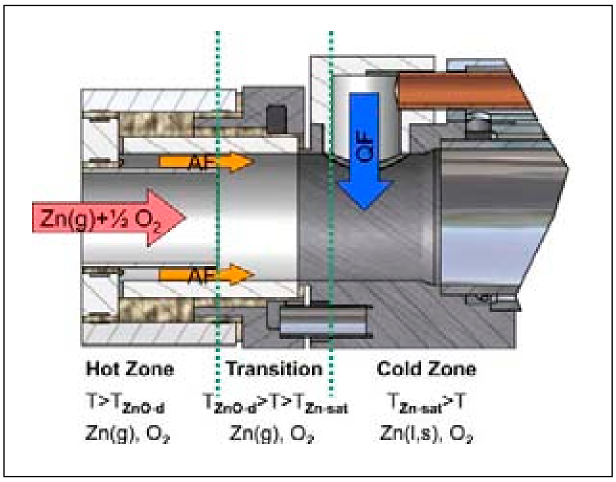

Figure 4: **Schematic of the quench apparatus illustrating the three temperature zones (AF: annular flow; QF: quench flow).**

Acknowledgements

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Combustion of syngas for power generation

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The importance of robust, low-emission gas turbine combustion systems for highly reactive, hydrogen-containing fuels (e.g. syngas) is growing rapidly, due to increased interest in power generation with gasification processes using biomass, coal or tars. These integrated power systems potentially offer lower CO_2 emissions and reduced dependency on natural gas or oil-based fossil fuels if combined with fuel gas decarbonization. The present work summarizes experimental results on syngas gas phase combustion and numerical simulations of syngas hetero-/homogeneous combustion.

Syngas consists of hydrogen (H_2), carbon monoxide (CO) as well as diluents such as nitrogen (N_2), and its chemical composition varies according to the specific feedstock (e.g. biomass, coal, tar) and gasification process. Syngas combustion properties are characterized by very high flame speeds, a wide range of flammability limits and short ignition delay times [1] which all contribute to a high risk of flashback phenomena. Low-emission syngas fuel combustion is challenging due to the difficulty in achieving the right mix before combustion. The risk of flashback and associated overheating of burner components places tight constraints on burner design.

Mixture		Vol %	Simulated Process
1	H_2-CO-CH_4	20-20-60	natural gas / co-firing
2	H_2-CO	50-50	oil gasification
3	H_2-CO	33-67	coal gasification
4	H_2-CO-N_2	40-40-20	biomass gasification; air blown gasification

Table 1: **Investigated Syngas Mixtures.**

Lean premixed combustion is currently the favored method for low-emission power generation from natural gas used in stationary gas turbines. Homogenous mixing of fuel and air combined with ultra-lean operation ensure a lower flame temperature and are key to minimizing NO_x formation. Catalytic combustion can be a viable alternative for syngas or syngas rich fuels, and seems particularly well suited for syngas based fuels with a low calorific value. Depending on the chosen power generation cycle, the fuel can either be syngas with varying H_2/CO composition, or a mixture of syngas and natural gas diluted with oxidation products [2].

Our latest work focuses on homogeneous (gas phase only) combustion of syngas and a theoretical investigation of syngas catalytic combustion. In the latter case, the combustion characteristics are investigated in a tubular channel (diameter 1.2 mm and length 75 mm) using 2D steady and transient computer codes with detailed hetero /homogeneous chemistry, transport, and heat transfer mechanisms in the solid [3]. Simulations were carried out for syngas compositions with varying H_2 and CO contents, pressures of 1 to 15 bar, and linear velocities relevant to power generation systems. The homogeneous syngas combustion experiments were performed in a generic, high-pressure combustor (400 kW_{th}). The combustor [4] has complete optical access and is designed to study turbulent, lean premixed flames at pressures up to 30 bar.

Homogeneous (gas phase) combustion of syngas

NO_x emissions for a wide, representative set of operating conditions are presented in Figure 1 [5]. For "pure" syngas mixtures (without methane) the NO_x emission data are contained in a narrow band that shows the expected exponential trend in dependence on the adiabatic flame temperature, in line with the characteristics of thermal NO_x production. The small difference in NO_x emission between the three H_2/CO mixtures can be attributed to slightly lower adiabatic flame temperatures (ΔT=30 K) for the mixture with N_2-dilution (simulating air-blown biomass gasification).

Concerning "pure" syngas mixtures, the upper operational limit of the adiabatic flame temperature was determined by flashback occurrence. It was only with low turbulence inlet conditions (no turbulence grid in the fuel supply pipe) and

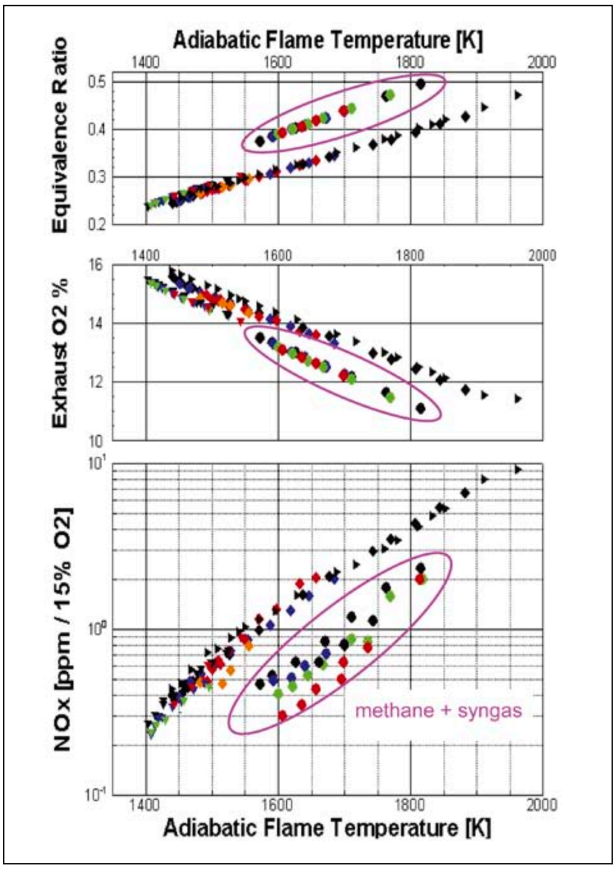

Figure 1: **NO_x emission and operational range for all investigated syngas mixtures at several conditions.**

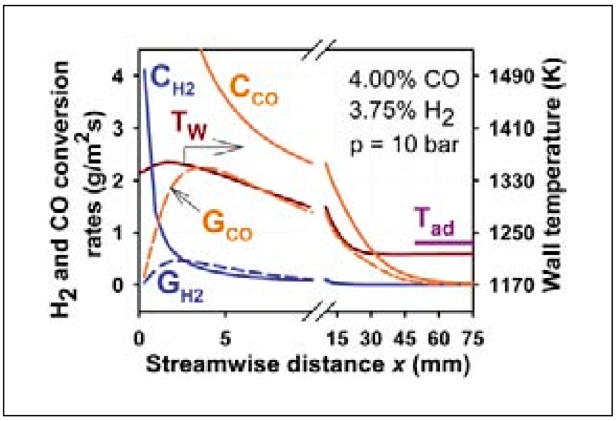

Figure 2: **Computed profiles of catalytic (C) and gas phase (G) conversion rates of H_2 and CO, and surface temperature (T_w). Inlet temperature: 600 K. Tad: adiabatic equilibrium temperature.**

moderate operating pressure (5 bar) that syngas mixtures could be operated up to equivalence ratios of $\Phi \approx 0.45$ corresponding to adiabatic flame temperatures around 1950K. With a turbulence grid in place, the operational range was strongly limited ($\Phi_{flashback} \approx 0.35$). Further tests are under way, and a detailed discussion of flashback phenomena for syngas fuel mixtures will be presented in future publications.

Heterogeneous (catalytic) combustion of syngas

For channel flow reactor studies, it was shown that the homogeneous (gas phase) chemistry of both H_2 and CO cannot be neglected at elevated pressures, even within the very large geometrical confinements relevant to practical catalytic reactors. The diffusional imbalance of hydrogen can lead, depending on its content in the syngas, to superadiabatic surface temperatures (see Figure 2) that may endanger catalyst and reactor integrity. On the other hand, the presence of gas phase hydrogen combustion moderates the superadiabatic wall temperatures by shielding the catalyst from the hydrogen rich channel core and reducing heterogeneous conversion that is responsible for wall superadiabaticity.
Based on the previous results, strategies for reactor thermal management are being developed, which include reactors with smaller geometrical confinements (larger channel radii) to promote homogeneous hydrogen combustion at the expense of catalytic combustion.

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A closer look into the heart of electrochemical cells – a few examples

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Electrochemical energy conversion and storage devices offer unique properties – high efficiency, environmental friendliness, and modularity. They are used as components in applications ranging from stationary to mobile and portable energy supply. To meet market demand, the performance and cost competitiveness of these devices have to be improved continuously. Advanced diagnostic tools developed in-house give an insight into processes occurring in these devices. Relevant spatial dimensions range typically from few nm (catalyst or electrode grains) to meters (stacks), whereas time scales range from µs (current steps) to hours (cell equilibration).

Electrochemical energy conversion and storage devices, – fuel cells or batteries – are complex macroscopic chemical reactors. Charge, mass, and heat transfer are part of the processes occurring "in their heart". Current-voltage characteristics yield an overall picture of the performance and changes over time; however, they provide no insight into the processes occurring at different spatial and time scales. A major research area during recent years has been the development of advanced diagnostic tools allowing us to take a closer look into the heart of these cells.

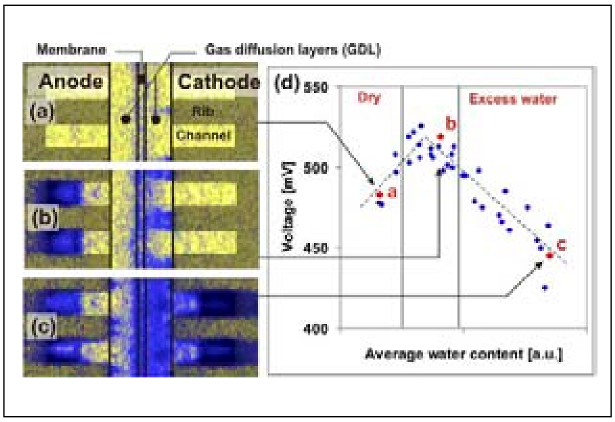

Figure 1: ***In plane*** **Neutron Radiograms (2.5 µm per pixel perpendicular to membrane) of a PEFC showing the water distribution at 1A/cm² for different inlet relative humidities at the anode/cathode: (a) 60%/0% (b) 110%/40% (c) 90%/ 110%.**

Polymer electrolyte fuel cells

Water management of PEFCs, or water distribution within the membrane-electrolyte assembly (MEA), is of vital importance for performance. Considerable progress was achieved during the past year in determining water distribution across the MEA under varying operation conditions using the ICON beamline of PSI's SINQ neutron source [1]. The correlation between operational parameters (gas flow, relative humidity) and water distribution was studied: at middle humidification levels (Figure 1b), water mainly concentrates under the ribs on the cathode side while at higher humidification levels (Figure 1c), the distribution is more homogeneous. Conditions that were either too dry (Figure 1a) or too humid (Figure1d) had a clear impact on cell performance.

Water distribution in the membrane is affected by the channel-rib geometry of bipolar plates, necessary for the distribution of reactants. As a consequence, the local membrane resistance is also affected. These variations could be detected by *sub-mm* resolution current distribution measurements at different levels of relative humidity (rh) (Figure 2) in model cells [2] and contribute to the understanding of flow field geometries as well as specific materials properties (conductivity, porosity, wetting, etc.) of gas diffusion materials [3]. Water management in particular can be optimized with respect to bipolar plate structures and operating conditions.

Changes in water distribution within a membrane undergoing a load change (stepwise increase in current) can be monitored by local measurements of the high frequency resistance along the flow field. The local transient behavior of membrane resistance under "dry" conditions (dry O_2, r.h. H_2 40%, Nafion 111

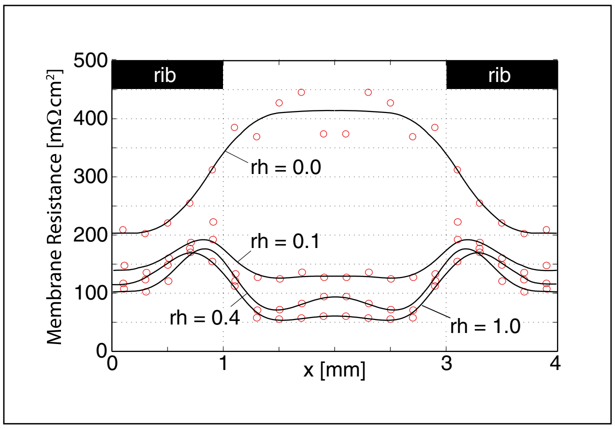

Figure 2: ***Sub-mm* resolved resistance measurements of membrane under channel and rib at different relative humidity (rh). Current density 400 mA/cm²; Tcell = 70 °C; p = 1.5 bar$_a$.**

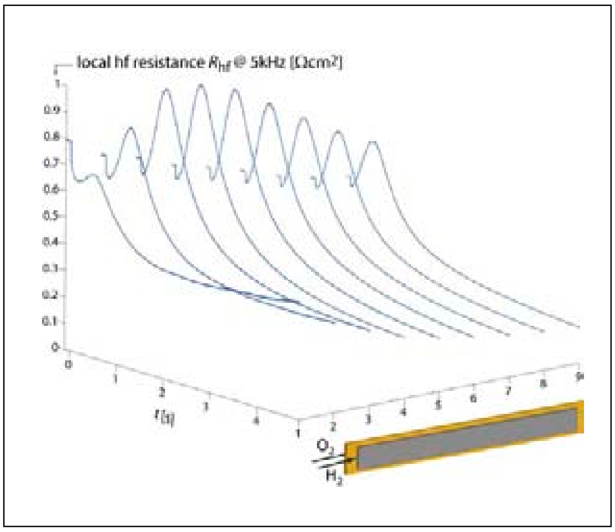

Figure 3: **Locally resolved (9 segments, 63 cm² active area) transient response of the hf resistance (5 kHz) in a nine-fold segmented PEFC with linear flow field, after a stepwise increase in current from 0.1 to 0.8 A/cm².**

membrane) was demonstrated for the first time (Figure 3) in a nine-fold segmented cell with linear flow field [4]. Local response is determined by two processes: i) depletion in water content at the anode due to higher electroosmotic drag from the anode to the cathode after the step, and ii) higher water production rate at the cathode and transport of water back into the bulk of the electrolyte.

The results show that even for a thin membrane (25 µm) the high frequency resistance increases locally within a few hundreds of milliseconds after the step as a consequence of anode drying. Yet, as product water starts to rehydrate the anode the resistance reaches a maximum and then decreases within a time frame of around 10 s as a consequence of the improving hydration state of the membrane at an overall higher current density.

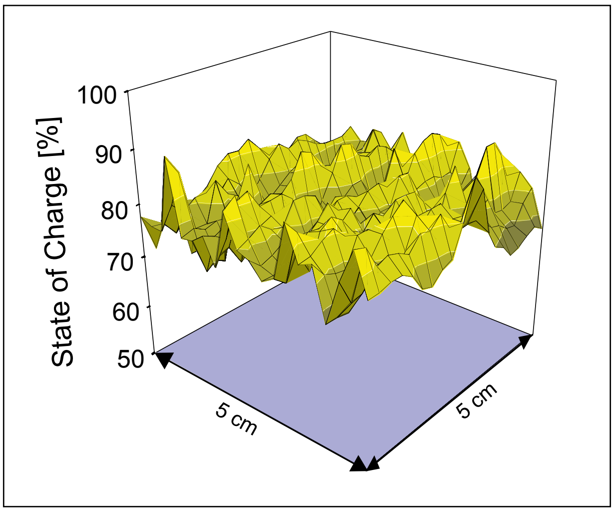

Figure 4: **Locally resolved state of charge of a carbon-based anode.**

Lithium-ion batteries

Lithium-ion batteries use graphitic carbons as intercalation material for the negative electrode (anode). The electrode is comprised of a mixture of electronically interconnected particles. Inhomogeneities in lithium distribution can develop during repeated charge cycles. The state of charge of graphitic carbons reflects itself in a different color, ranging from “gold” for a 100 % value for the state of charge to more or less “dark” for a 50 % value.

A homogeneous charge distribution state over all particles would be favorable, in order to achieve the optimal possible charge density for the respective electrode potential. A novel colorimetric method has been developed that analyses the color of the electrode surface and allows the determination of the local charge (Figure 4) [5]. These results are important for the evaluation of the cycling stability of lithium-ion batteries.

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Competence Center Energy and Mobility CCEM – first results from an active research network

Philipp Dietrich, Alexander Wokaun, *PSI*

In the second year of operation of the Competence Center Energy and Mobility CCEM, a new series of projects was funded, and initial results were obtained in several other projects. The investment projects have progressed from planning to the realization phase, and in 2008 the facilities will be available to research groups. The collaboration with two Universities of Applied Sciences could also be formalized to foster the contribution of research groups from these institutions. On several occasions, CCEM also contributed to the energy debate in Switzerland. Among the most visible actions is CCEM's scientific contribution to the "Energie-Trialog-Schweiz".

CCEM has completed its second year of operation. The creation of research consortia and capacity building dominated activities. With new projects launched in the second and third calls for proposals, the CCEM's available financial capacity was fully engaged. Seventeen projects in the fields of mobility, electricity and construction as well as renewable fuels were approved and launched. All institutions of the ETH-domain are represented in these projects. Beside industrial contributions, several Universities of Applied Science (UAS) are integral project partners as well. To finance the contributions of the UASs, framework agreements have been signed with some schools.
From the PSI perspective, these activities are well connected with the research activities of the departments of General Energy research and Nuclear Energy and Safety.

First results of collaborative projects

Cross-institutional collaboration is well established. Two examples to highlight this: The first joint Master between ETH Zurich and EPF Lausanne could be established. For this Nuclear Engineering master program, both schools and PSI are collaborating for teaching purposes.
As part of the project for cost-efficient thin-film photovoltaics, a discussion platform involving all major research groups pursuing the different thin-film technologies as well as industrial companies active in the field, was established. The goal is to exchange and foster techniques that are valuable for all or some of the participating groups.

In the field of *mobility,* where eight projects have been launched, PSI is participating in five of these. In the HY.MUVE project a team from EMPA and PSI is developing and testing a municipal vehicle with a hydrogen-based fuel cell system (Fig 1.). The system layout has been finalized, and the potential for energy consumption reduction has been simulated compared to the current series production version with an internal combustion engine. Based on these simulations, the two hydraulic circuits of the vehicle will be substituted by electric ones.

Figure 1: **Municipal vehicle to be converted and the fuel cell powertrain for enabling local emission-free operation.**

In the field of *renewable fuels* the project "Second Generation Biogas – new pathways to efficient use of biomass for power and transportation" aims to demonstrate the technical feasibility of new highly efficient process paths to pipeline-grade methane from a very broad range of biomass (wood, solid agricultural residues, manure, sludges etc.) with a team from PSI, EMPA, EPFL, ETHZ, EAWAG and WSL

In the field of *electricity production* seven projects have been launched; PSI is contributing to four of them. In the project named "Computational Engineering of Multiscale Transport in small-scale surface based Energy Conversion" (CEMTEC), a team from ETHZ, EPFL, PSI and EMPA is developing a numerical tool to simulate multicomponent reacting flows in porous media, with specific applications in solid oxide fuel cells (SOFC) and microreactors for portable power generation. The collaboration among different partners will provide the numerical groups with the data needed for the implementation and validation of new accurate models. In 2007 a new, complete and systematic array of Lattice Boltzmann models was derived, implemented and tested, with a specific focus on compressible flow simulation, simulation of microflows beyond continuum physics, and extensions to include surface-based chemical reactions of multicomponent mixtures.
Furthermore, a study of reforming activity of rhodium nanoparticles was completed based on the experimental investigation of a reacting multicomponent flow in porous micro reactors. The acquired data about reaction kinetics will serve as a basis for the validation of computational models of SOFC porous anodes. A macroscopic model of SOFC anodes with internal reforming of the steam/methane mixture has been developed utilizing a Computational Fluid Dynamics (CFD) software package.
A new method to make Ni-cermet SOFC anodes, molten carbonate fuel cell anodes and fuel processing catalysts less sensitive towards sulphur was also invented, and the manufacture of these catalysts developed. Chemical speciation of sulfur on a set of pristine and operated SOFC anodes was carried out using S(1s) X-ray absorption spectroscopy.

In the *heat and buildings* field two projects are underway. One of the two projects is dedicated to improving the energy efficiency of buildings undergoing renovation, whereas the second project is investigating technologies for new constructions.

New facilities

A nano-indenter and a focused ion beam (FIB) have been installed at PSI in laboratories that handle radioactive substances. At EMPA, an indentation device for a scanning electron microscope (SEM) and a dual-beam FIB prototype have been installed. With this equipment, material behavior of micrometer-sized samples can be analyzed. Other groups than those who host the installation can also use the facilities. Planning for a second investment, a new dynamometer test bench for heavy-duty truck engines at EMPA, was completed. Construction of the building started in autumn 2007. Start of operations is planned in summer 2008. A third investment is the research-facility for large engines (a 1.2 MW Engine) to be installed at PSI. The construction of a test bench shall be finished in 2008.

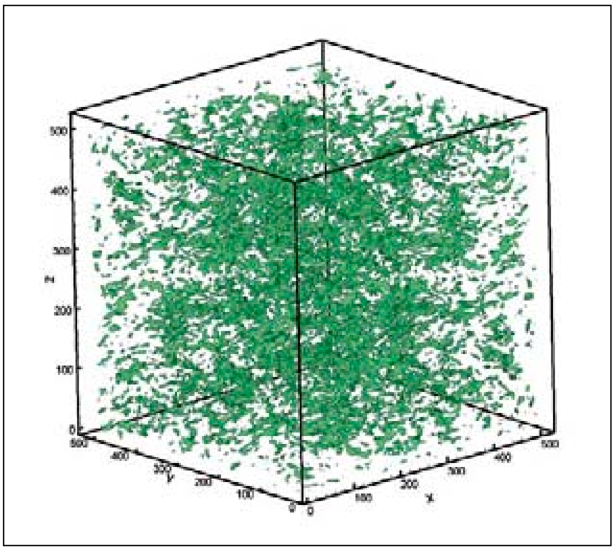

Figure 2: **Entropic Lattice Boltzmann simulation of the three-dimensional Kida-vortex flow at Re=20000. Iso-vorticity surfaces at the peak of enstrophy are presented on a 512x512x512 grid.**

Interaction with society

The discussion on energy use and its perspectives, as well as its interaction with climate, intensified in 2007. Experts of the CCEM-network made many scientific contributions to a more factual dialogue. In particular, CCEM contributed substantial input to the "Energie-Trialog-Schweiz", an initiative to explore a road map for the future Swiss energy supply mix. This initiative tries to foster the understanding between society, economy and science.

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Monitoring the embrittlement of reactor pressure vessel steels by using the Seebeck coefficient

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The degree of embrittlement of a reactor pressure vessel (RPV) limits the lifetime of a nuclear power plant (NPP). Therefore the neutron-irradiation-induced embrittlement of RPV steels demands accurate monitoring. Current federal legislation requires a surveillance programme in which specimens are placed inside the RPV for several years before their fracture toughness is measured (by notched-bar impact testing). The INTEGER project aims to find alternative, non-destructive diagnostic methods for the prediction of material degradation, such as embrittlement, by measuring changes in specific material properties. Changes in the thermoelectric properties of the material due to irradiation is one such alternative. Consequently, the Seebeck coefficient (S) of several specimens irradiated by neutrons with energies greater than 1 MeV, and with fluences ranging from 0 up to $4.5 \cdot 10^{19}$ neutrons per cm^2, were measured [1]. Within this range, it was observed that S increased by ≈ 500 nV/°C, and a linear dependency was noted between S and the temperature shift ΔT_{41J} of the Charpy energy vs. temperature curve, which is a measure for the loss of fracture toughness. The conclusion is that the change in S has the potential for non-destructive monitoring of the neutron embrittlement of RPV steels.

Embrittlement of the RPV due to neutron irradiation

The RPV of a nuclear reactor is one of the most important safety barriers between the fuel and the environment. Therefore, making sure it retains its integrity is of vital importance. Irradiation of RPV steels with a neutron fluence $\phi \geq 10^{17}$ n/cm², and with energies above 1 MeV, may result in defects in the material, leading to an increase in yield strength and a decrease in fracture toughness (embrittlement). As part of the surveillance programme for NPPs, this toughness is measured by means of the energy absorbed when breaking a V-notched specimen (i.e. Charpy energy). This fracture energy is measured as a function of temperature, yielding a Charpy-energy vs. temperature curve. The curve has a steep slope at the temperature where the material goes from ductile to brittle. Material embrittlement can be represented by the shift, ΔT_{41J}, of the ductile-to-brittle transition zone. Since a failure of the RPV would result in an accident, the lifetime of a NPP is ultimately limited (among other factors) by its approved minimum fracture toughness.

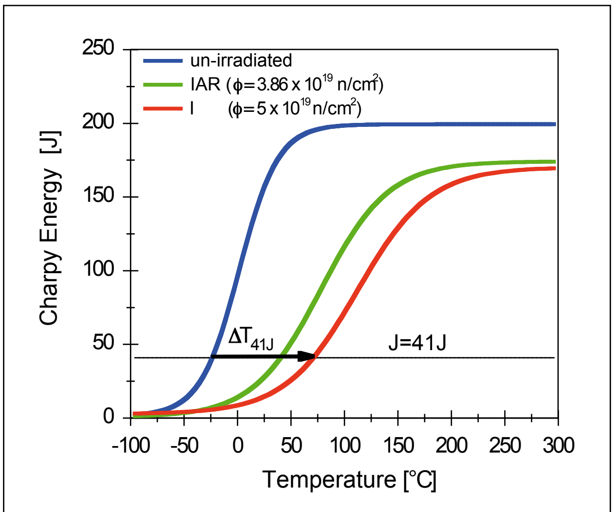

Figure 1: **Charpy energy vs. temperature for un-irradiated, irradiated (I), and irradiated-annealed-re-irradiated (IAR) specimens [2].**

The Charpy energy vs. temperature curves for two sets of Japanese RPV steel (according to ASTM 533 B Cl. 1) is shown in Fig. 1. Set I (irradiated) was irradiated with fluencies from zero up to $\phi=5\times10^{19}$ n/cm². A second set IAR was irradiated up to $\phi=2.5\times10^{19}$ n/cm², then annealed (18h at 460°C) before being re-irradiated up to 4.5×10^{19} n/cm². The shift of the transition temperature, ΔT_{41J}, between the ductile and brittle regimes was measured at a Charpy energy of 41J.

Correlation between Seebeck coefficient and material embrittlement

The thermo-electric Seebeck effect, often employed for measuring temperatures with thermocouples, has been considered as a possible non-destructive method for diagnosing mate-

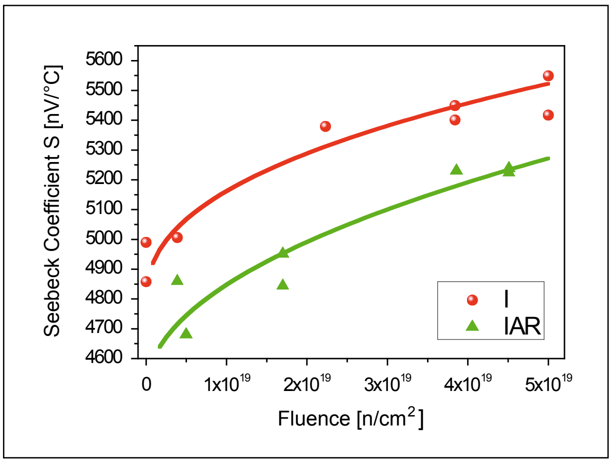

Figure 2: **Measured Seebeck coefficients for irradiated (I) and irradiated, annealed and re-irradiated (IAR) specimens.**

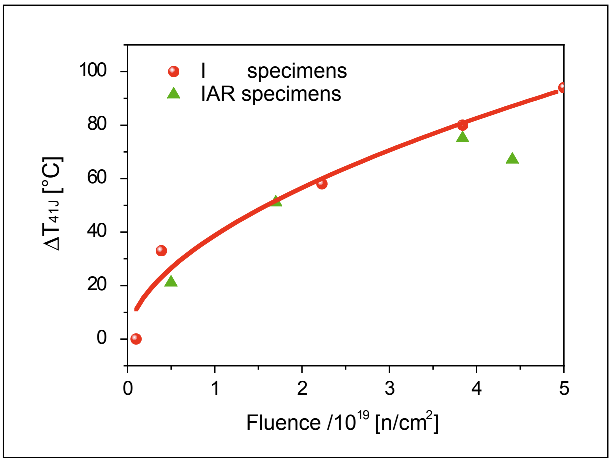

Figure 3: **The shift ΔT_{41J} of the transition temperature vs. fluence for the I and IAR specimens.**

rial degradation. In our case, the Seebeck coefficient (S) was measured for two sets of irradiated specimens, I and IAR. As shown in Fig. 2, S increased monotonously by about 500 nV/°C due to neutron irradiation with a fluence of $5x10^{19}$ n/cm^2. This requires very precise measurements of temperature and thermo-electric voltage.

Thermo-electrical voltage

In solids, heat is transported by phonons and free electrons. For metals, the main contribution to thermal conduction results from the electrons, which are carriers of both thermal energy and electric charge. This means that thermal and electric currents are coupled, with the consequence that an electric current accompanies heat transfer. This is the origin of the Seebeck effect, the manifestation of which is the generation of a thermo-electric voltage that follows

$$U = \int_0^l E(x)dx = \int_0^l dx S(T,x)\frac{\partial T}{\partial x} = \int_{T_0}^{T_1} S(T,x)\ dT = S(T_1 - T_0)$$

the path of the temperature gradient $\partial T/\partial x$ between points 0 and 1. The quantity $S(T,x)$ is the Seebeck coefficient, which depends on temperature T and location x, while E represents the accordant electric field. By measuring U and $\Delta T=T1-T0$, the average Seebeck coefficient $S=U/\Delta T$ is obtained, which is a material property that may change due to material degradation. In practical terms, a temperature difference $\Delta T=10°C$ is applied between two points and the thermo-electric voltage U generated between them is measured.

As indicated in Fig. 1, the transition temperature shift ΔT_{41J} has been measured at the energy level of 41J. In Fig. 3, ΔT_{41J} is plotted as a function of the neutron fluence ($\Delta T_{41J}=f_1(\phi)$), and shows a dependency on the fluence similar to that of the $S=f_2(\phi)$ shown in Fig. 2.

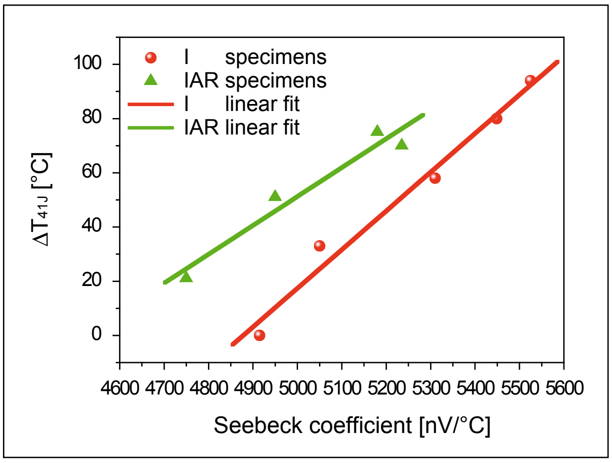

Figure 4: **Correlation between ΔT_{41J} and the Seebeck coefficient for the I and IAR specimens.**

Figure 4 illustrates the almost linear relationship between ΔT_{41J} and S, evaluated for the I and IAR materials. Once $\Delta T_{41J}(\Delta S)$ is known, the degree of embrittlement can be determined just by measuring the Seebeck coefficient. This represents the non-intrusive measuring technique we were seeking.

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The influence of competitive sorption processes on radionuclide migration

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Reactive transport calculations contribute increasingly to our understanding of geochemical processes occurring in the vicinity of nuclear waste disposal facilities. Sorption, the dominant retardation process for radionuclides, competes with the sorption of other ions in solution for the same sites. Recent calculations, taking into account competitive sorption processes, have shown that radionuclide retardation may be reduced, depending on the valence of the radionuclide and on the chemistry of the porewater.

Bentonite is likely to be used as a buffer material surrounding high-level nuclear waste canisters (Fig. 1), due to its capacity to sorb radionuclides and other cations.

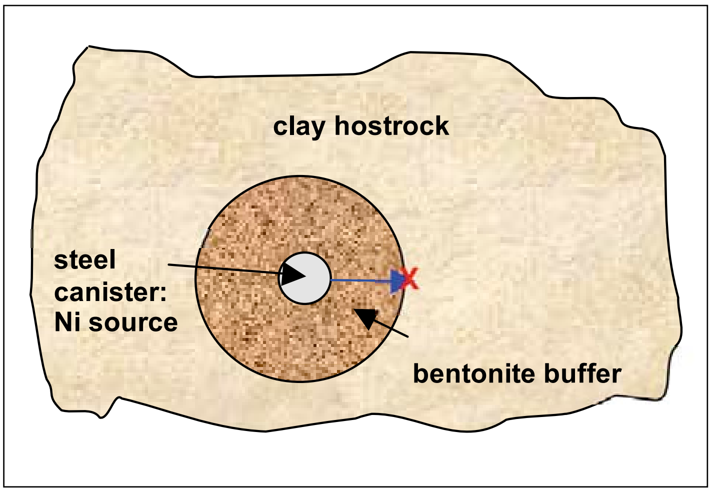

Figure 1: **Schematic cross-section through the nearfield of a high-level nuclear waste repository. The migration path is indicated by the blue arrow; X indicates the interface for which the Ni arrival time is calculated.**

Radionuclide sorption on bentonite has been measured in laboratory experiments yielding so-called distribution coefficients, or K_d values, which describe the equilibrium partitioning of the radionuclides between the bentonite surface and the pore water. The greater the distribution coefficient, the stronger the retardation. The values found are used in calculations for performance assessment studies of high-level waste repositories with a single value for each radionuclide, independent of other ion concentrations in solution. The uncertainty in individual K_d values is taken into account by making conservative estimates to define a reference, an optimistic, and a pessimistic value. The whole geochemical interaction of any particular radionuclide is then summarized with this single K_d value.

Recent laboratory sorption experiments with radionuclides and other ions indicate that competition for sorption sites exists for equivalently charged metals, influencing radionuclide sorption. Since bentonite and its water composition change over time in the repository, due to interaction with the surrounding host rock and with the waste canister, the concentrations of competing ions also changes. Canister corrosion will also probably increase the Fe(II) concentration already present within the bentonite porewater. The Fe(II) ion will compete with transition metals such as Ni(II), leaching from the waste matrix, for the same sorption sites and thus reducing the sorption of these metals (Fig. 2).

Better computer performance now allows radionuclide transport calculations that take into account all other relevant species in solution – in this case more than 100 – as well as the different mineral phases and related sorption sites. A changing pore water composition and/or changing sorption site occupancies can be automatically included in calculating the Ni(II) migration. This procedure takes into account the near-field evolution of the repository, and describes the complex geochemical system in great detail, using explicit sorption reactions and mechanistic models, without the need to use conservative estimates of the K_d values. Furthermore, the improved radionuclide transport calculations lead to more robust predictions of repository performance.

For the calculations, the 2-Site-Protonation-Non-Electrostatic-Surface-Complexation / Cation-Exchange (2SPNE SC/CE) model was included in the reactive transport code MCOTAC describing multi-species 1-D transport (here diffusion) away from the waste canister surface through the bentonite; related data were deduced from laboratory experiments. The

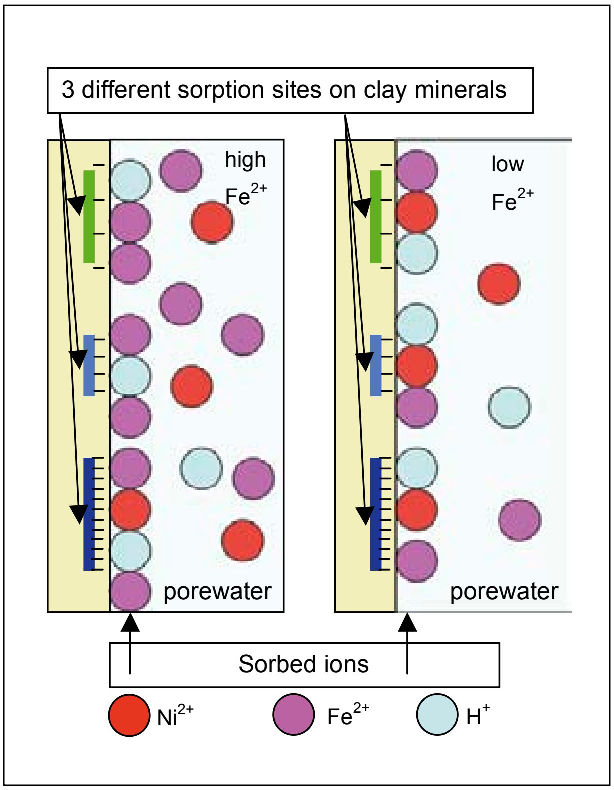

Figure 2: **Competition between Fe^{2+} and Ni^{2+} on three different sorption sites. Lower Fe^{2+} in solution results in an increased sorption of Ni^{2+} (right), and vice versa.**

Fe(II) sorption parameters were estimated using the Linear Free Energy Relationship (LFER) of Bradbury & Baeyens [1], as implemented in the geochemical database used by MCOTAC.

Concentrations of Fe(II) in the bentonite porewater were measured by means of careful laboratory experiments, and determined by the solubility limit of the mineral siderite contained in the bentonite. The results, which show the Ni concentration as a function of time at the bentonite-clay interface (X in Fig. 1), were compared with simplified calculations using the K_d approach, integrating values from the last safety report [2]. The comparison is shown in Fig. 3.

Applying the mechanistic sorption model for Ni(II) only – i.e. no competition from other sorption processes – already yielded a lower retardation of Ni(II) compared to the optimistic K_d approach. Taking into account competitive Fe(II) sorption reduces Ni(II) retardation by an order of magnitude, i.e. Ni(II) arrives an estimated 90000 years earlier at the bentonite interface to the host rock than in the case when competitive sorption with Fe(II) is not taken into account. Nevertheless, the results of these complex calculations still lie within the boundary values of the arrival times determined for pessimistic and optimistic K_d values. However, additional competitive sorption of other bi-valent ions, such as Mn(II), or further increases in Fe(II) concentrations due to canister corrosion, mineral alteration and secondary mineral precipitation, will be investigated in order to improve understanding, and to fully incorporate these processes in performance assessment studies.

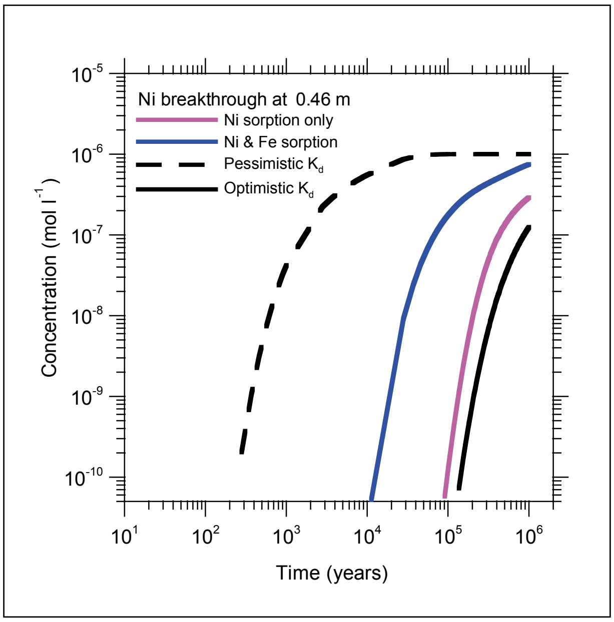

Figure 3: **Calculated Ni^{2+} concentration at the bentonite buffer/host rock interface. Sorption of Ni(II) is described by multi-species reactive transport, including mechanistic sorption models. A second calculation accounts for the effects of sorption competition between Ni and Fe. The results from calculations based on the simple K_d approach using bounding pessimistic and optimistic K_d values for Ni(II) are also shown.**

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Experimental validation of the reactivity loss of highly-burnt PWR fuel

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As nuclear utilities are generally increasing the total energy extracted from the fuel, interest in extending the validation base for core analysis methods to high burnup is growing. In Phase II of the LWR-PROTEUS experiments, the reactivity loss of a Pressurized Water Reactor (PWR) fuel has been directly measured by inserting fresh and burnt fuel samples into a PWR test lattice. Analysis carried out using an industry-standard fuel assembly depletion code shows close proximity between estimated and measured reactivity effects.

With increasing discharge burnup of commercial Light Water Reactor (LWR) fuel, validation of estimates of fuel reactivity loss up to high burnup becomes more important for both core design calculations (used for fuel management and safety analysis) and burnup credit for the storage and transportation of spent fuel. Phase II of the LWR-PROTEUS experimental programme, carried out in the framework of a collaboration between PSI and Swiss nuclear utilities, has addressed these issues by measuring the reactivity worths and isotopic composition of highly-burnt fuel rod samples from Swiss nuclear power plants. Analysis of the reactivity worths of PWR fuel samples using CASMO-4E fuel assembly code is presented here.

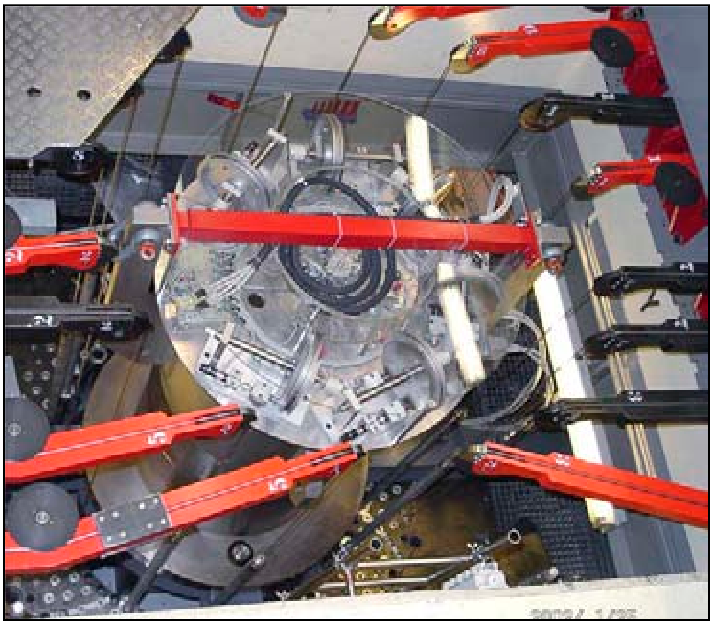

Figure 1: **The shielding flask and sample changer on top of the PROTEUS reactor**

Experiments

The reactivity worths of 40 cm-long samples from fuel rods irradiated in the Gösgen PWR were measured by oscillation in the PROTEUS facility. Seven UO_2 samples with burnups ranging from ~40 to ~120 MWd/kg, and four MOX samples with burnups between ~20 and ~70 MWd/kg, were investigated as part of the study. The highly radioactive samples were placed inside a special shielding flask (Fig. 1), from which one sample at a time could be lowered into the reactor by remote control.

PROTEUS is a zero-power experimental reactor in which the central test zone – too small to sustain a fission chain reaction by itself – is driven critical by the surrounding thermal driver regions. The layout of the test zone, together with a suitably designed buffer region, ensures that the impact of the outer zones on important neutronics characteristics is negligible at its centre. For the experiments described here, the central test region was constituted of PWR UO_2 fuel rods.

The reactivity effect of replacing a fresh UO_2 reference sample (whose enrichment is the same as the initial value for the burnt samples) by a burnt one was determined both by compensation, using a calibrated, automatically-driven, fine control rod, and by the inverse kinetics method [1]. This reactivity difference was divided by the effect of replacing the fresh enriched sample by a natural U one. The ratio of these two reactivity changes

$R = \Delta\rho(\mathit{fresh} \rightarrow \mathit{burnt})/\Delta\rho(\mathit{fresh} \rightarrow \mathit{natural})$

is, unlike absolute reactivity worths, independent of the size of the system calculated, and can thus be directly compared to the values calculated for a reduced-size configuration. Measurements were performed in three different moderators (and hence different neutron spectra) in the test region: pure light water (full density at room temperature), a mixture of heavy and light water in approximate proportions 1/3 to 2/3 (simulating hydrogen density at the operating temperature of a PWR), and light water poisoned with 2000 ppm of natural boron. The experimental precision of the reactivity worth ratios is approximately 0.5% (1σ).

Calculations

All calculations were carried out using CASMO-4E fuel assembly code, and a cross-section library based on ENDF/B-VI. Irradiation histories were followed in detail using data obtained from nodal core-follow calculations, and the surroundings of the samples as well as the relocations of the highly-burnt (>4 cycles) UO_2 samples to different assemblies were modelled. Radioactive nuclide decay was calculated until the time of the measurements. Comparisons of the calculated nuclide inventories with the results of chemical analyses have been published previously [2].

The reactivity worths of the samples were determined from CASMO-4E calculations for a "reflected-assembly" model of the PWR test region. In these calculations, the compositions of the samples obtained from the depletion calculations described above, as well as those of the fresh enriched and natural U samples, were successively allocated to the central rod position, while keeping axial buckling fixed at the critical value for the case of the reference sample (fresh enriched U). The reactivity worth ratios relative to natural U were then computed from the multiplication factors found for the different samples at the central position.

Results

A comparison of calculated and measured reactivity worths is shown in Fig. 2 in terms of calculated-to-experimental (C/E) ratios for the reactivity worth ratios relative to natural U plotted vs. the sample burnup. It can be seen that CASMO-4E predicts the reactivity loss with burnup accurately: the average of the C/E ratios for all the samples, and all the moderators, is 0.99, with a standard deviation of 0.024. However, a certain spread between the different moderators can be seen. In particular, the C/E ratios for pure light water are generally somewhat lower than those for the other two cases. For the D_2O/H_2O mixture, all the C/E ratios lie in a narrow band between 0.98 and 1.01, whereas larger spreads can be observed for pure and borated H_2O. An increasing trend of the C/E ratios with burnup (i.e. weaker under-prediction of the reactivity worth for higher burnup) is apparent for the pure light water moderator only.

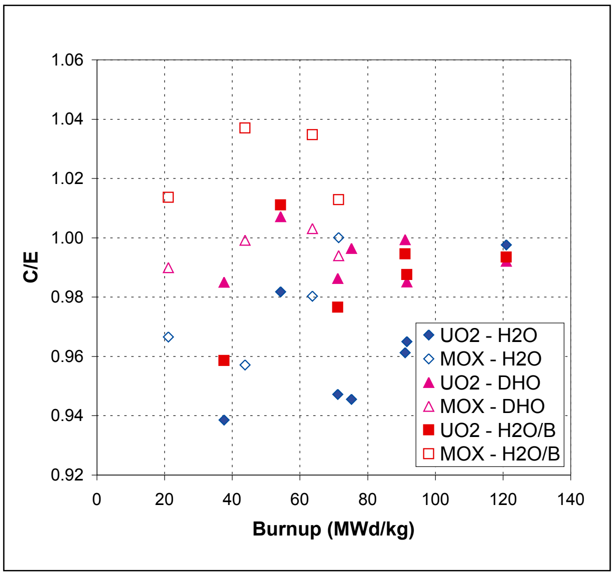

Figure 2: **Calculated-to-experimental (C/E) ratios for the reactivity worths of the burnt samples vs. burnup (DHO = D_2O/ H_2O mixture, H2O/B = borated H_2O)**

Conclusions

The reactivity loss of PWR fuel with burnup has been directly measured by successively interchanging fresh and highly burnt fuel samples in a PWR lattice in the framework of the LWR-PROTEUS Phase II programme. Comparison of the results with the values calculated using CASMO-4E demonstrated the high quality in the prediction of this reactivity loss: discrepancies are within a few percent, even for the very high burnups (up to 120 MWd/kg) of some samples, and the accuracy of the prediction does not deteriorate at high burnup.

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Aerosol removal in the ARTIST steam generator facility

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A particular safety challenge to a nuclear power plant might arise from a Steam Generator Tube Rupture (SGTR), which combined with other failures, could lead to a core meltdown, resulting in radioactive fission products entering the environment. The ARTIST project (2003–2007) at PSI has provided a large database of aerosol and droplet retention measurements for a model steam generator (SG). The studies have shown that the risks associated with SGTR are at least one order of magnitude lower than earlier estimates.

Despite their low probability, SGTR containment bypass sequences represent a significant, or even dominant, risk factor. Although probabilistic safety assessments (PSA) take little account of fission product retention in the secondary side of a SG, its complex geometry in fact provides a large surface area on which fission products might be deposited. However, the processes that control retention are complex and there are no reliable models or empirical data that provide accurate assessments of particle removal rates. Based on the need for more accurate aerosol retention data during an SGTR, a model steam generator was built at PSI. The facility called ARTIST (Aerosol Trapping In a Steam Generator), is a scaled-down version of the SG in operation at the Beznau nuclear power plant (KKB) and enables data collection at both the separate-effect and integral levels.

The ARTIST facility consists of a tube bundle, a separator unit (1:1 scale), and a dryer cell (1:1 scale). The tube bundle section is composed of a scaled 0.57 m diameter tube bundle, comprised of 274 straight tubes with an outer diameter of 19.05 mm and a height of 3.8 m. Features include a U-bend section on top of the tube bundle, a tube sheet, three support plates and a shroud. A schematic representation of the ARTIST test section in comparison to the KKB steam generator is shown in Fig. 1. The aerosol mixture, generated in a fluidized bed, is transported to the ARTIST test section by a carrier gas composed of steam and non-condensable gas (N2 or Air) in appropriate proportions.

A sophisticated aerosol measurement system is attached at the inlet and outlet piping system to determine the aerosol particle size and concentration. An axisymmetric, guillotine-type break, with a one-diameter equivalent flow area, is used in all tests.

Figure 1: **Schematic of the KKB SG alongside the ARTIST facility showing the relative proportions.**

The ARTIST consortium project

Initiated by PSI, the ARTIST consortium brings together 12 organizations. Under its stewardship, a total of 90 aerosol and droplet tests were carried out. Seven distinct accident phases were considered to assess the aerosol particle and droplet retention potential in the various sections of the SG, from the

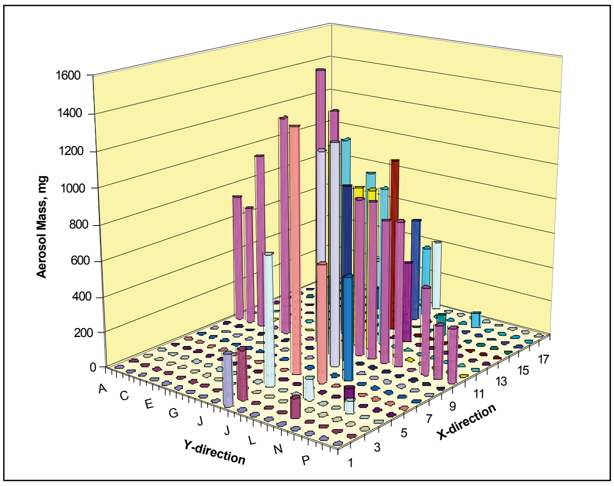

Figure 2: **Aerosol deposition profile in the tube bundle.**

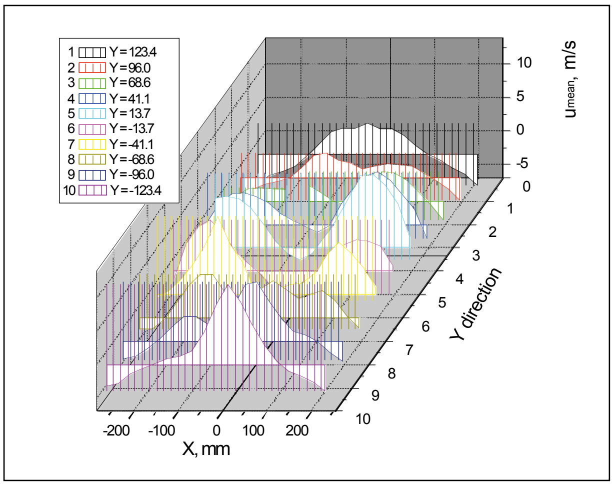

Figure 3: **Vertical velocity profiles in the tube bundle.**

breach location all the way to the separator and dryer sections. Here we present a short summary of Phase II of the programme, which deals with aerosol particle removal in the bundle region where the break occurs. The break is located 250 mm above the tube sheet, near the centre of the tube bundle.

ARTIST Phase-II: aerosol removal and flow characterisation near the break

Monodisperse spherical SiO_2 particles, with aerodynamic diameters of 1.4 µm and 3.7 µm, were fed through the break. Velocities reached several hundred m/s near the break location, but decreased significantly as the flow dissipated in the radial and axial directions. Measurements using several devices showed that aerosol removal rates were substantial. Detailed post-test measurements on selected tubes indicated that aerosols were deposited on a large fraction of the bundle tubes (Fig. 2).

Measurements of velocities in the region of the break were taken using Laser Doppler Anemometry (LDA). Mean and rms values of the vertical velocity profiles were collected at different horizontal planes. Figure 3 shows the mean velocity profiles in the plane 350 mm above the break. The complex flow structure in the bundle is clearly visible, and the fact that the break is slightly off-centre can also be seen.

Aerosol deposition in the break region is intimately linked to the prevailing flow pattern. To improve our understanding of the jet dissipation dynamics, CFD computations were performed using Fluent code. In a first exercise, a hexahedral grid with 6 million cells was constructed, and simulations were undertaken employing the isotropic *k*-ε and anisotropic Reynolds Stress Model (RSM) turbulence models.

As seen in Fig. 4 for a sample comparison with the data, only the RSM model provides qualitative agreement with the measured velocity trends. Better quantitative agreement will

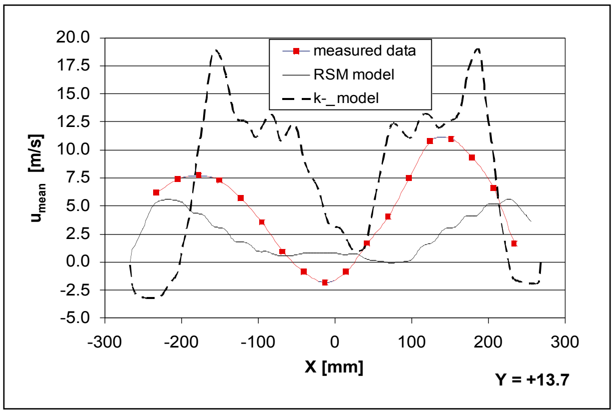

Figure 4: **Comparison between CFD and measured velocity data.**

be sought in a second step, by incorporating a higher resolution grid and using an enhanced wall treatment rather than the standard wall function approach employed in this scoping study.

Conclusions

The ARTIST consortium tests have provided invaluable data on aerosol and droplet retention in a model SG. Through scaling and use of severe accident system codes, the ARTIST data have demonstrated that the SGTR bypass risk uncertainty is at least an order of magnitude lower when compared to earlier estimates. The project has also provided a forum for measurements, systems code and CFD code predictions as well as help advance our understanding of the complex phenomena encountered in SGTR events.

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Climate records preserved in high-alpine glaciers

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Understanding present and future climate change depends on knowledge of natural climate variability. High-resolution ice core records provide particularly good proxies for past climate and atmospheric parameters. This is illustrated with the ammonium record of an ice core from Nevado Illimani in Bolivia, used to reconstruct tropical South American temperature anomalies over the past 1,600 years. Major findings are that the Medieval Warm Period (MWP) and Little Ice Age (LIA) type episodes are distinguishable in tropical South America, a region for which, until now, only very limited temperature proxy data exist.

Introduction

The temporal and spatial extent of climate fluctuations during past millennia is strongly debated. While the terms "Little Ice Age" and "Medieval Warm Period" can be used without controversy to describe the most recent advances of mountain glaciers in Europe during the 16th – mid 19th century and the relatively warm conditions in Europe during the 10th – 12th century, this notion has been dismissed for globally synchronous cold and warm periods. There is evidence for colder and warmer periods in many locations beyond the influence of the North Atlantic [1], but their timing, magnitude and spatial extent are unclear. This is especially true for the tropics, where proxy data are scarce. Furthermore, temperature reconstructions using oxygen isotopes in tropical ice cores are also hindered by the isotopes' sensitivity to precipitation in tropical regions [2].
We present here the ammonium record of an ice core from Nevado Illimani (16°39'S, 67°47'W; ~6300m asl, Figures 1 and 2), Bolivia, as a new proxy for tropical temperature.

Figure 1: **Nevado Illimani, Bolivia (photo courtesy of Bernard Pouyaud). The ice core was drilled in the central glacier saddle.**

Calibration

The timescale for the Illimani core was derived from a multi-proxy approach including annual layer counting, tritium and volcanic reference horizons (including the "1258 AD" volcanic eruption) and ^{14}C dating [3]. A two-parameter model was fitted to these time markers to get a continuous depth – age relationship.
Ammonium (NH_4^+) in the Illimani ice core is believed to originate mainly from tropical vegetation in the Amazon Basin and is transported by easterly winds to the Illimani. Warmer (or colder) tropical temperatures are thought to influence the source strength and results in higher (or lower) amounts that are deposited on the glacier.
Because there are no long-term series of instrumental station data available for this region, the gridded HadCruT3 dataset of 30°S – 30°N tropical temperature anomalies [4] from 1850 to 1998 was used for this analysis. The NH_4^+ data were averaged to yearly values and split into different series for calibration (1998-1924) and verification (1924-1850) (Figure 3). The calibration series showed a significant correlation ($p<0.001$) with annual tropical temperature anomalies.

Reconstruction

The reconstructed temperature anomalies for the last 1600 years (Figure 4) show a period with lower temperatures during the 7th to 10th century followed by relatively warm conditions

Figure 2: **Satellite image of South America and location of Nevado Illimani (16°37'S, 67°46'W).**

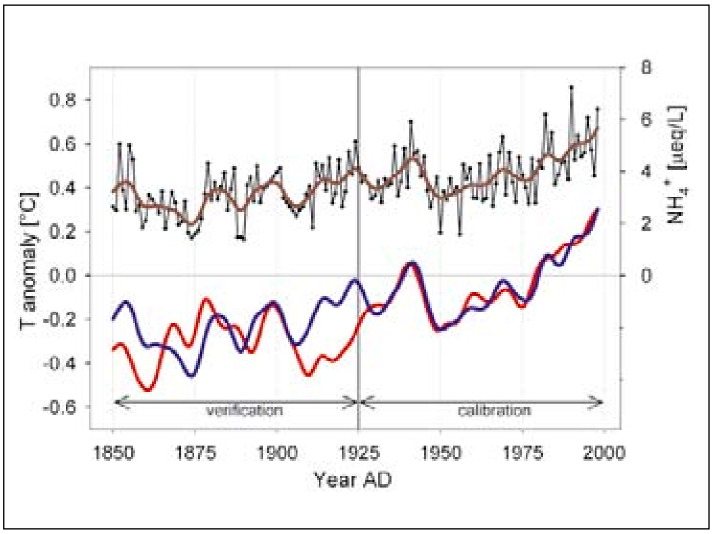

Figure 3: **Top: Yearly averaged NH_4^+ concentrations (black diamonds) from 1850-1998 A.D. and smoothed (brown curve) with a 21-point binomial filter (right scale).**
Bottom: reconstructed temperature anomalies (blue curve; left scale) for calibration and verification period and HadCrut3 30°S-30°N tropical temperature anomalies (red curve, left scale) from the Hadley Centre/CRU.

during the mid 11th to the 13th century. A considerably cooler period is observed from the 14th to the 17th century. In the following centuries, there was a rise in temperature that exceeds in the late 20th century the range of past variation.

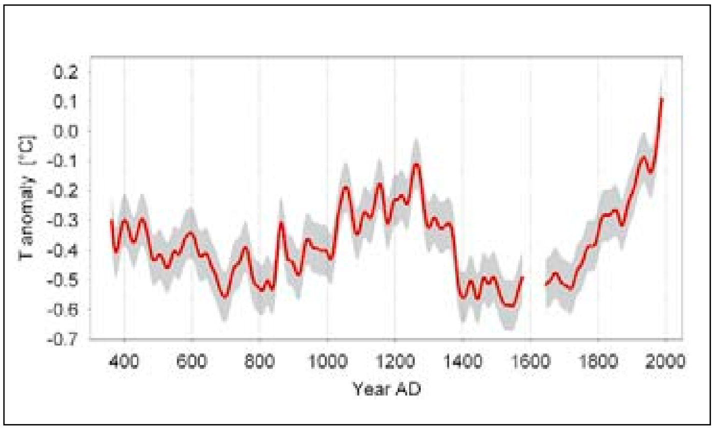

Figure 4: **Reconstructed tropical South American temperature anomalies (with respect to the 1961-1990 average) for the last ~1600 years (red curve, smoothed with a Gaussian filter (σ=10). The grey shading envelops the ±2σ uncertainty as derived from the calibration period. From A.D. 1580-1610 no data is available due to bad core quality.**

Conclusions

We introduced ammonium concentrations in the Illimani ice core as a new proxy for tropical South American temperatures, and used them to reconstruct temperatures over the last ~1600 years. Relatively warm temperatures during the first centuries of the past millennium and subsequent cold conditions from the 15th to the 17th century may suggest that the MWP and the LIA were not confined to high northern latitudes but also have a tropical signature.

Acknowledgements

Illimani ice core drilling was a joint operation of the French Institut de Recherche pour le Developpement (IRD) and PSI. We thank Bernard Francou, Robert Gallaire, Patrick Ginot, Bernhard Pouyaud, Ulrich Schotterer, Felix Stampfli and Benjamin Zweifel for their contribution to the drilling operation, Elisabeth Dietze for the satellite image, and Matthias Ruff for ^{14}C analysis.

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New findings on the sources of fine particles in ambient air in Switzerland

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The Laboratory of Atmospheric Chemistry has used for the first time anywhere a combination of two innovative methods, aerosol mass spectrometry and ^{14}C analyses, to determine the sources of fine particles in ambient air in Switzerland. In winter, the most important component is nitrates. Primary particulate emissions from traffic and wood combustion are of equal importance but contribute altogether only around 25% to particulate mass. The main source of particles is secondary and involves oxidation of various trace gases in the atmosphere. Taking into account primary emissions and emissions leading to secondary aerosols, traffic, wood combustion and industry contribute the most to particulate matter but agriculture and conventional heating cannot be ignored.

Particulate matter (PM10: particulate mass of all particles with a diameter lower than 10 μm) is measured continuously at many monitoring stations in Switzerland. These measurements are necessary to document exceedances of legal thresholds and the long-term development of pollution. However these measurements alone hardly provide any clue about the chemical composition and the sources of particulate matter (Figure 1).

New analytical techniques

Aerosol mass spectrometry is a recently developed measurement technique that allows the detection of the volatile particulate mass of PM1 (particulate mass of all particles of with a diameter smaller than 1 μm) at high time resolution (better than one minute) and low detection limits. The volatile fraction includes nitrates, sulfates, ammonium, chlorides, and organic mass. In collaboration with the University of Bern, a method was developed to quantify the fossil and non-fossil contribution to the particulate black and organic carbon using ^{14}C radioisotopes. ^{14}C is best known for its use in archeological dating. For the first time, we used the combination of these two very powerful techniques, allowing for a near complete characterization of PM1.

Figure 1: **Aerosol mass spectrometer and other instrumentation in the PSI mobile laboratory.**

Measurements

In winter, we found that the highest concentrations were due to long-lasting temperature inversions that favor the accumulation of pollutants because of limited vertical mixing and dilution. Direct emissions of traffic (black carbon and organic matter) were only 12% of the total particulate mass (Figure 2). Wood combustion contributes roughly the same amount (14%).

In Alpine valleys, we found an even higher contribution from wood combustion [2, 3, 4] but we were surprised to see a high contribution on the Swiss Plateau as well. Very similar results were found in rural areas and locations near highways. During a period of winter smog, both the concentrations and the composition are similar over a larger region. The largest part of PM1 is therefore not emitted by the two best-known sources but is produced by other processes. Ammonium nitrate (NH_4NO_3) and ammonium sulfate ($(NH_4)_2 SO_4$) are formed by

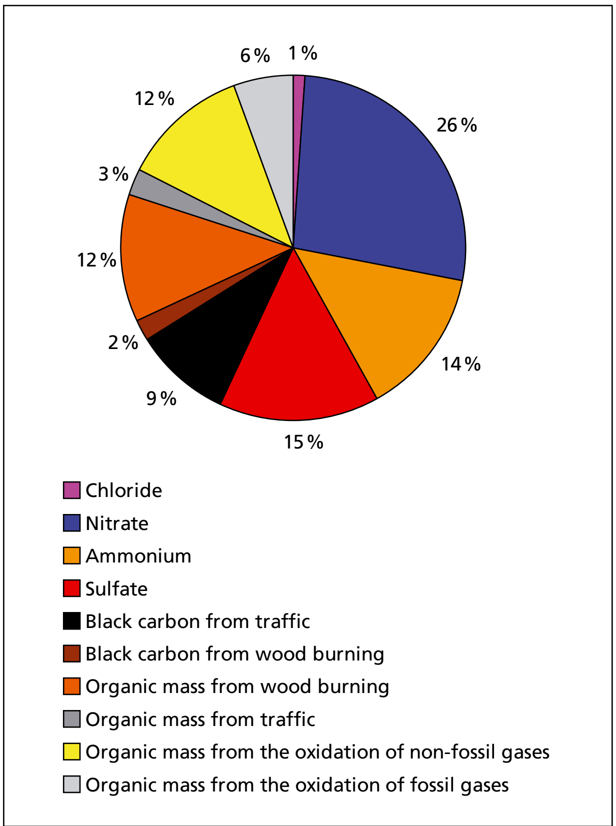

Figure 2: **Composition of PM1 in Zurich urban background, winter 2006 [1].**

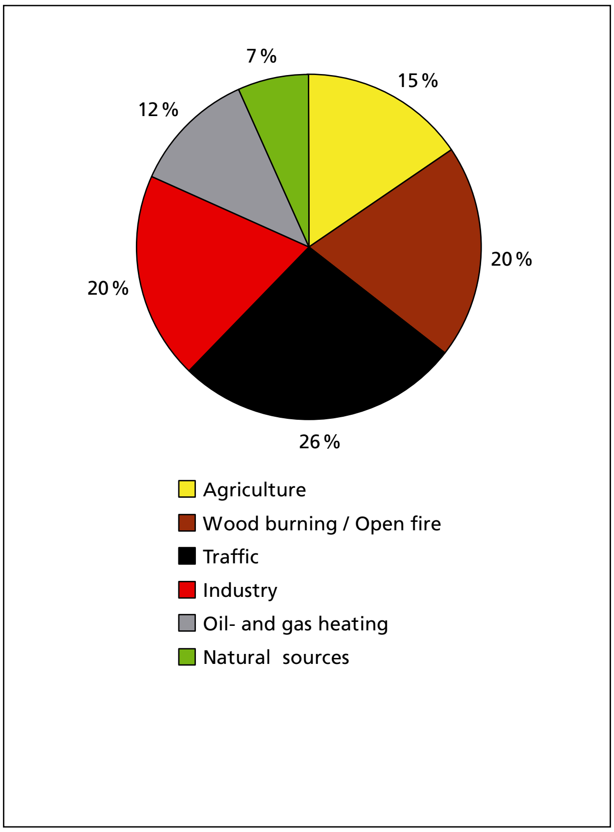

Figure 3: **Contribution of different sources to PM1 in Zurich urban background, winter 2006.**

the combination of ammonia (NH_3) and nitric acid (HNO_3), produced from oxidation of nitrogen oxides (NO_x) and sulfate (SO_4), and from the oxidation of sulfur dioxide (SO_2). Most of the secondarily produced organic mass in particulate matter is of non-fossil origin which could be from natural emissions of vegetation or more likely from gaseous emissions from wood combustion.

How important are the different sources?

Overall, it is important to note that the total particulate mass coming from atmospheric oxidation of trace gases is around 75%. In order to assess the total contribution of different sources like traffic, industry, etc. we need to take emission inventories of trace gases into account. These inventories show that agriculture is the most important source of ammonia, while industry is the most important source of SO_2, and traffic the most important source of NO_x. A total source attribution of PM1 is given in Figure 3 taking the measurements and emission estimates into account.

Traffic, wood combustion and industry are estimated to contribute the most to PM1. The most important contribution of traffic to PM1 is not due to the particulate emissions but actually due to high NO_x emissions (also to a large degree from diesel vehicles), which contribute to the very high nitrate particle concentrations. Various sources contribute with similar amounts to the particulate matter problem, showing that combined measures to improve air quality concerning all different sources seem appropriate. It should be mentioned that although the direct emissions of traffic and wood combustion contribute only 25% to PM1, it is still very important to put a special emphasis on reduction measures in this respect because of the carcinogenicity and high toxicity of these particles.

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Impact of efficiency improvements on the overall energy system: perspectives for Switzerland

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Climate protection must remain in focus when deciding Swiss energy policy for the coming years. Swiss CO_2 emissions should be reduced by at least 50% by the year 2050. Improvements in energy efficiency are of fundamental importance for sustainable energy policies, but alone will not be enough. Keeping electricity production nearly CO_2-free will be a decisive factor in achieving such a reduction.

The work reported here concerns the role of energy efficiency as one of the pillars of a sustainable energy policy, with particular emphasis on the prospects for meeting the goal of climate protection. A number of theses addressing the relevant issues have been formulated; more details, and the evidence supporting the theses, are given in [1].

Theses

Thesis I: *The performance record of the Swiss energy system in terms of primary energy consumption and low CO_2 emissions is internationally respected, but is highly dependent on the electricity mix (dominated by hydro and nuclear), high conversion efficiency (hydro), and the structure of the economy (no energy-intensive industries, and the major role played by the service sector).*
The share of fossil fuel in current primary energy use in Switzerland is 66%, compared to 80% globally. The total loss from primary to useful energy is close to 60%. The current primary energy consumption corresponds to a constant equivalent power level of about 4800 watts per capita (almost 42 000 kWh per capita per year). In addition, there are about 4000 W per capita in terms of grey energy. While 6 t CO_2 per capita are emitted in Switzerland, the grey energy consumption corresponds to an additional 5 t CO_2 per capita. Swiss electricity production is practically CO_2-free (18 g CO_2-eq. per kWh_e), but if imported electricity is included, emissions rise to 121 g CO_2-eq. per kWh_e consumed in Switzerland.

Thesis II: *Efficiency improvements have played a very important role in the past, and will do so in the future.*
Impressive efficiency improvements of energy technologies (particularly with regard to fossil fuel) have taken place in the past. The energy intensity improved in the EU by 1.4% per year during the 1990's. However, progress since 2000 is much less impressive: 0.5% per year, of the same order as in Switzerland.

Thesis III: *Efficiency improvements are necessary, and highly important, but alone are not sufficient to respond to the principal goals of the sustainable energy policies.*
To keep warming of the Earth's atmosphere within tolerable limits, global CO_2 emissions must be cut by 50% by 2050. Using Kaya's equation, which associates CO_2 emissions with population density, energy production per person, the energy intensity of the economy, and the carbon content of energy, it can easily be proven that, even assuming very optimistic efficiency improvements, such a decrease requires an impressive expansion of the "carbon-free" technologies (renewables and nuclear).

Thesis IV: *In parallel to the global situation, Switzerland also needs better energy efficiency, as well as new technologies. By 2050, we can save at most 30% of energy demand in a way that is socially acceptable. But the fact that we cannot reach the 2000-watt level per person is not decisive for the climate, since quite ambitious CO_2-emission reduction goals could be reached in any case. Furthermore, constraints in primary energy consumption do not guarantee sufficient reductions in the use of fossil fuel, and hence the necessary reductions in greenhouse-gas emissions.*
Figure 1 shows the projected primary energy consumption per capita in the year 2050 in Switzerland. The results were obtained using an energy-economic optimisation model covering the whole Swiss energy system [2]. Each solution corresponds to the least expensive energy system, under specific constraints with regard to primary energy consumption and CO_2

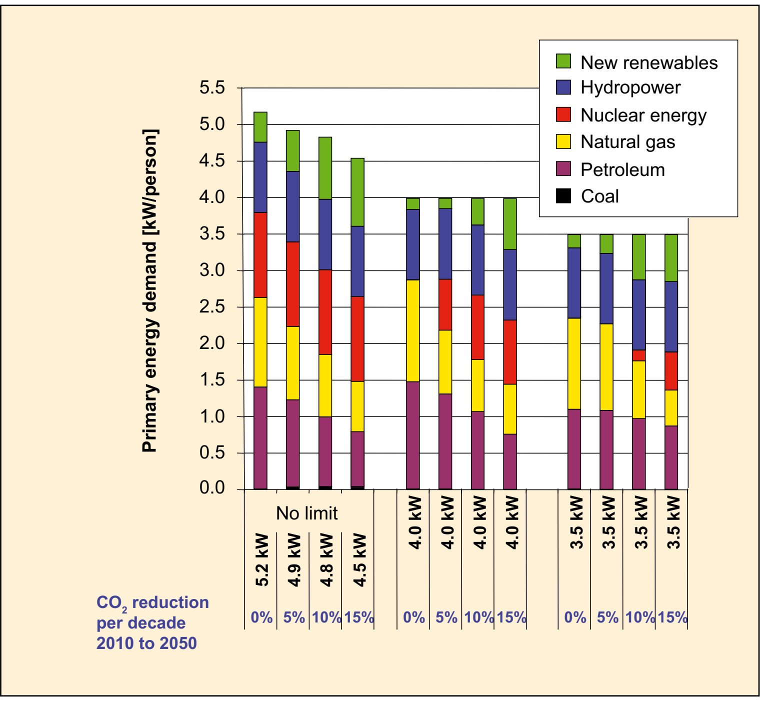

Figure 1: **Primary energy demand in the year 2050. Scenarios with exogenous boundary conditions with respect to primary energy and CO_2 emissions [2].**

emissions. A reduction in CO_2 emissions by a factor two can only be achieved if the consumption of fossil fuels is also reduced by almost the same factor, the renewable sources are expanded, and nuclear energy remains in the Swiss energy mix. The discounted cumulative cost of such a reduction in CO_2 emissions to the year 2050 is of the order of at least 70 billion CHF.

Thesis V: *Large efficiency improvements are feasible, particularly in the building and transport sectors, and are manifested through substantial reductions in demand.*
Energy-saving construction and renovation to Minergie and MinergieP standards could reduce heat demand to less than 40% of current values. With a massive shift to the use of heat pumps, annual CO_2 emissions could be reduced by 10 million tonnes, which is about 20% of today's total Swiss greenhouse-gas emissions [2].
In the transport sector, hybrid-drive trains could economically replace petrol and diesel motors. With such a technology shift, it would be possible to reduce energy end-use by one third, and CO_2 by 5 million tonnes per year by 2050 [2].

Thesis VI: *Electricity in the future will be more important than ever for our service economy. Electricity can efficiently replace other energy carriers, so its CO_2-free production is the key to an effective reduction of CO_2.*

If CO_2 emissions are halved in order to meet the Kyoto targets (which means almost 15% reduction per decade), then by 2050 the electricity share of total energy use will grow from today's 23% to 35–40% [2].

Thesis VII: *The total costs, though not uncontroversial, reflect the economic and environmental efficiency of the various options. Internalisation of external costs increases the competitiveness of renewables and nuclear.*
Renewable technologies have the highest potential for technological improvement and hence cost reductions. Nuclear power has the lowest total costs, both now and in 2030 [3]. Total costs provide only limited representation of all the social aspects, the broader consideration of which may affect the ranking of nuclear vis-a-vis other options. Social factors can be better represented in terms of Multi-Criteria Decision Analysis (MCDA), which depending on stakeholder preference, may lead to a different technology ranking.

Conclusions

Swiss CO_2 emissions should be reduced by 50% by 2050. Attaining this goal should be the highest priority item of energy policy. A one-sided focus on the reduction of primary energy consumption does not automatically lead to much lower CO_2 emissions. Use of efficient technologies can reduce the per capita primary energy consumption by a maximum of 30% by the year 2050, thus reaching the level of 3500 watts per person. In order to reach both levels of reduction, long-term measures are needed, in particular in the building and transport sectors. The share of electricity in total energy consumption will further increase. For this reason, keeping electricity production nearly CO_2-free is a decisive factor in achieving major overall reductions in CO_2 emissions.

References

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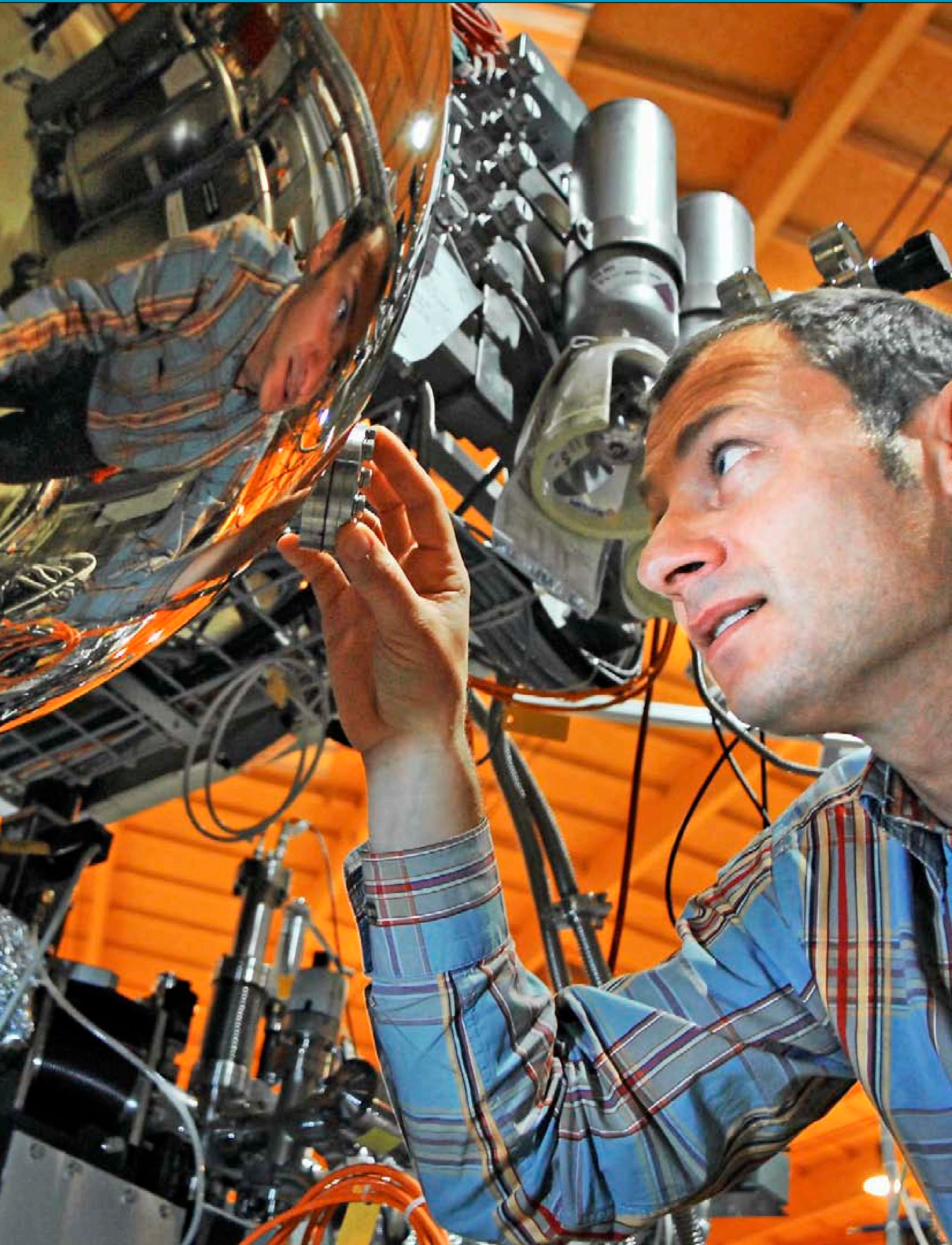

User facilities

◀ **Luc Patthey is a curious researcher who likes to push the envelope. The 42-year-old physicist's experiments focus on the electron, a particle whose properties he measures at the Swiss Light Source SLS.**

The muon, neutron and photon user facilities at PSI attracted a record number of users last year. The delivered beam integrals increased significantly, thanks to the development and optimization programs of the proton and light sources. New instruments and beam lines contributed to a strong increase in publications based on research conducted at PSI.

The reliability of the two major workhorses, the Ring Cyclotron and the SLS was higher than 90%, reaching over 97% in case of SLS. The newest member of the accelerator family at PSI, the 250 MeV superconducting cyclotron built by ACCEL got off to a spectacular start, already demonstrating 95% availability in its first year of operation.

The main Ring Cyclotron reached in 2007 the record intensity of 2.16 mA, delivering 1.3 MW on target. The stage has been set to replace the remaining two aluminum RF cavities in the ring cyclotron during the 2008 shutdown and to start operations with a full complement of more efficient copper cavities.

The Proton Therapy Center started patient treatment using the superconducting 250-MeV COMET cyclotron at Gantry I and preparations were almost complete for commissioning Gantry II. COMET will also replace the older Injector I as the proton source for the eye cancer treatment program. OPTIS II preparations were in full swing last year and the switch from OPTIS I is expected by the middle of 2008.

The Swiss government approved last year the funding for a 250-MeV electron linear accelerator, designed to demonstrate the technology needed for the construction of the cost-effective X-Ray Free Electron Laser – the planned future facility at PSI.

Operation of the Swiss Light Source in 2007

Andreas Lüdeke, Åke Andersson, Michael Böge, Boris Keil, Thomas Schilcher, Volker Schlott, Andreas Streun,
Department of Large Research Facility, PSI

The last year was very successful for light source operation. The beam has been operating at its design current of 400 mA since the middle of the year and a world record vertical emittance was reached by careful control of the coupling. Many new beamlines became operational and at the same time an excellent beam availability of 97.4 % was maintained.

Operation and development

A major highlight in 2007 was the coupling reduction to 0.05% to reach a world record vertical emittance of three-picometre radian. A prerequisite was the decrease of all local orbit bumps for the beamlines and a new beam-size measurement beamline.
Regular user operation at 400 mA since June allowed us to increase the delivered beam dose by 30%.
Many activities in 2007 were related to newly installed beamlines. Three superbend magnets were installed. Their central magnetic field strength is twice that of normal bending magnets and therefore the critical photon energy of this source is 11.9 keV. The existing Tomcat beamline and the new beamlines SuperXAS and PX-III make use of these superbends. A fixed-gap apple-type permanent magnet undulator has been installed for the ADRESS beamline. The novel approach of relinquishing a changeable gap allowed for a substantial reduction of the size and cost of this device. With the beamlines cSAXS, Infrared and VUV, the total number of beamlines at the SLS almost doubled from nine to 16.

The operation of the SLS moved to the new central PSI accelerator control room in June. This room is located in a new building close to the SLS. Many groups supporting accelerator operation are now located in the same building, benefiting operation of all PSI accelerators. Both old control rooms, in the WBGA and the WSLA buildings are now dismantled.
The four longest outages were responsible for about half of the total downtime. In the first week of operation a cryostat failure required warming of the third harmonic cavity, causing 36 hours of downtime.
In September a 16 kV main transformer failed with an internal short circuit. This was the second transformer of this type to fail and we have to assume that the whole series used at the SLS is potentially faulty. The accelerator's two other transformers will be exchanged too. A spare transformer from EWZ Zurich was delivered and installed within one day thanks to the fast work of the electrical supply section. The total downtime caused by that event was only 17 hours, compared to 67 hours after the first transformer breakdown in 2006.
Two more failures caused each eight hours of downtime: a vacuum leak at the Linac and an unscheduled warm up of the

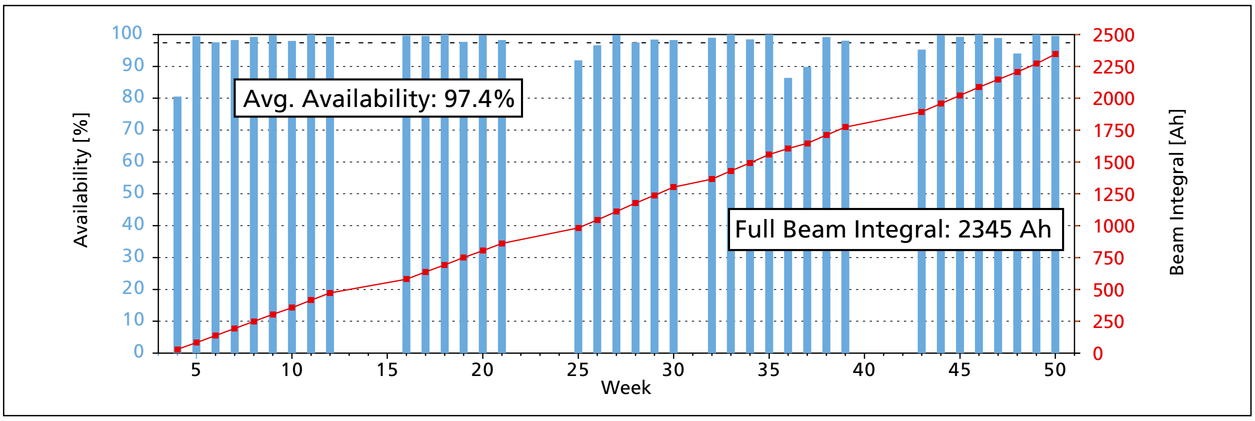

Figure 1: **SLS operation statistics: weekly availability and integrated beam dose.**

third harmonic cavity cryostat. The latter was caused by the actuation of an emergency stop button. The cryostat system will be re-cabled in order not to be affected by the emergency stop buttons in the tunnel.

Operation statistics

The operational data is summarized in Table 1. Availability improved to an excellent 97.4 % even though the number of outages increased slightly. This is because there were fewer events lasting more than two hours. In 2006, 15 events of this type caused 180 hours of downtime. Last year only eight of those events generated 80 hours of total outage (see Figure 2).

The major culprit responsible for outages was the radio frequency (RF) of the storage ring, which accounted for about 62 hours of downtime (see Figure 3). Total RF outage was similar to 2006, but about three quarters of the downtime last year had its source in the third harmonic cavity cryostat system. Only 15 hours of downtime were caused by the 500 MHz accelerating RF. Outages of the electrical supplies, the safety systems and water cooling all contributed to more than 10 hours of downtime each. The latter two increased significantly compared to the previous year. In both cases this was partly related to the large number of new beamlines.

The availability of the injector system stayed constant at 99.5%. Again two thirds of the outages were related to the Linac and the Linac RF, modulator 1, caused more than half of all outages. The klystron of this modulator has now been exchanged. The longest outages of the injector were caused by problems of the electron source. The cathode of the source has now been replaced after seven years of operation.

Outlook

All available straight sections of the SLS are now filled and only a few bending ports are available for new beamlines. The Lucia beamline will be dismantled and be replaced with the split beamlines Phoenix and Xtreme. The 9L long straight will be split up to serve the two beamlines SIS and XIL in parallel. A new dipole beamline NanoXAS will be built. All those beamlines should start operations in 2009.

There is a dense development program to further enhance the light source. The fast orbit feedback has to be upgraded in order to generate dynamic local orbit displacements for the PolLux beamline with several bump alternations per second. PolLux will use the polarisation of photons for difference measurements. In order to increase the beam lifetime we plan to make use of additional skew quadrupoles and auxiliary sextupoles. Doubling the lifetime at the present brilliance should be achievable.

Seven years after the SLS started operation, it is still among the world leading light sources. Considerable ongoing efforts are required to retain that position.

Beam Time Statistics	2007		2006	
Total beam time	6912 h	78.9 %	6768 h	77.3 %
• user operation	5200 h	59.4 %	5160 h	58.9 %
– incl. compensation time	0144 h	01.7 %	0144 h	01.7 %
• beamline commissioning	0880 h	10.0 %	0696 h	08.0 %
• setup + beam development	0832 h	09.5 %	0804 h	10.3 %
Shutdown	1856 h	21.2 %	2168 h	22.7 %
*User operation downtimes**	095		084	
• unscheduled outage duration	0138 h	02.6 %	236 h	4.8 %
• injector outage (non top-up)	0028 h	00.5 %	026 h	0.5 %
Total beam integral	2345 Ah		1775 Ah	
Availability	097.4 %		95.4 %	
Availability after Compensation	100.1 %		98.2 %	
MTBF	54.2 h		60.0 h	
MTTR (mean time to recover)	01.4 h		02.8 h	

Table 1: **SLS Operation Statistics**
***Two beam interruptions that occur within one hour are counted as one, long downtime, because the short uptime in between is generally not useful for experiments.**

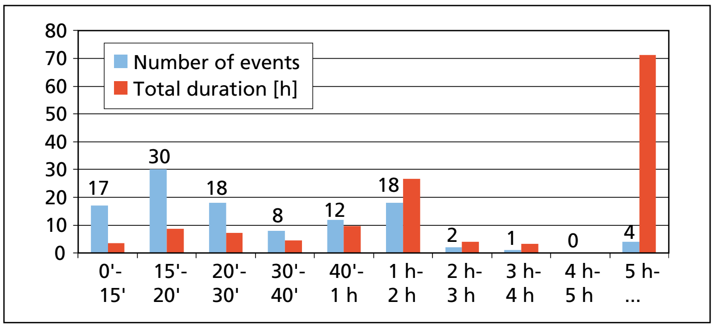

Figure 2: **Duration distribution of downtimes**

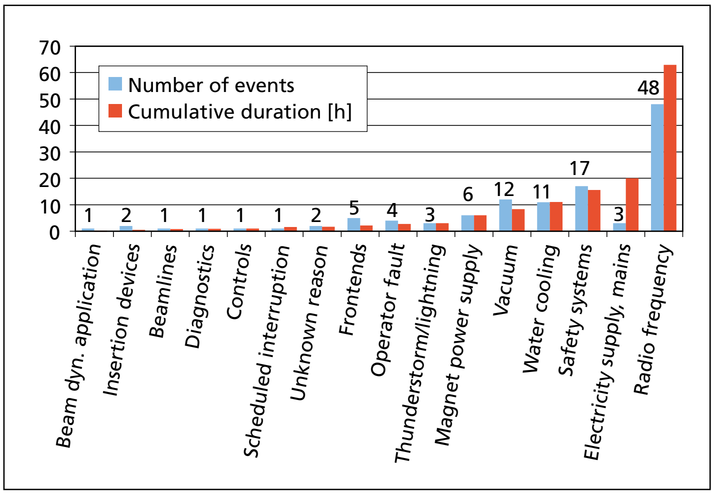

Figure 3: **Downtime events and duration per system**

Happy birthday SINQ: 10 years of successful operation

Stefan Janssen, Werner Wagner, Joël Mesot, Kurt Clausen, *NUM Department, PSI*

2007 was the tenth year of full user operation at the Swiss spallation neutron source SINQ. After the very first tests in December 1996 some pilot experiments were carried out in the second half of 1997. Routine operations began in 1998. Since then 2,400 experiments have been performed and 3,800 user visits registered. The jubilee was celebrated during two events: a scientific symposium on September 21 and a public visitor day – 'neutron day' – on October 28.

Bye bye MEGAPIE…

After the very successful test operation with a liquid metal Pb/Bi target during the MEGAPIE (Megawatt Pilot Experiment) project [1] in the second half of 2006 with a neutron flux gain of approximately 80%, 2007 started with the planned decommissioning of the MEGAPIE target during the annual shutdown. The project entered the next – and still ongoing – phase with a detailed inspection of the target and its components. Those results will deliver useful input for the long-term goal of developing a liquid metal target for routine operation.

…welcome back: solid target

Neutron production started in mid-April with an improved version of the steel-clad solid lead target: In the new 'generation-3' SINQ target the steel cladding tubes have been replaced by Zircaloy, which has less neutron absorption. Hence the intrinsic flux reduction of the solid target compared to the MEGAPIE target could be partially compensated. In 2007 SINQ received a total charge of 3885 mAh and the proton current routinely reached approximately 1.35 mA. During the months of operation SINQ ran again very reliably with an availability of approximately 93%. Operations were however interrupted during July and August because of a leak in one of the heat exchangers of the D_2O cooling loops, which occurred on June 29. After a careful inspection a strategy was developed to be operational again as soon as possible. Thanks to a common effort of several PSI groups it became possible to resume operations already on September 3 and continue with stable neutron production for the rest of the year, with a reduced flux. The 2008 shutdown will be used to install an intermediate cooling loop to avoid any future performance loss through contamination of the heavy water in the moderator tank by normal water.

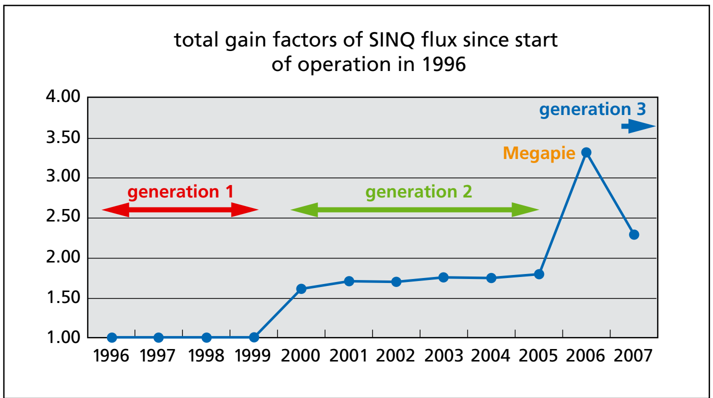

Figure 1: **Development of the neutron flux at SINQ since the start of operations. The gain is caused by both neutron target development and an increase of the accelerator's proton current.**

New record of user visits

Despite the interruption during the summer, 2007 was again very successful for the user operations at SINQ: 11 instruments for neutron scattering and another two for neutron imaging were fully available to the national and international scientific community and were strongly solicited. The instruments delivered more than 1,300 days of operation and almost 350 experiments were performed. For the first time the new backscattering spectrometer 'MARS' was opened to users and was fully operational.

The number of user visits was again very high: for the first time we counted over 600 visits by 350 different individual researchers within one year. SINQ is the home base for the Swiss neutron scattering community. Approximately 56 % of the use is from Swiss institutions with 26 % in-house and 30 % from other Swiss universities and institutions. Within Switzerland the strongest non-PSI use of SINQ is from ETH Zurich, the universities of Fribourg and Geneva and from EMPA Dübendorf. Approximately one third of the SINQ users come from EU countries, with the biggest numbers coming from Germany (10 %), the United Kingdom (7 %), Denmark and France (6 %). 9 % of the beam time is used by groups from outside Europe. The users were affiliated in 2007 to institutions from 21 different countries. Around 156 new proposals were received in 2007, which ensure and confirm the strong interest in neutron beam time at SINQ also in 2008.

The tenth anniversary of SINQ

2007 was the 10th consecutive year of full user operation at SINQ. In those ten years more than 11,000 instrument days were delivered and more than 3,800 user visits tallied. 2,400 experiments were performed and almost 1,600 new proposals were submitted. The publication record contains 600 papers based on SINQ experiments. Over those 10 years, SINQ was continuously subject to improvements in instrumentation, especially in the sample environment. Figure 1 illustrates the flux increase of SINQ caused by neutron target development and upgrades of the proton accelerator. Together both strategies caused the neutron flux in 2007 to be approximately 2.5 times higher than in 1997. With the liquid metal target, the gain factor was even as high as 3.3 in 2006.

PSI used the occasion of the tenth anniversary to organize two dedicated events related to SINQ: a scientific symposium on September 21 and a public visitor day on October 28. The SINQ user community and PSI staff involved in the project gathered in Villigen in September to look back on the first ten years of SINQ operation: Walter Fischer and Albert Furrer recalled the construction period and the first years of operation. Their contributions were complemented by a talk of Hans-Rudolf Ott (ETH Zurich), who discussed the shift of the scientific focus of PSI towards solid-state physics. Kell Mortensen (Copenhagen) and Ted Forgan (Birmingham) took the audience on a tour of recent scientific highlights from soft condensed matter and solid state physics. Finally, Werner Wagner (SINQ source and target) and Joël Mesot (science and instrumentation) presented SINQ's future perspectives .

After the great success of the last public visitor day in 2005, PSI opened its doors again and invited the general public to a dedicated 'neutron day' on Sunday, October 28. The event was meant to attract public attention to the fascinating capacity of neutrons to probe the microscopic world and to extract unique information about samples from diverse fields such as physics, chemistry, biology and materials science.

Figure 2: **The PSI 'neutron day' was a great success with more than 3,500 visitors.**

More than 3,500 visitors were informed about neutron research and the experimental facilities. At six major visitor stations tour guests were introduced to the technique and the scientific applications of both neutron scattering and imaging. Special emphasis was put on the phenomenon of superconductivity, the SANS studies of grey cataract formation and the broad variety of neutron imaging applications.

Many thanks to all the staff involved in making this event a huge success both for the visitors and for PSI. The user-oriented character of PSI was clearly demonstrated through the strong involvement or support from some of the key Swiss users of our facilities in the form of demonstration experiments. In particular, we wish to acknowledge the generous and valuable support and contributions from the universities of Fribourg (Peter Schurtenberger and Anna Stradner), ETH Zurich, Geneva, Neuchatel, the NCCR project 'MaNEP' [2] and the 'Kantonsspital Aarau' (Bruno Blumer) .

Reference:

[1] http://megapie.web.psi.ch
[2] MaNEP: Swiss NCCR project on 'Materials with Novel Electronic Properties', http://www.manep.ch/

Swiss Muon Source SμS

Dierk Herlach, Alex Amato, Elvezio Morenzoni, *Laboratory for Muon Spin Spectroscopy, LMU*

The future has a name: AMPDs – Avalanche Microchannel Photodiodes. Compact, fast components that are insensitive to magnetic fields, they are revolutionizing particle detection in μSR instruments, as demonstrated by the successful test of a prototype detector assembly for the 5-Tesla ALC magnet in 2007. This and other instrument upgrades, developments and plans will help secure our position as a leading μSR facility in the future.

Instrument upgrades and developments

The outstanding milestone in 2007 was the development of AMPD-based scintillation detectors at PSI in collaboration with the Joint Institute for Nuclear Research in Dubna (Russia), and their successful use in a prototype set-up for ALC-μSR (Figure 1) in magnetic fields up to five Tesla. Compactness, very high time resolution, and magnetic field insensitivity make them the detectors of choice for all time-resolving μSR instruments, in particular the planned PSI High Field (10 Tesla) Instrument that has been simulated and optimized in the framework of a FoKo project using Geant4. Other important achievements are: the development of a low-background set-up for small samples on the Low Energy Muon (LEM) apparatus in collaboration with R. Kiefl from UBC, new detectors for GPD, high pressures (2.6 GPa) at low temperatures (230 mK), new data acquisition electronics using VME architecture, and more.

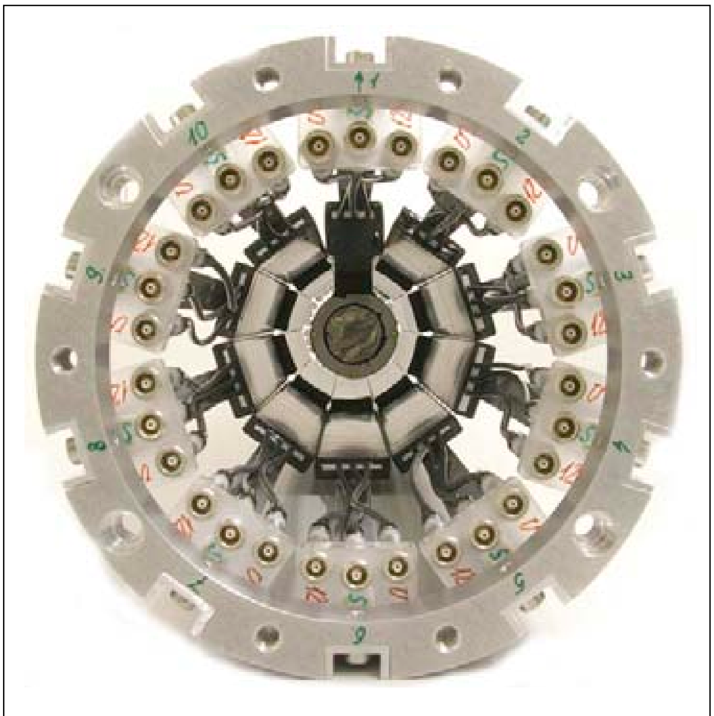

Figure 1: **Prototype detector assembly for ALC μSR, equipped with Avalanche Microchannel Photodiodes (AMPD's) tested in magnetic fields up to 5 Tesla.**

User lab

In 2007, a record number of 177 experiments were carried out by external and internal research groups at the six SμS instruments: GPS (74 experiments), LTF (29), LEM (28), GPD (25), Dolly (14) and ALC (7), including 9 short-term ("urgent beam time requests") and 24 in-house experiments. Altogether, 688 days of beamtime were allocated to 220 scientists from 24 different countries all over the world. The strongest user communities (number of scientists) have been Switzerland (40), Japan (35) Germany and the United Kingdom (29 each), and France and Italy (14 each).

Rich scientific harvest

In 2007, 48 articles (43 with LMU authors) related to the SμS were published in peer-reviewed journals. A significant proportion of the publications are in high-ranking journals, e.g. Phys. Rev. Letters (9 publications, 5 of which with LMU authors), J. Phys. Chem. B (1,1), Phys. Rev. B and A (11,8), J. Physics: Condensed Matter (5,3).

The PSI/ETH Laboratory of Ion Beam Physics

Hans-Arno Synal, Vasily Alfimov, George Bonani, Marcus Christl, Max Döbeli, Irka Hajdas, Peter Kubik, Marc Mallepell, Arnold Müller, Matthias Ruff, Martin Suter, Martin Stocker, Emanuel von Wartburg, Lukas Wacker, *Research Department Particles and Matter, PSI and Institute of Particle Physics, ETH Zurich*; Susan Ivy-Ochs, *Institute of Particle Physics, ETH Zurich and Geography Institute, University of Zürich*

In 2007 the PSI/ETH-Laboratory of Ion Beam Physics had four accelerators operating. The 6 MV EN Tandem was online for more than 2,774 hours. The 600 kV Tandy AMS system was used for experimental AMS work and routine operations with ^{129}I, Pu, Pa. Routine handling of ^{14}C samples has begun with the 200 kV MICADAS AMS System. In addition, the gas feed operation has been extended. The new 200 kV BioMICADAS system was completed in October 2007. This system is under specification tests and it is planned to ship it to Vitalea Science, our partner for biomedical AMS, in 2008.

Approximately 5,700 AMS samples were analyzed at the laboratory of ion beam physics in 2007. About 65% of them, ^{10}Be, ^{26}Al, ^{36}Cl and 55% of the ^{14}C samples, were measured with the 6 MV Tandem based AMS system. The remaining 35% were analysed with our smaller systems Tandy and MICADAS. Here, about 45% of the ^{14}C samples and all ^{129}I, Pu and Pa were analysed. A significant fraction of the ^{14}C analyses were made with very small samples of less 50 µg carbon using the MICADAS system. This became possible by routinely using our gas ion source. In 2007, we had to exchange the charging belt of the EN Tandem accelerator. Consequently, an increased portion of beam time had to be spent on conditioning and machine testing. The new belt has now been running for six months and we can expect to have stable operation conditions again for the next three years. The Material Science (MS) program has used about 20 per cent of the total EN accelerator time. A new annular gas ionisation detector became operational for Heavy Ion Rutherford Backscattering (HIRBS). With this detector, a significantly enhanced mass resolution over conventional best practice RBS experiments has been achieved.

EN Tandem Accelerator Operation Hours			
AMS	2005	2006	2007
Be-10	738	978	617
C-14	804	700	703
Al-26	33	126	56
Cl-36	265	472	287
Heavier Elements			126
MS			
Materials Science	438	422	447
SSIMS	42	159	94
Maintenance			
Conditioning/Tests	428	259	444
Total	2748	3116	2774

Table 1: **Beam time statistics 2005-2007 EN Tandem.**

Figure 1: **The new BioMICADAS system.**

The dedicated biomedical AMS system BioMICADAS was completed in October 2007. The new ion source in particular has shown excellent performance and design specifications have been exceeded.

Using the HE-spectrometer magnet of the BioMICADAS system for test experiments at the Tandy AMS system, we were able to demonstrate that background events can be significantly reduced. For ^{10}Be it became possible to reach a detection limit of few times 10^{-15}, a value which had before only been reached with large AMS systems. Based on these results the design of an improved spectrometer for the Tandy AMS system has begun.

Operation and development of the proton accelerator facilities in 2007

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The high intensity proton accelerator showed very stable operation over the whole production period with only a small number of incidents. The 90 % availability and the total beam integral of 8.9 Ah on the meson targets with a production current up to 2 mA reflect the good performance of the facility. As a result of a defect of the neutron spallation target cooling, SINQ was out of service for nine weeks. During this period the facility was run exclusively for users of the meson beams. During experimental test runs a new record beam current of 2.16 mA, corresponding to a beam power of 1.27 MW, was achieved. A beamline for the Ultra Cold Neutron Source UCN was also commissioned with pulsed beam diagnostics.

Operation

Immediately after completing the yearly shutdown in week 14, the beam current on the meson targets was increased to the 1900 μA production current. During the shutdown a collimator in the ring cyclotron was found to be misaligned and re-adjusted. This repair lead to lower losses and the full current (2 mA) was more easily achieved. However, due to a problem in the cooling system of the neutron spallation source, SINQ was out of operation from week 26 to week 35. During this period the beam had to be switched to the beam dump behind the E target. A temperature peak in the beam dump limited the production current to 1450 μA, until better beam optics allowed a more uniform temperature distribution. Afterwards, currents beyond 1800 μA were possible in the beam dump. Two other major interruptions were caused by a failure of the thin M target in week 29 that took 30 hours to be repaired, and by high water in the River Aare in week 32, leading to a 60-hour interruption of the cooling facilities. During the

Beam Time Statistic for the high intensity facility	2007
total beamtime	
to meson production targets	5200 h
to SINQ	3700 h
beam integral	
total beam integral on meson targets	8.9 Ah
total beam integral on SINQ	4.3 Ah
outage	
unscheduled outage duration	407 h
total unscheduled outage including trips	524 h
availability	90 %

Table 1: **Beam time statistics for the proton accelerator.**

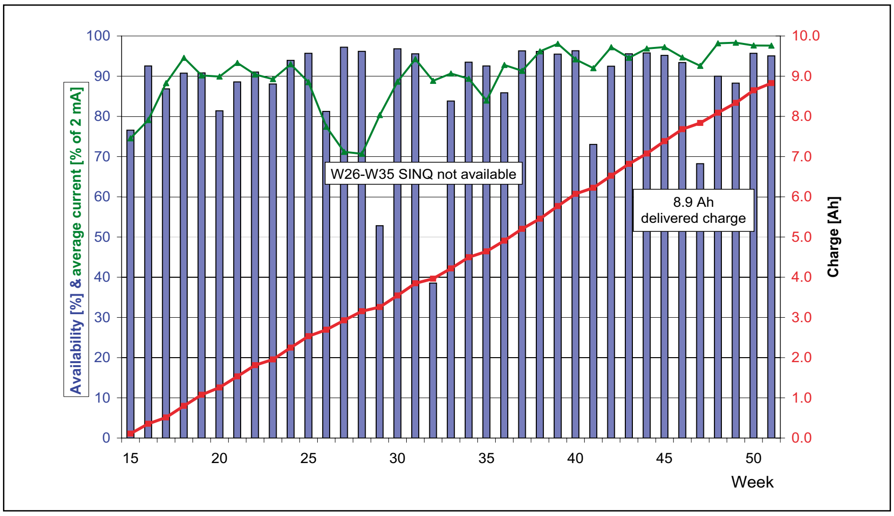

Figure 1: **Operation of the proton facility: availability, average production current and delivered charge.**

production period no problems occurred with the electrostatic devices in the ring cyclotron. The modifications that were applied to these devices, as reported in the 2007 scientific report, improved their reliability. Statistical data of the production period 2007 are shown in Figure 1 and Table 1.

In 2007 the operation schedule was changed from weekly services of 1–2 days to a schedule that foresees service blocks of 3.5 days every three weeks. The experience with the new schedule was very positive and it contributed to the facility's high availability. Injector I was again used throughout the year intensively by scientists and over a period of 11 weeks for medical eye treatment as part of the OPTIS program.

Failure analysis

The relative contributions of various factors to downtime in 2007 are shown in Figure 2. Besides the single large contribution from the cooling failure, most of the other items are similar to values observed in the past. Two new items appear in the statistics: one is the unscheduled maintenance of the ion source. The ion source cannot be operated continuously over three weeks as required by the new operation schedule. Several unscheduled interruptions for 2–4 hours were necessary to change heating filaments in the source. In the future this maintenance will be a fixed part of the schedule and not counted as downtime anymore. The other new item appearing was the unavailability of SINQ. The relatively high contribution to downtime from the control system was mainly due to problems with a data transmission field bus. A lasting solution to this problem was achieved by introducing the VME system, which has been selected as the default bus system for the long term.

Development

The government authorisation for the operation of the proton facility limits the beam current to a maximum of 2.0 mA. In the future it is planned to raise the level to 2.6 mA and ultimately to 3.0 mA. To achieve these goals several technical improvements of the facility are necessary. In 2007 the Federal Health Office granted PSI an allowance to operate the facility at currents beyond 2.0 mA for eight hours per week. The goal of this experimental operation was to gain experience with the behaviour of the accelerator at higher current levels. This option was used 5 times for one shift each time. A new record current was reached at 2.16 mA corresponding to 1.27 MW beam power. Since the high current tests were done with the same number of revolutions in the ring cyclotron, the beam losses showed an over-proportional increase, but stayed within acceptable limits. It was possible to reduce the losses with some optimization of the cyclotron parameters.

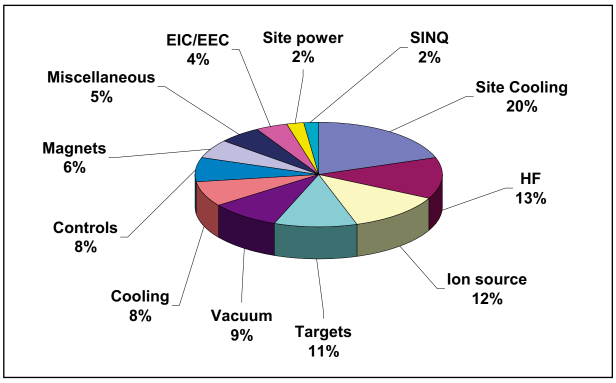

Figure 2: **Downtime characterization for interruptions llasting more than 10 minutes (ca. 300 hours).**

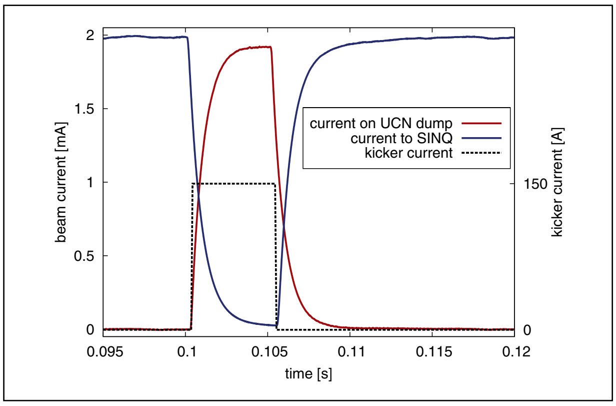

Figure 3: **Beam current measured during fast switching of the beam into the new UCN beamline. The UCN beam pulse is 5 ms long in this experiment and it will have a duration of 8 s later.**

Starting in October 2007 a modified beamline of the former PIREX experiment was tested ahead of the commissioning of PSI's ultra cold neutron source (UCN). For this purpose a beam dump, designed for a maximum average current of 25 μA, was installed at the location of the former PIREX target station. After some initial tests with a few μA of continuous split beam, the full intensity beam of 2 mA was routinely aimed for a short time, typically 5 ms, at this beam dump (Fig. 3). Several diagnostic elements as beam position monitors, transmission and loss monitors were tested under these pulsed-beam conditions. Normally, the beam at the proton accelerator facility is continuously accelerated. For the anticipated UCN operation the beam has to be switched onto the target for 8 s, with a repetition period of 800 s. A mistargeted beam at full intensity could melt the beam-pipe material in a short time. Therefore correct beam centering in the UCN beamline has to be verified by kicking and diagnosing short pilot pulses before the main pulse is sent. In addition, fast machine protection systems have to be switched to a different mode during the UCN pulse. The correct function of these procedures can already be tested with this setup before the UCN target becomes available.

PSI-XFEL: On the road to a new ultra-bright X-ray light source

René Bakker, Romain Ganter, Christoph Hauri, Chistopher Gough, Peter Ming, Marco Pedrozzi, Anne Oppelt, Bruce Patterson, Frédéric Le Pimpec, Jean-Yves Raguin, Fuqiang Wei, Albin Wrulich, *PSI-XFEL with support from the departments of Large Research Facilities (GFA), Logistics (LOG), and Synchrotron Radiation and Nanotechnology (SYN)**

PSI plans the construction of a Free-Electron Laser (FEL) for femto-second X-ray science as its next large-scale facility. Combined with the SLS it will then form the basis of a unique Ultra-fast X-Ray Science Park for the national and international scientific community. The challenges ahead are the complexity and cost of the accelerator technology that is needed for X-ray FELs. PSI has initiated a research program to develop this technology, which can pave the way towards a cost-effective and a reliable design.

Introduction

An X-ray Free-Electron Laser (FEL) can generate light-pulses with a selectable wavelength, peak power of several GW, and duration of several fs. It also is the ideal complement to the Swiss Light Source, enabling the pursuit of revolutionary new science.

The XFEL is a new development, which is still costly because it requires a high-energy electron linac. However, the costs can be reduced dramatically with a design based on a moderate energy accelerator. At present this solution lacks a high-brightness electron source, and suitable accelerating-scheme for this source. The PSI-XFEL project looks at these aspects with the aim of building a cost-effective X-ray FEL facility.

High brightness electron source

The Low Emittance Gun (LEG) project introduces new technology for generating ultra-bright electron-beams. LEG consists of an electron source, a high-gradient 500 kV pulsed accelerator, and a custom designed RF accelerator. A layout of the system is shown in Figure 1 and 7. The starting point is a high-power laser, which triggers electron emission. The electrons are then accelerated to near light-speed in a 500 kV electric field. Further acceleration is provided by a two-cell standing wave RF cavity.

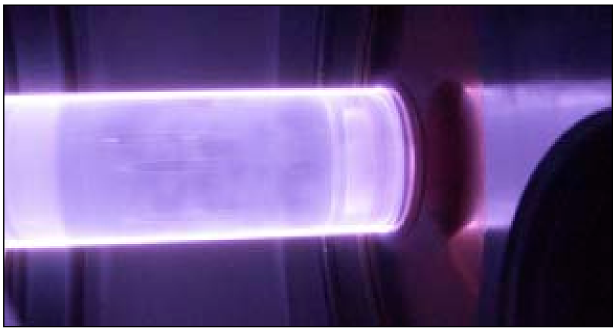

Figure 2: **Glow discharge, used for high-voltage, high-gradient commissioning of the 500 kV pulser.**

Last year was marked by the commissioning of the 500-kV pulser (Figure 3), and the production of its first electron beam. 2008 will be dedicated to diagnosis of this electron beam, a further improvement of the gradient, and additional acceleration of the beam up to 5 MeV. The latter involves the installation of a two-cell standing wave cavity, required to preserve the beam's high brightness (Figure 4).

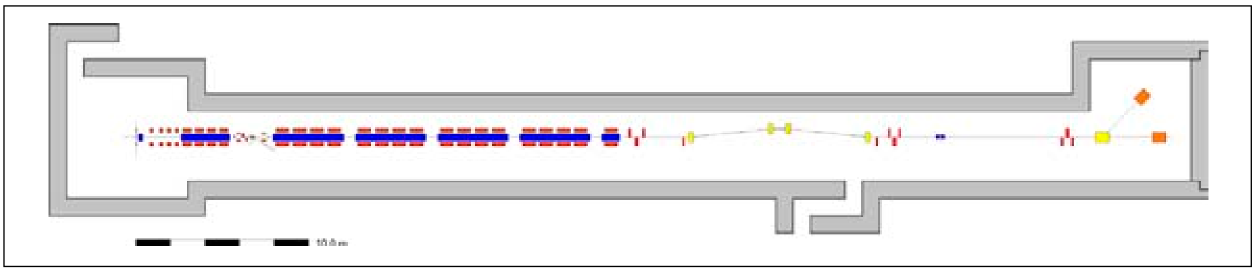

Figure 1: **Planned layout of the 250 MeV accelerator.**

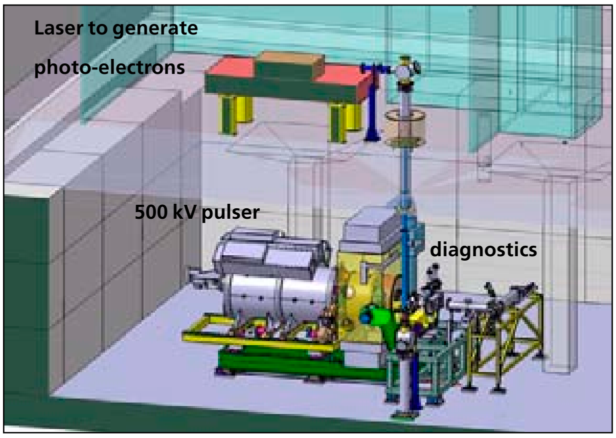

Figure 3: **Layout of the present electron source. See text for details.**

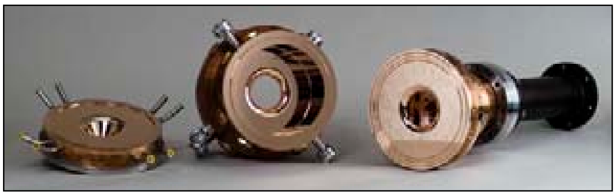

Figure 4: **1.5 GHz 2 cell cavity before assembly for low power test.**

250 MeV acceleration

At the gun exit, peak current is still insufficient to drive an X-ray FEL and, more importantly, the quality of the beam remains sensitive to space charge. Studies of the electron beam dynamics show that the first 250 MeV of acceleration are critical. It is for this reason that the next step of the PSI-XFEL project will concentrate on the design of a test accelerator for this energy range. Construction and operation are proposed for 2008 to 2011, a period during which it will serve as an experimental test environment to evaluate the technological risks of high-brightness beam acceleration in relation to its use as a future injector for an X-ray FEL linac system.

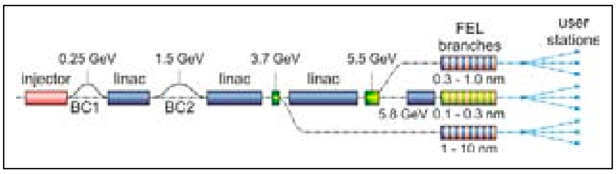

Figure 5: **Schematic layout of the PSI-XFEL. A single linac feeds three FEL branches, that together cover the wavelength range from 10 nm (120 eV) to 0.1 nm (12.4 keV).**

The main elements of the 250 MeV accelerator design were specified in 2007 and the construction of the infrastructure (Figure 7) is planned for 2008. Beyond the technological risk assessment, the accelerator is also designed so that it can serve as an injector for the planned XFEL.

X-ray FEL facility

The layout of the PSI-XFEL is shown in Figure 5. The facility is driven by a 6-GeV linac with three independent beamlines: a VUV beamline with variable polarization for the spectral range from 10 nm to 1 nm, an XUV beam line with variable polarization for the spectral range from 1 nm to 0.3 nm, and an X-ray beamline that goes from 0.3 nm down to 0.1 nm. All beamlines are designed to provide 25 fs pulses at peak brightness above 10^{31} photos/sec/mm^2/mrad^2/0.1, i.e. a value that is more than six orders of magnitude above the brightness provided by state of the art synchrotron facilities.

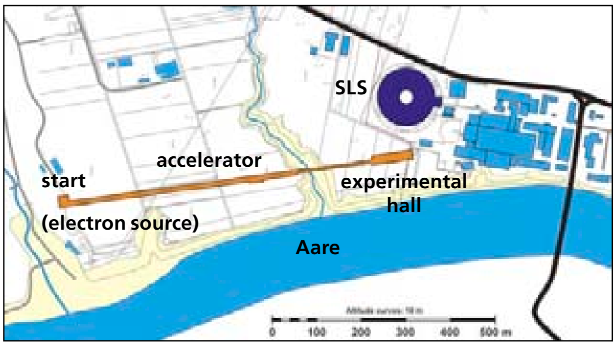

Figure 6: **Planned infrastructure for the PSI-XFEL shown in Figure 5.**

Further Information: http://fel.web.psi.ch

* A. Adelmann, A. Andersson, A. Anghel, M. Dehler, H.-R. Fitze, D. George, S. Ivkovic, C. Kraus, S. Leemann, K. Li, B. Oswald, M. Paraliev, L. Rivkin, T. Schilcher, T. Schietinger, V. Schlott, L. Schulz, A. Streun, F. Stulle, D. Vermeulen, (GFA); Hanspeter Gehrig, Florian Waser (PSI FEL); R. Betemps, F. Jenni, W. Pfister, C. Zumbach, F. Waser, (LOG); R. Abela, P. Beaud, J. Gobrecht, G. Ingold, E. Kirk, H. Sehr, S. Tsujino, T. Vogel, (SYN)

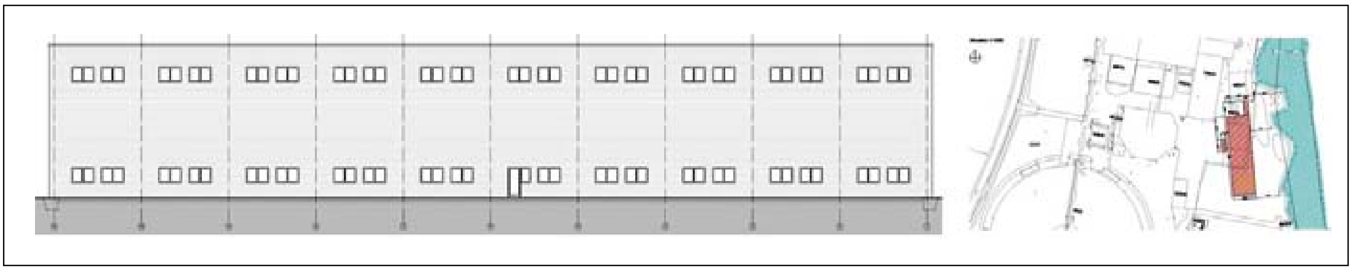

Figure 7: **Location and plans for the building that houses the accelerator tunnel.**

Technology transfer

The transfer of PSI research results into product development and process design in the economy is an important part of the institute's mission. Knowledge and technology transfer are part of PSI scientists' job description. In some areas of basic research, knowledge transfer is more dominant, while in other fields where activities are much closer to applications and innovations, industry is attracted by the possibilities of technology transfer.

The technical solutions at the forefront of technology which are implemented in the large research facilities and have shown reliable operation are another source for technology transfer. Several innovative industrial projects benefited from scientific services such as measurement periods, analyses and imaging support at the large facilities of PSI.

The technology transfer office assisted PSI staff in signing more than 100 research agreements with companies in 2007. Industry is not alone in benefiting from PSI expertise since governmental bodies signed more than 20 research agreements with the institute.

A considerable number of intellectual property rights were generated from research activities in 2007. The total number of patent applications topped the previous year's figure again with 52 applications. Out of these, 16 were priority applications with many originating from cooperation projects with industry. Such intellectual property rights are one way of exploiting the research results. In 2007 five new agreements for the use of PSI technology by patent transfer or licensing were signed.

Research at the institute with its broad spectrum of activities and projects will remain an attractive partner for industrial innovation processes. PSI and its scientists will continue to be on the lookout for new collaborations.

◀ **Research with a global reach: pixel chips for the LHC experiments at CERN.**

Neutron micro-tomography: examination of a LHC Rutherford cable

Gabriel Frei, Stefan Hartmann, Guido Kühne, *Neutron Imaging and Activation Group, PSI;*
Christian Scheuerlein, Gerard Willering, *European Organization for Nuclear Research (CERN)*

The thermal-electromagnetic stability of a superconducting cable against local heat deposition is of major importance for the reliable operation of superconducting high-field accelerator magnets, as found in the Large Hadron Collider (LHC) at CERN. Simulations of cable stability require for instance as an input the cable void fraction filled with liquid He (LHe). The inner void fraction across the cable width has been determined for a 01 LHC Rutherford-type cable using neutron tomography. The metallic composition of the sample makes the use of X-ray tomography impossible .

Tomograms were acquired with the micro-tomography setup of the ICON neutron imaging facility at PSI's SINQ spallation neutron source, with a detector pixel size of 13.5 µm. Final resolution was about 50 µm. Tomograms of a nude cable and part of a LHC inner magnet coil with insulated cables are shown in Figure 1. Due to the high scattering of neutrons by hydrogen the Kapton cable insulation appears clearly (indicated in yellow).

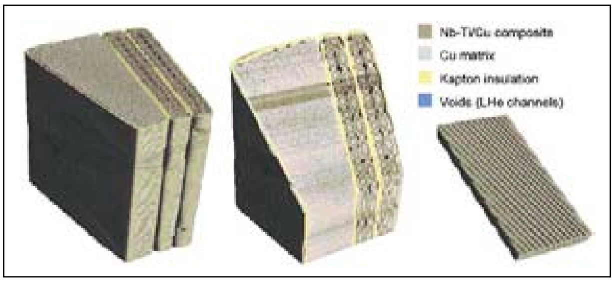

Figure 1: **Tomograms of two insulated cables removed from an inner LHC magnet coil and a nude 01 LHC cable (right). The Rutherford cable with a width of 15.1 mm and a mid-thickness of 1.896 mm is composed of 28 strands with a nominal diameter of 1.065 mm.**

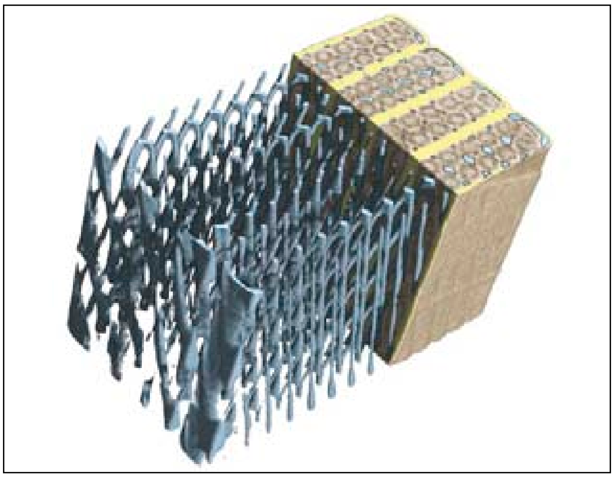

Figure 2: **Tomogram of a stack of four 01 B cables with partly removed structure for the visualization of the free space volume for the He cooling liquid (indicated in blue).**

Quantitative tomography results were elaborated from tomograms of a compressed stack of four cables with Kapton insulation. The inner-cable void volume (Figure 2) in the compressed 01 cable has been determined from neutron absorption contrast. Figure 3 shows the plane maps of the neutron absorption contrast in the centre sagittal cable slice and in a stack of 60 central slices.

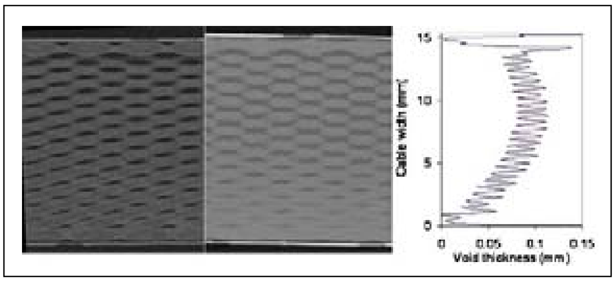

Figure 3: **Plane maps of the neutron absorption contrast in a centre sagittal cable slice (left) and a stack of the 60 central cable slices (centre). The grey values were converted into a void thickness scale (right). The total void cross section is only 4 % of the entire cross section.**

References

[1] G. Kühne et al., Nucl. Instr. and Methods in Physics Research A 542 (2005) 264–270
[2] G. Kühne et al., Swiss Neutron News, Nr 28 (December 2005) 20–29, http://sgn.web.psi.ch/sgn/snn.html

Non-destructive determination of hydride concentrations in Zircaloy

Holger Wiese, *Hot Laboratory, PSI;* Kurt-Åke Magnusson, *Fuel Engineering Division, Westinghouse Sweden AB*

Westinghouse AB and PSI are co-operating to find a non-destructive method to analyze local hydride concentrations in irradiated fuel cladding. A first milestone was met last year with the joint patenting of the technical apparatus and the project is now reaching the end of its second year with an application for a joint patent on the measurement procedure.

During irradiation of nuclear fuel rods, the zirconium alloy (zircaloy) claddings are exposed to high temperatures, pressure, vibrations, aggressive radiolysis products and high neutron fluence. In this environment, zircaloy slowly oxidizes, following the chemical reaction: $Zr+H_2O=ZrO_2+2H$. The zirconium-based cladding material absorbs part of the hydrogen produced. If the solubility limit is exceeded, hydrogen forms hydrides in the cladding, deteriorating the zircaloy's material properties (e.g. ductility and impact toughness) and may accelerate corrosion. Hydrogen content in the cladding is therefore an important parameter, normally determined by metal melting and hot gas extraction or scanning electron microscopy. Neutron radiography can also be applied to detect hydride lenses in the cladding. These methods are all used at PSI but are destructive and imply rod cutting.

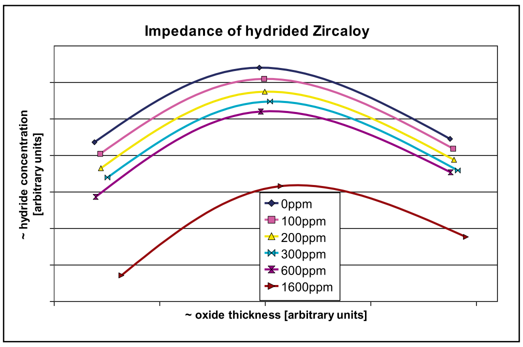

Figure 1: **Non-destructive determinations of hydride concentration in fuel claddings: Impedance curves of differently hydrided zircaloy samples.**

An idea for non-destructive testing

PSI and Westinghouse Electric Sweden AB (WES) presented a multi-frequency eddy-current analysis for non-destructive hydride assessment that could also be applied during power station poolside inspection without fuel transport and hotcell requirements. The concept is based on the fact that the electrical conductivity of pure zircaloy and zirconium hydride is different. The conductivity of zircaloy cladding should therefore depend on its hydride content. By taking into account hydrogen solubility, the total hydrogen content should be accessible. As eddy-current measurements are already applied in poolside inspections to determine oxide thickness, this technique is extended to determine the hydride content of the cladding material. A diploma thesis at PSI indicated this possibility in 2004. In 2005, WES and PSI signed an agreement to develop a non-destructive method for hydride analysis in claddings. An earlier co-operation saw the development of a method (Magnacrox) for oxide thickness analysis on fuel cladding tubes in presence of magnetic, waterborne surface deposits, which distort normal oxide thickness determinations. The patent for this process was extended [1] after the applicability of a non-destructive hydride analysis method on clean reference material and irradiated cladding was demonstrated [2] (Fig. 1).

Status and outlook

The method was tested under laboratory conditions on hydrided, non-irradiated material and later on irradiated fuel cladding. The measurement and calibration procedure was further improved during these experiments and the feasibility of ND-hydrogen measurements was shown under experimental conditions with a high local resolution (< 50 wt.ppm H). Additional investigations on samples from a blind ND-test rod and subsequent destructive hydrogen analyses should allow us to determine if the method can be used under pool conditions. An extension of the co-operation is being discussed.

References

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Fast magnet power supplies for dynamic proton beam control for tumor treatment

René Künzi, Felix Jenni, *Power Electronics Section, PSI*

Tumor treatments at PSI are performed by actively scanning a three-dimensional target volume – the tumor – with a thin proton beam, depositing a specific energy dose [1]. A newly developed treatment facility "Gantry II" shall allow multiple rescanning of moving target volumes in a reasonable timeframe. The proton beam is deflected rapidly and independently in two directions by dipole magnets. Two highly dynamic magnet power supplies (PS) were developed and commissioned for that purpose.

Power supply specifications

The proton beam is designed to sweep in the T- and U-direction orthogonal to the beam. The main PS specifications are:

	T-Sweeper-PS	U-Sweeper-PS
Maximum Current	+/– 150A	+/– 220A
Maximum Voltage	+/– 175V	+/– 320V
Maximum Current Slope	+/– 55A/ms	+/– 11A/ms

After completion of a T-sweep, the current in the U-Sweeper PS needs to be changed typically by 22A (10%) to adjust the beam for the following sweep. After 3ms the current should be within 0.1% of the rated current.

Bandwidth

A power supply with high dynamic and stability requirements needs high bandwidth. Concerning the bandwidth, the switching frequency should be as high as possible, but this increases switching losses. Junction temperature should be kept low in order to maximize lifetime and availability. The converters operate at switching frequencies of 25kHz (T-sweeper) and 16.7kHz (U-sweeper) and at junction temperatures below 80°C, a rather conservative compromise.

The controller is another speed-limiting component. A very powerful digital control system for high-precision power supplies has been developed at PSI [2].

High dynamic and precision requirements often call for sophisticated control algorithms. But a commonly used algorithm like a PI-controller can offer much better handling. The control algorithms implemented at PSI are always as simple as possible in all PS systems. Therefore, the two-sweeper PSs were commissioned with PI-controllers with reference filtering and a feed forward control for DC link ripple rejection. Should it become necessary to improve control performance, the digital control can be programmed with other algorithms without any hardware changes.

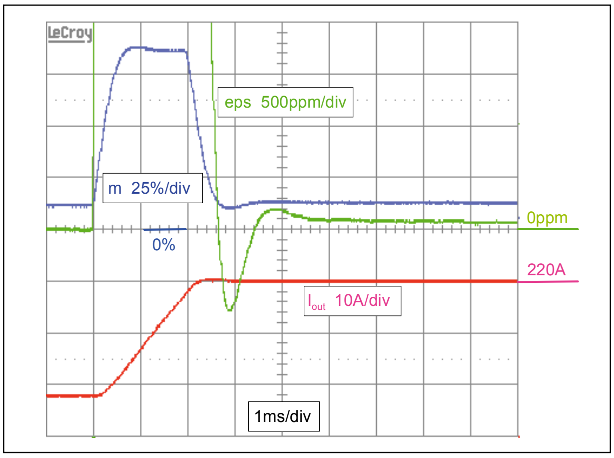

Figure 1: **U-sweeper closed loop control performance.**

Results

Fig. 1 shows a current step from 198 to 220 A (red) of the U-sweeper PS with its maximum current slope. The modulation index (blue), which is proportional to the output voltage, rises for 2 ms. The control deviation (difference between reference and actual current, green) is less than 0.1% after 2.6 ms and less than 0.01% after 5 ms, which is well within the specifications.

References

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Urea-SCR for diesel engines: unraveling the reaction mechanism of HNCO hydrolysis

Oliver Kröcher, Izabela Czekaj, Gaia Piazzesi, *Combustion Research Laboratory, PSI*

Selective catalytic reduction (SCR) with urea is the most efficient process for the reduction of NO_x in diesel exhaust gas. Urea acts as a safe and environmentally benign precursor substance for ammonia, which is the actual reducing agent for NO_x on the SCR catalyst. Süd-Chemie and the Paul Scherrer Institute have developed a urea decomposition catalyst based on TiO_2, whose functionality was elucidated at PSI by a combination of DFT calculations, DRIFT spectroscopy, catalytic tests and kinetic measurements.

In the SCR process to reduce NO_x in diesel vehicle exhaust, reducing agent urea has to be quantitatively and selectively decomposed to ammonia, which is the actual reducing agent in the SCR reaction. Whereas in conventional SCR systems the urea solution is decomposed on the SCR catalyst, sophisticated systems use a special catalyst upstream for this purpose. Süd-Chemie and PSI have developed together such a urea decomposition catalyst based on TiO_2, with Süd-Chemie developing the coating process for metal monoliths and PSI carrying out an in-depth investigation of the urea decomposition chemistry on different metal oxide materials. Tens of thousands of urea decomposition catalysts based on TiO_2 from Süd-Chemie are now on the road in MAN trucks.

Urea decomposition is a two-step process, in which urea first breaks down into ammonia and isocyanic acid. In a second phase the isocyanic acid hydrolyses easily into ammonia and carbon dioxide. Since only the second step of urea decomposition, i.e. isocyanic acid hydrolysis, is accelerated by catalysts, we focused our research on understanding this second reaction step better with the aim of developing improved decomposition catalysts.

We were able to reveal the reaction mechanism of the isocyanic acid hydrolysis on TiO_2 in our laboratory with a combination of DFT calculations, DRIFT spectroscopy, catalytic tests and kinetic measurements. The course of the reaction is illustrated in Figure 1 and can be summarized as follows: after the adsorption of isocyanic acid, water attacks the isocyanate group and carbamic acid forms on the surface. The carbamic acid is then transformed into a carbamate complex, which leads to CO_2 desorption and the formation of an NH_2 group. In the last step of the hydrolysis reaction, hydrogen is transferred from molecularly adsorbed water to the NH_2 group and NH_3 finally desorbs.

We assume this is a universal mechanism for this reaction, which will be used for virtual catalyst screening based on computer DFT calculations to identify the most active metal oxides in their best conformations. On the basis of these results we hope to be able to design and prepare lighter and improved urea decomposition catalysts, which will help to lower NO_x and carbon dioxide emissions of future diesel vehicles.

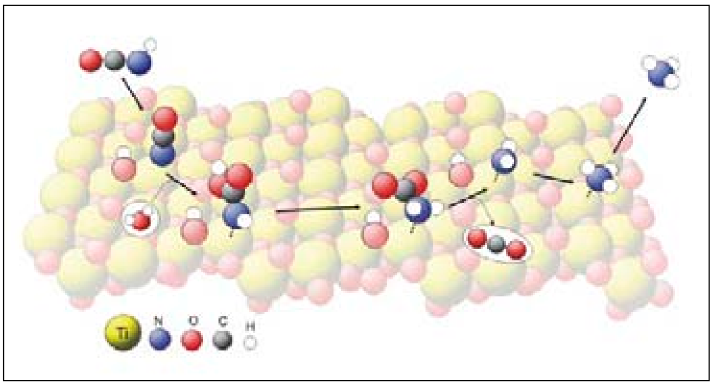

Figure 1: **Mechanism of the isocyanic acid hydrolysis on the (101) surface of TiO_2 in the anatase phase.**

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The PSI CVD-diamond x-ray beam monitors

Clemens Schulze-Briese, Claude Pradervand, Harald Sehr, Helmut Schift, Jens Gobrecht, *Research Department Synchrotron Radiation and Nanotechnology, PSI;* Roland Horisberger, *TEM, PSI;* Michael Horisberger, *NUM, PSI;* Elke Zimoch, Dirk Zimoch, *GFA, PSI*

The development of innovative devices at PSI benefits from the broad spectrum of research activities and from the quality and high motivation of its employees. This permitted the development of high-precision beam profile and beam position monitors for hard X-rays based on thin membrane CVD-diamond technology. These high-vacuum compatible, compact devices are ideally suited for monochromatic and filtered white beams. Highest transmission in conjunction with submicron resolution makes them ideally suited for online beam-monitoring. Commercialization is planned for 2008.

Third-generation synchrotron sources provide collimated beams which can be focused with advanced X-ray optics to submicron focal spot size. Thermal drifts and other perturbations induce positional and angular distortions, which seriously jeopardize the benefits of these unique properties. X-ray beam monitors are required to measure beam position and profile continuously to allow on-line correction. Over the past years we have developed a new class of X-ray beam monitors based on thin CVD-diamond membranes, which offer several advantages over existing technology. The most important is their low absorption, which allows several devices to be installed along the beamline for full control of all optical elements. When X-rays are absorbed in the membrane, they give rise to electron-hole pairs, which can be measured as a photo current. The distribution of the currents is used to determine beam position and profile. CVD-diamond on Si-substrate is purchased in Germany [1], while all other processing steps are carried out in different PSI laboratories.

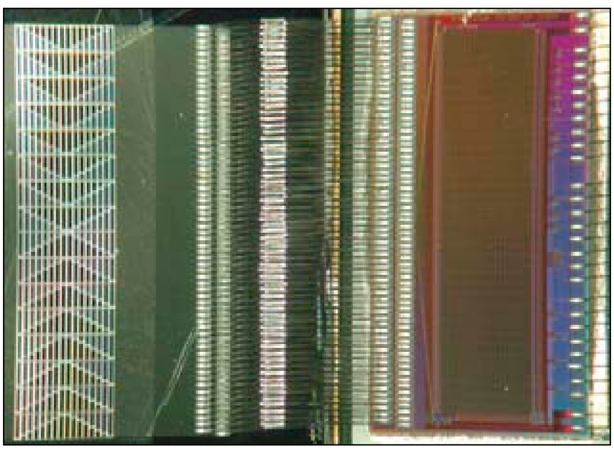

Figure 1: **Pixel array of profile monitor (left) with bond wires (centre) and APC128 read-out chip.**

Two different devices were developed: a quadrant monitor for on-line position monitoring of the X-ray beam and a pixelated beam profile monitor for on-line imaging. The latter consists of 256 pixels, whose measurements are acquired by an integrated circuit originally conceived for high-energy applications [2].

The 256-pixel sensor is read out by a standalone control system which is based on a multi-chip module CPU with serial, USB and Ethernet ports, yet is not larger than four jewel cases stacked on top of each other. This CPU runs on Linux and is interfaced by an FPGA (Field Programmable Gate Array) to the sensor, which ensures maximum flexibility and allows for future extensions. An EPICS driver has been developed for sensor readout and has been implemented in the control system. This allows for an easy integration with the beamline control system.

The quadrant monitors have been in routine operation at the protein crystallography beamlines of SLS for several years and are – besides the excellent stability of the SLS machine – the reason for their world-renowned beam stability. Their spatial resolution was determined to be better than 100 nm and the pico-ampere meter typically limits temporal resolution.

References

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Low energy electron detector from PSI for monitoring the particle environment in space

Wojtek Hajdas, Ken Egli, Christina Eggel, Stefan Scherrer, Niklaus Schlumpf, Bernd Schmitt, *PSI;*
Ali Mohammadzadeh, *ESA*

The Low Energy Electron Detector LEED is a miniature particle monitor for measurements in space. It is based on the MYTHEN Si-microstrip developed at PSI for X-ray detection at the SLS. The space version covers energies from a few up to a few hundred keV and is optimized for very high fluxes and a harsh radiation environment. The device aims to monitor space weather, map planetary radiation belts and study hot plasmas and particle acceleration.

The Low Energy Electron Detector LEED was designed in collaboration with the European Space Agency (ESA) to provide a new instrument covering an unexplored energy range of space electrons below a few dozen keV. The device shall demonstrate that ESA and its partners can develop miniature and cost-effective radiation monitors. The requirements on such monitors are very demanding and often contradictory. First the ideal monitor must be of low mass and size and draw minimal power. It should also detect very high fluxes with good energy resolution, efficient particle discrimination and background suppression. Its radiation hardness should be at least 100 krad for Earth-orbiting missions and about 1 Mrad for flights to Jupiter.

As result of our detailed studies we based LEED on the Microstrip system for the time-resolved experiment MYTHEN Si-microstrip instrument built at PSI for synchrotron X-ray detection at SLS – see Fig. 1.

MYTHEN uses the PSI-designed ASIC coupled with a microstrip Si-detector. The circuit is resistant to radiation, works at room temperature and offers simultaneous processing for 128 channels. Each channel is equipped with a low-noise preamplifier and fast shaping electronics, followed by a discriminator and a counter. Superior ASIC parameters are crucial for meeting space monitoring specifications and for its efficient and reliable operation. LEED should detect the highest anticipated particle fluxes in space and operate in extreme radiation environments like the Jupiter radiation belts. Its reduced power consumption, low total mass and size are major improvements over all its predecessors. The first version with enhanced radiation hardness levels is already designed for distant planetary missions – see Fig. 2.

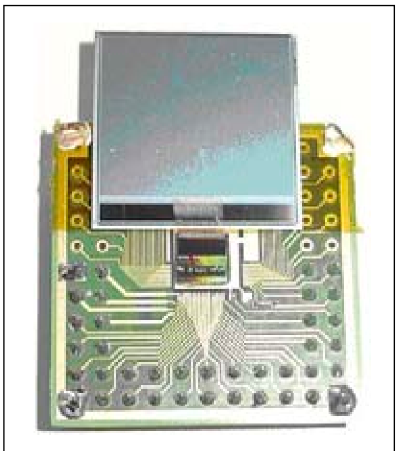


Figure 1: **Test structure with the Si-microstrip detector bonded to the MYTHEN readout ASIC.**

Figure 2: **CAD model of the LEED prototype.**

LEED was extensively modeled using the GEANT package from CERN. The results were confirmed by laboratory tests with radioactive sources. Our current efforts should make it possible to reduce the low-energy threshold of the monitor using novel Si-diodes with negligible dead-layer thickness on the surface. A fully functional prototype is now under construction. At the moment the standard MYTHEN sensors are used. Further optimization of strip widths to minimize multiple responses is under consideration.

The Swiss Space Office and ESA are supporting the development of LEED. The instrument has already attracted interest from industry, including PSI spin-off company DECTRIS as well as the large Oerlikon Space corporation. Future implementations onboard the International Space Station and on micro satellites are currently investigated.

Tc-tricarbonyl labelling of vitamin B12: towards the first clinical study of a new radiopharmaceutical

Peter Bläuenstein, Robert Waibel, Jürgen Bader, Raimo Pellikka, Roger Schibli,
Center for Radiopharmaceutical Science, PSI

Vitamin B12, which is mainly present in meat and absent in plants, is essential for cell growth. Our organism needs it to replace dead cells and maintain the normal function of all organs. Tumor cells also need Vitamin B12 and in some cases make excessive use of it. A radiolabeled Vitamin B12 analogue was developed and successfully tested pre-clinically. Producing a safe product and a reliable labeling process is rather demanding, so considerable time was spent developing a radiopharmaceutical that is authorised for human usage. We expect it to help improve treatment of cancer patients.

The introduction of $Tc(CO)_3(H_2O)_3^+$ as a new labeling tool (see also last year's report) has attracted wide interest in the radiopharmaceutical community, mainly due to the isolink kit which was developed and patented as part of a co-operation between PSI and Mallinckrodt. However this tool is of minor importance if there is no application in clinical practice. This means compounds with specific biological properties have to be evaluated.

Figure 1: **Safety is not only a matter of process and product analysis but also staff training: learning how to perform HPLC-purification.**

A new vitamin B12 radiopharmaceutical

Since Vitamin B12 is an important factor for cell growth it is of potential interest for tumor diagnosis and therapy. A key property is its affinity to the Vitamin B12 transporters Transcobalamin I and II (TC I and TC II). One of many compounds, which were investigated in vitro and in mice, it binds selectively to TC I. The lost affinity to TC II is why uptake is reduced in many organs but still high in tumors. Animal experiments proved the hypothesis. The next step is human application.

GMP – Good Manufacturing Practice

The GMP synthesis of the precursor was carried out by our partner Solidago and finished at the end of 2006. Risk analysis forced us though to reevaluate the labeling process in 2007. One example can illustrate the problems: morpholinoethane-sulfonic acid (MES) is an optimal buffer for Tc-tricarbonyl labeling of VitaminB12, but should not be injected into patients. Chromatographic analysis has trouble revealing MES and it is impossible to guarantee complete elimination during chromatographic (HPLC) purification. Replacing MES by a physiologic phosphate buffer led to the formation of a side product.

Many improvements were necessary to reach the point where human usage can be considered. To receive permission from the authorities (e.g. the Swiss Federal Health Office) vast amounts of paperwork are necessary but also crucial since it must be proven that a new drug is safe before it is injected in humans for the first time. Good results in patients, which hopefully will confirm the results obtained in animals, will help us to find an industrial partner for further clinical studies (multi-center study) which are beyond our capacity.

Successful demonstration of long-term catalyst stability in the methane from wood process

Tilman. J. Schildhauer, Martin Seemann, Serge M. A. Biollaz, Samuel Stucki, *Laboratory for Energy and Materials Cycles, PSI*; Daniel Ulrich, *CTU – Conzepte Technik Umwelt AG, Winterthur;* Reinhard Rauch, *TU Wien*

A 1 MW-Process Development Unit (PDU) is being set up in Güssing/Austria to demonstrate the production of synthetic natural gas by wood gasification and the subsequent methanation of producer gas (methane from wood process). PSI carried out long duration tests on a 10-kW scale to prove that the process concept for the methanation step enables catalyst stability for more than 1,000 hours with high methane content. This test shows that stable runs on the 1-MW PDU should be possible; an important milestone for the commercialisation of the process has been reached.

The production of synthetic natural gas (SNG) by wood gasification and subsequent methanation of producer gas (methane from wood process) is headed for commercialisation. Within the European Union project BioSNG, a 1-MW Process Development Unit (PDU) is under construction and will demonstrate the complete process from wood to SNG on a technical scale.

Research at PSI has focussed on the conversion of the product gas from the gasifier to a methane-rich mixture within a fluidised bed reactor filled with catalyst particles. For this purpose, a fully automated methanation set-up on a 10-kW scale was connected to the industrial biomass gasifier in Güssing/Austria. Using this set-up, PSI carried out long-duration tests to prove that the operational range for the methane from wood process is suitable for industrial application.

As sulphur poisoning has been one of the main issues during previous tests, special attention was paid to optimising sulphur removal. As shown in figure 1, the chosen operating conditions are representative for the planned operation of the 1-MW PDU and allowed us to demonstrate catalyst stability for more than 1,000 hours with a high methane content of about 40% and a very small amount of CO (less than 0.5%). With this result, an important milestone for the commercialisation of the process has been reached.

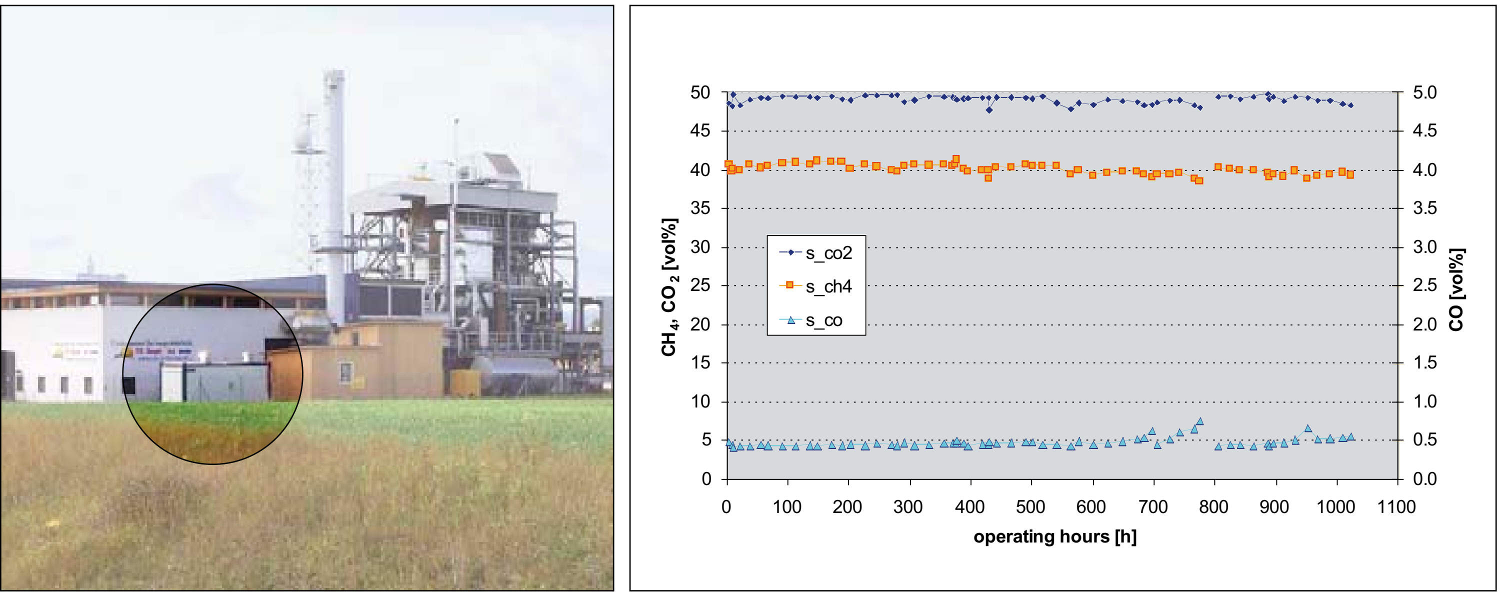


Figure 1: **PSI 10 kW scale test facility (inside white container) at the industrial wood gasifier in Güssing/Austria (left), concentrations of methane and carbon oxides during the 1000h test (right)**

Facts and figures

Research centre and user lab

The Paul Scherrer Institute (PSI) is a multi-disciplinary research centre for natural sciences and technology. Research priorities lie in areas of basic and applied research, particularly in fields that are relevant for sustainable development, as well as of major importance for teaching and training, but which are beyond the capabilities of a single university department. In national and international collaborations with universities, other research institutes and industry, PSI is active in solid-state physics, materials sciences, elementary particle physics, life sciences, nuclear and general energy research, and energy-related environmental research.

The institute is committed to future generations by paving the way for sustainable development of society and economy. Through its research, PSI acquires new basic knowledge and actively pursues the application of this knowledge within industry.

With 1,280 employees, it is the largest national research institute and is unique in Switzerland. PSI develops and operates complex research installations that call for especially high standards of know-how, experience and professionalism, and is one of the world's leading user laboratories for the international scientific community.

◀ **The new state-of-the-art control room opened in 2007 simplifies management of all the major research facilities.**

Research and user labs

PSI's total expenditure on R&D, construction and operation of research facilities, infrastructure and services in the year under review amounted to CHF 280 million. The Swiss Federal Government provided 85% of this figure, amounting to CHF 237.5 million.

Investments reached CHF 52.7 million (19 % of the total budget). HR costs were CHF 169.7 million (61%). Total costs dropped by CHF 10 million to around CHF 280 million. Third-party funding in 2007 amounted to CHF 55.7 million, 44% of which came from private business and 27% from Swiss federal research programs (Swiss National Science Foundation, Federal Energy Office); 13% was derived from EU programs.

PSI Financial Statement (in CHF millions)		
	2007	
Expenses		
Operations	227.3	81 %
Investments	52.7	19 %
Total	**280**	**100 %**
Thereof from:		
Federal government funding	237.5	85 %
Third party expenditure	42.5	15 %
HR (incl. trainees, ongoing staff education and scheduled work)	169.7	61 %
Third party revenue from		
Private industry	24.4	44 %
Federal research funding	15	27 %
EU programs	7.3	13 %
Other	9.0	16 %
Total	**55.7**	**100 %**

70% to user lab

Some 70% of total expenditure in 2007 was linked to PSI's function as a user laboratory. External pressure from foreign users continued to restrict the time available for the Institute's own research activities. In a long-term perspective, this trend should not be encouraged, as PSI can only provide optimal support and consultative services for external users if its own research remains at a consistently high level.

User lab 2007						
	SLS	**SINQ**	**SμS**	**Particle physics**	**PSI Total**	**(2006)**
No. of beamlines/ instruments	13	13	6	8	**40**	(40)
No. of experiments	849	347	1368	8	**1372**	(1058)
No. of user visits	2399	614	204	300	**3517**	(2758)
No. of users	1228	366	163	130	**1887**	(1421)

At the end of 2007, some 1,280 people were employed full-time at PSI. Three quarters of these employees (approx. 77 %) live in canton Aargau, 10% in canton Zurich, and the rest in other cantons as well as across the border from Switzerland. 22% of employees are women, and 39% of staff are foreign citizens.

Training in high demand

In 2007, 270 postgraduates completed their PhD theses wholly or partly at PSI, benefiting both from the research facilities and from the support of PSI staff. More than 170 of these were funded by PSI. At the end of the year the institute also employed 76 apprentices in 12 different areas.

With its commitment to doctoral education, as well as to teaching at the two Swiss Federal Institutes of Technology (ETH) and at classical and applied sciences universities, PSI is a major contributor to the Graduate School sector. Recognized the world over, our cutting-edge research, as well as our user lab with its global reach, ensure that students are competitive on the international scene. More than 70 PSI scientists had teaching commitments at classical and applied science universities in 2007.

Taking the strain off the Swiss universities

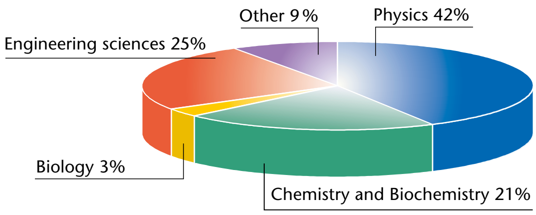
In 2007 PSI spent some CHF 35 million on training and infrastructure facilities for PhD students, as well as on university teaching. Around 75% of this was for post-graduate students from universities and from the Zurich and Lausanne ETH institutes. By providing research training and lab facilities for postgraduates and external research groups, PSI takes a considerable financial and academic burden off the shoulders of the Swiss universities.

Alongside academic and vocational training, PSI also offers courses on radiation protection and reactor technology. The institute's special schools gave 3,000 lectures that were attended by more than 2,000 professionals in 2007.

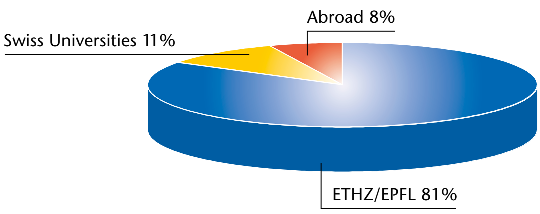
Research at PSI is closely linked to the design, development and operation of large, complex research facilities. Unique in Switzerland, we are also, thanks to this specialty, the biggest national scientific research institute. Indications of our success and standing are on the one hand the number of papers published by our scientists in refereed journals, and on the other the impact score that tallies how often publications are cited by other researchers.

Bibliometric data supplied by the University of Leiden shows that the output of scientific articles from PSI rose again. With more than 800 publications last year, the result was well above the ten-year average of 500. The impact score (citations) has also regularly risen and currently stands at 2,500 per year. This means that on average each paper is referred to between three and five times by other scientists.

Basic PhD training at PSI –
women comprise a quarter of student employees.



Educational background
of PSI doctorate students



An attractive partner

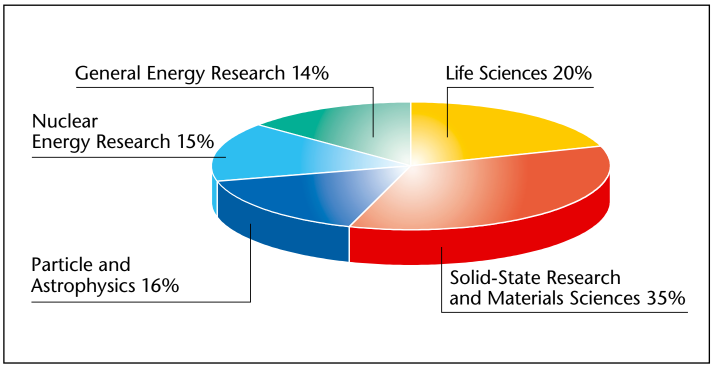
PSI's main research fields – solid-state and particle physics, life sciences, energy research – are also generally those in which the institute's researchers have a middle to high impact factor. There is a close fit between PSI's research profile and scientific output. Some 80% of our publications are in our core areas. Analysis of various collaborations shows that PSI is an attractive partner, especially at the international level. This, as well as the institute's outstanding impact score, puts us among the world's leading research centers.

SLS

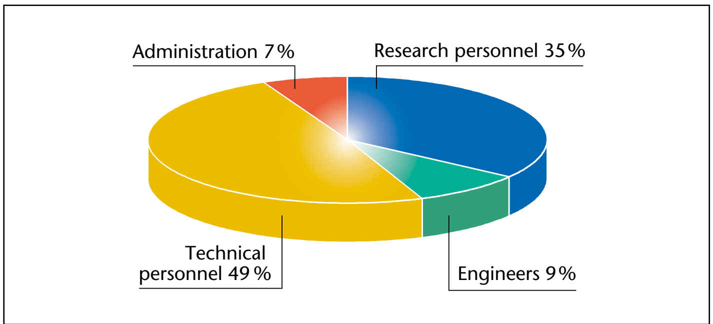
The Swiss Light Source (SLS) is both a massive microscope and a giant x-ray machine. It accelerates electrons close to the speed of light and steers them with special magnets so that the characteristic high intensity synchrotron light follows a pre-defined path. This electromagnetic radiation spanning from infrared wavelengths to hard X-ray light is ideally suited to structural analysis of matter and of ultra-fine material surfaces in the nanometer range as well as spectrometry.

SINQ

The Spallation Neutron Source (SINQ) is another oversized microscope. It produces neutrons, which at PSI are mostly used for experiments in materials research, solid-state physics (e.g. superconductors, magnetic and ferroelectric materials) and technology (neutron radiography). The neutrons are produced via spallation reactions induced by bombarding heavy metals (for example lead) with a proton beam from the accelerator.



In the total budget distribution for 2007 (incl. external funding) across PSI divisions, research facilities – in particular accelerator, SLS and SINQ – were allocated to the various departments.



HR structure clearly reflects PSI's function as a user lab. The large-scale facilities and complex research equipment require a high technical staffing level.

PSI as a user lab

PSI's three major experimental research facilities, SLS, SINQ and SμS, offer an internationally unique combination of complementary methods for structural research, spectroscopy and materials structuring. PSI aims to continue attracting the best international scientists in their fields. This means that our employees, our research spectrum and infrastructure as well as our vital research culture must all meet the highest demands.

In 2007, PSI's user laboratory, a leading national and international centre, recorded more than 3,500 visits by about 1,900 scientists who carried out 1,400 experiments. Around half the available time for experiments was given over to research groups from PSI and Swiss universities, with the rest going to foreign researchers, most of them from the European Union. Foreign users representing 61 nationalities came from institutes in 34 countries. The experiments at the three main facilities led to 359 scientific publications. Publications in top journals such as "Science", "Nature", "Cell" and "Physical Review Letters" rose significantly. Altogether 66 articles and reports in relation with PSI's NUM and SYN research domains were published in this category, including 50 that involved experiments with the SLS, SINQ and Sμs facilities

60 million Swiss francs

PSI invests 60 million Swiss francs yearly for the development and operation of research facilities for Switzerland's universities.

Neutrons for MARS

MARS is the newest instrument at SINQ. Due to its high-energy resolution, this backscattering spectrometer greatly extends the range of experimental possibilities of the large scale facility.

SμS

Harnessed to the proton accelerator, the Swiss Muon Source (SμS) produces muons by directing the proton beam on a carbon target. When implanted in materials, these unstable elementary particles function like minute gyroscopes, providing precise information about localized internal magnetic fields. Thanks to their spins (individual angular momentum), muons serve as highly sensitive probes that are widely used in materials and solid-state research.

Thirty per cent more experiments at the SLS

The Swiss Synchrotron Light Source (SLS) has been operating for six years and is considered one the best facilities of its type in the world. In 2007, 1,228 scientists carried out 849 experiments there, benefiting from the top-quality beamlines. This was a 30 per cent increase over the previous year. The scope of experiments being carried out is wide. For example, the structure of proteins is being probed, crucial for the development of pharmaceuticals and the understanding of human genome functions. The synchrotron light is also used to determine the structure and properties of new materials and material surfaces, and allows the implementation of new imaging techniques. Demand for the SLS' extremely stable synchrotron light is enormous: all its instruments are overbooked, sometimes by a factor of six to eight. At the end of 2007, there were 13 beamlines in use at the SLS, and five more are planned or under construction.

Ten years of successful operations at SINQ

The proton accelerator was originally developed over 30 years ago for fundamental experiments in particle physics. Today, 70 per cent of the protons produced are for the spallation neutron source SINQ, the most powerful facility of its type in the world. Currently, there are 13 instruments available for experiments with neutrons. Last year, 370 scientists from Switzerland and abroad made use of them. The year 2007 was also cause for special celebration by SINQ's builders and managers, with a decade of successful operations.

Research with SINQ focuses mainly on solid-state physics and materials science. Superconductors will be particularly important in the future, as they can conduct current without loss at certain temperatures. So far, they must be cooled to at least minus 125 degrees Celsius. To improve on this, the mechanism of superconductivity needs to be fully understood – one of the challenges facing SINQ researchers. Another specialty of SINQ groups is research into new materials that combine electrical and magnetic properties. This helps for example the development of materials for sensors, transducers as well as high-performance data storage.

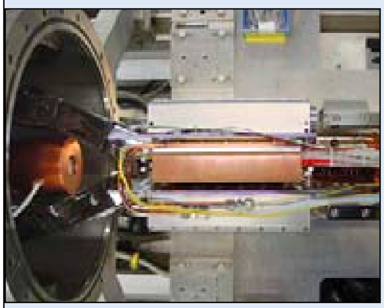
Around one third of the proton current is used to create the world's most intense continuous muon flow. The Swiss muon source SμS includes six instruments that were used by 160 scientists in 2007 for nearly 170 research projects. Muons are used as sensitive magnetic probes, especially for solid-state physics, materials science and chemistry.

Unique research offer

Demand for instrument time and experiment slots is at times eight times more than what is available (this is the case for protein crystallography). This means that only the best projects get beam time. Allocation is based on research proposals that are made to an international committee of scientific experts.

Active in environmental research

Understanding environmental problems and developing greener technologies requires complex research equipment. PSI is developing and managing large-scale facilities that are used intensively in this field. Two SLS beamlines are also to be set aside to study the dispersion and intensification of harmful substances in the atmosphere, as well as the long-



Particle physics

Particle physics investigates the fundamental building blocks of matter and their interactions. Many experiments have confirmed the standard physical model with great exactitude, but one element of this theoretical structure – the Higgs boson – has yet to be found. Particle physics is currently engaged on a twofold quest, on one hand seeking the Higgs and on the other a new supersymmetry that will link elementary particles and the different interacting forces, helping explain gravity.

The hot-lab

The PSI hot-lab is home to applied materials research on highly irradiated radioactive samples and radioactive waste disposal. The only facility of its type in Switzerland, it provides backup for Swiss nuclear power plants as well as for university and industrial research.

term storage of radioactive waste. The proton accelerator allows for the production of short-lived radionuclides that can be used to study atmospheric chemistry.
In environmental research, analysis of ice cores now benefits from the help of a new type of accelerator/mass spectrometer that allows for carbon 14 dating of very small samples. In PSI's smog chamber, researchers are carrying out experiments that simulate the formation of aerosols and provide new knowledge about these airborne particles that have a real impact on the climate.

Particle and high-energy physics

The excellent experimental conditions provided by the world's most intense pion and muon beams attracted research teams from Europe, the United States, Russia and Japan. Their experiments focused on the fundamental properties of these tiny particles. The MEG experiment, which looks for unusual forms of decay in muons, has now been installed and tested, with data collection to begin in spring 2008. A project involving a source of ultra cold neutrons is in the final construction phase and will begin the search for the neutron's electric dipole moment in 2009. This type of experiment and others at PSI are seeking out very subtle, but also very important, effects for the comprehension of particle physics.
PSI is also an active participant in the high-energy program of the LHC collider at CERN near Geneva. One of the Institute's important tasks has been the development, construction and operation of a new type of pixel detector to precisely retrace the path of particles inside the so-called CMS experiment. The construction of this technologically demanding detector was pushed through last year so that it could be installed at CERN in spring 2008.

Expansion of cancer therapy

The expansion of the proton therapy facility for the treatment of cancerous tumors (Proscan Project) continued last year. The new superconducting medical cyclotron Comet was put into operation in February 2007 with the existing Gantry 1. Around 50 patients benefited from this new radiation therapy technology. PSI is still the only institute anywhere in the world offering the high-precision Spot-Scanning radiation technique. Other projects abroad are now starting to implement this technology
PSI has granted industrial licenses for its precision radiotherapy scanning technology. Commercial facilities in Germany using the scanning process and compact cyclotron developed at PSI will soon begin operations. Further projects are in planning or construction phase. Swiss industry has benefited from this development work carried out at the Institute with sales of components and systems.
A new type of radiation gantry, Gantry 2, is in the final construction phase. It will be able to handle tumors that move during treatment (breast, lungs). Gantry 2 will probably ready for patient treatment in the first half of 2009 after tests are completed. From then on, PSI will have two high-precision radiation systems dedicated to medical treatment that should be able to handle 500 to 600 cancer patients per year for proton therapy. A new radiation treatment facility for eye tumors (OPTIS 2) should also be ready at the beginning of 2008. In 2007, more than 220 patients were successfully treated at the existing OPTIS facility.

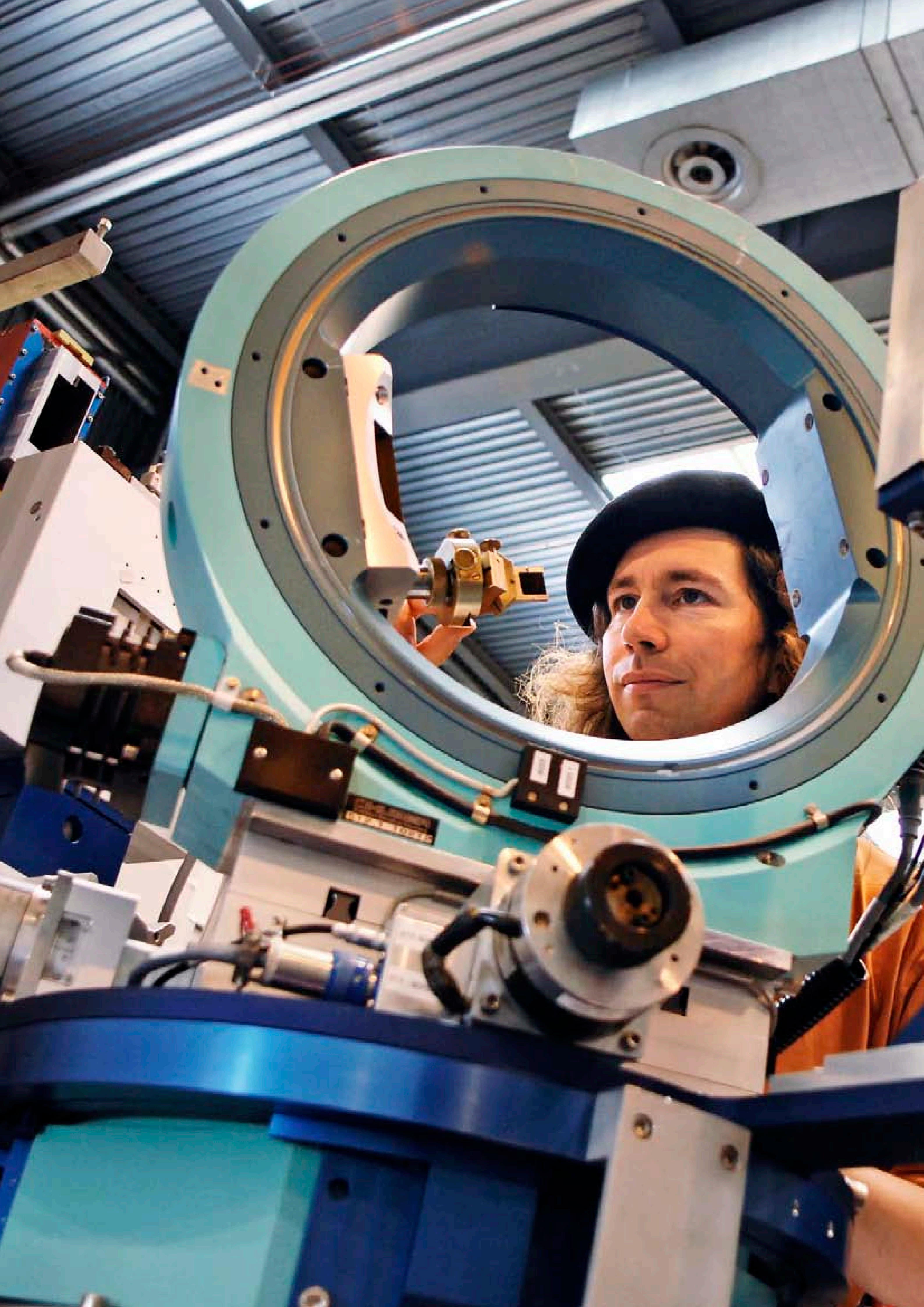
Jochen Stahn loves surprising effects, especially on the surface of materials. The 38-year-old chemistry PhD observes these effects with the help of neutrons at PSI's SINQ. ▶

The solar furnace

PSI's solar concentrator, an 8.5 m diameter concave mirror, focuses solar radiation to an intensity of 5000 suns. The high temperatures (up to 2000° C) created inside a special reactor are used for research into solar-chemical processes such as efficient production of solar fuels. A high-flux solar simulator twice as powerful was recently installed for experiments into radiation under controlled conditions irrespective of the weather.

The smog chamber

The smog chamber helps simulate specific conditions for atmospheric chemistry experiments. A 27-m3 Teflon sack can be filled, for example, with exhaust gases for exposure to artificial sunlight, and the ensuing chemical reactions can be observed and measured. The results can be used in some cases to determine what chemical reactions take place when there are high concentrations of fine particles in the atmosphere.



Commission and committees

(status end of 2007)

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Atel, Olten, CH

Prof. Dr. M. Giot
Université Catholique de Louvain, BE

Dr. P. Miazza
Nuclear Power Plant Mühleberg, CH

Dr. U. Schmocker
HSK, Würenlingen, CH

Dr. J.B. Thomas
CEA-Saclay, Gif-sur-Yvette, FR

Prof. Dr. S. Virtanen
Universität Erlangen, DE

Dr. P. Zuidema
Nagra, Wettingen, CH

General Energy ENE

Prof. Dr. T. Peter, President
ETH Zurich, CH

Dr. T. Kaiser
ALSTOM (Schweiz), Birr, CH

Prof. Dr. H. Müller-Steinhagen
DLR, Stuttgart, DE

Prof. Dr. Ph. Rudolf von Rohr
ETH Zurich, CH

H.U. Schärer
BFE, Berne, CH

Prof. Dr. L. Schlapbach
Empa, Dübendorf, CH

Prof. Dr. A. Voss
University of Stuttgart, DE

Publications

Where to find what

On CD and online

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

The lists include the following:

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

Also included on the CD is the Annual Report (Jahresbericht) in German.

Links to other research not featured here can also be found on our website, www.psi.ch (Research at PSI).

◀ **"Proton radiation therapy clearly improves patient outcomes for different types of cancer," says PSI chief physician Eugen Hug.**

LIST OF PUBLICATIONS

CENTER FOR PROTON RADIATION THERAPY 2007

PUBLICATIONS

Albertini F., Lomax A.J., Hug E.B.
In regard to Trofimov et al: radiotherapy treatment of early-stage prostate cancer with IMRT and protons: a treatment comparison.
Int J Radiation Oncology Biol. Phys 69 (2007) 1333-1334

Ares C., Khan S., Gruber G., MacArtain A., Lutters G., Heuberger J., Bodis S., Lomax A.J.
Postoperative Proton Radiotherapy for Localized and Loco-Regional Breast Cancer: Potential for Clinically Relevant Improvements?
Int J Radiat Oncol Biol Phys 2007;69(3S1):S140-S141

Bölling T., Schuck A., Pape H., Rübe C., Meyer F.M., Martini C., Timmermann B., Asadpour B., Kortmann R.D., Beck J.D., Langer T., Paulides M., Willich N.
German register for detection of late sequelae after radiotherapy for children and adolescents (RiSK): present status and first results
Strahlenther Onkol. 2007 Dec;183 Spec No 2:7-8. No abstract available.
PMID: 18166996 [PubMed - in process]

Buehrer S., Immoos S., Frei M., Timmermann B., Weiss M.
Evaluation of propofol for repeated prolonged deep sedation in children undergoing proton radiation therapy
British Journal of Anaesthesia 2007: 99 (4): 556-60

Hinkes B., von Hoff K., Deinlein F., Warmuth-Metz M., Soerensen N., Timmermann B., Mittler U., Urban C., Bode U., Pietsch T., Schlegel P.G., Kortmann R.D., Kuehl J., Rutkowski S.
Childhood pineoblastoma: Experiences from the prospective multicenter trials HIT-SKK87, HIT-SKK92 and HIT9
J Neurooncol 2007 Jan;81(2):217-23

Kolb A., Buchler P., Buchler M., Friess H., Rittgen W., Edler L., Debatin K.M., Krammer P.H., Rutz H.P., Herr I.
Clinical and mechanistic aspects of glucocorticoid-induced chemotherapy resistance in the majority of solid tumors
Cancer Ther 2007 Feb;6(2):278-87. Epub 2007 Feb 27

Kortmann R.D., Bongartz R., Dieckmann K., Dunsrt J., Flentje M., Gademann G., Christiansen H., Kamprad H., Karstens H.J., Pape H., Schmidt B.F., Willich N., Schulz-Ertner D., Schwarz R., Timmermann B., Pohl F., Klingebiel T., Jürgens H., Rübe C.
Anforderungen und Leitungsprofile der Arbeitsgemeinschaft Pädiatrische Radioonkologie (APRO): Eine Bestandsaufnahme und Darstellung zukünftiger Entwicklungen
Klin Pädiatr 2007; 219:166-172

Rutz H.P., Weber D., Sugahara S., Timmermann B., Lomax A.J., Bolsi A., Pedroni E., Coray A., Jermann M., Goitein G.
Extracranial Chordoma: Outcome in Patients treated with Function-Preserving Surgery followed by Spot-Scanning Proton Beam Irradiation
Int J Radiat Oncol Biol Phys 2007; Feb 1; 67(2)512-20

Rutz H.P., Weber D.C., Goitein G., Ares C., Bolsi A., Lomax A.J., Pedroni E., Coray A., Hug E.B., Timmermann B.
Postoperative Spot-Scanning Proton Radiation Therapy for Chordoma and Chondrosarcoma in Children and Adolescents: Initial Experience at Paul Scherrer Institute
Int J Radiation Oncology Biol Phys 2007 (Ahead of publishing).

Rutz H.P., Lomax A.J.
Radiotherapy for Prostate Cancer (Letter to the editor)
N Engl J Med 356 (2007) 308-309

Rutz H.P., Weber D.C., Sugahara S., Timmermann B., Lomax A.J., Bolsi A., Pedroni E., Coray A., Jermann M., Goitein G.
Extracranial chordoma: Outcome in patients treated with function-preserving surgery followed by spot-scanning proton beam irradiation
Int J Radiat Oncol Biol Phys. 2007 Feb 1;67(2):512-20.
PMID: 17084540 [PubMed - indexed for MEDLINE]

Schneider U., Lomax A.J., Besserer J., Pemler P., Lombriser N., Kaser-Hotz B.
The impact of dose escalation on secondary cancer risk after radiotherapy of prostate cancer
Int J Radiat Oncol Biol Phys 68 (2007) 892-897

Timmermann B., Schuck A., Niggli F., Weiss M., Lomax A.J., Pedroni E., Coray A., Jermann M., Rutz H.P., Goitein G.
Spot-Scanning Proton Therapy for Malignant Soft Tissue Tumours in Childhood: First Experiences at PSI
Int J Radiat Oncol Biol Phys 2007;Feb 1;67(2):497-504

Timmermann B., Lomax A.J., Nobile L., Grotzer M.A., Weiss M., Kortmann R.D., Bolsi A., Goitein G.
Novel Technique of Craniospinal Axis Proton Therapy with the Spot-Scanning System : Avoidance of Patching Multiple Fields and Optimized Ventral Dose Distribution
Strahlenther Onkol. 2007 Dec;183(12):685-688.
PMID: 18040613 [PubMed - as supplied by publisher]

Timmermann B., Schuck A., Niggli F., Weiss M., Lomax A.J., Pedroni E., Coray A., Jermann M., Rutz H.P., Goitein G.
Spot-scanning proton therapy for malignant soft tissue tumors in childhood: First experiences at the Paul Scherrer Institute
Int J Radiat Oncol Biol Phys. 2007 Feb 1;67(2):497-504.
PMID: 17084557 [PubMed - indexed for MEDLINE]

von Siebenthal M., Cattin P., Lomax A.J., Boesiger P., Székely G.
4D MRI imaging of respiratory organ motion and its variability
Phys Med Biol 52 (2007) 1547-1564

von Siebenthal M., Székely G., Lomax A.J., Cattin P.
Inter-subject modelling of liver deformation during radiation therapy
Med Image Comput. Comput. Assist. Interv. 10 (2007) 659-666.

von Siebenthal M., Székely G., Lomax A.J., Cattin P.
Systematic Errors in Respiratory Gating due to Intrafraction Deformations of the Liver
Med. Phys. 34 (2007) 3620-3629.

Weber D.C., Rutz H.P., Bolsi A., Pedroni E., Coray A., Jermann M., Lomax A.J., Hug E., Goitein G. *Spot Scanning Proton Therapy in the Curative Treatment of Adult Patients with Sarcoma: the Paul Scherrer Institute Experience*
Int J Radiat Oncol Biol Phys 2007

Weiss M., Frei M., Buehrer S., Goitein G., Timmermann B.
Deep propofol sedation for vacuum-assisted bite-block immobilization in children undergoing proton radiation therapy of cranial tumors
Pediatr Anaesth 2007 Sept; 17(9):867-73

Zhang C., Wenger T., Mattern J., Ilea S., Frey C., Gutwein P., Altevogt P., Bodenmuller W., Gassler N., Schnabel P.A., Dienemann H., Marme A., Hohenfellner M., Haferkamp A., Pfitzenmaier J., Grone H.J., Zarovnaya E.L., Pallatroni H.F., Hug E.B., Ball P.A., Cromwell L.D., Pipas J.M., Fadul C.E., Meyer L.P., Park J.P., Biegel J.A., Perry A., Rhodes C.H.
Atypical teratoid/rhabdoid tumor of the spine in an adult case report and review of the literature
J Neurooncol. 84(1):49-55, 2007

INVITED TALKS

Hug E.
Ionentherapie in USA, Europa, und im deutschsprachigen Raum
12.Alpbacher Seminar für Radio-Onkologie. Alpbach/Tirol, Austria,

Hug E.
Medizin und Kommerz – Werte, Leistungen, Abhängigkeiten
Alpbacher Seminar für Radio-Onkologie, Alpbach/Tirol, Austria, April 2007

Hug E.
Protonentherapie am PSI
Kantonsspital Aarau, April 2007

Hug E.
Protontherapy in Children
Dept. Of Radiation Oncology, Uppsala University Medical School, Sweden, May 2007

Hug E.
Proton Radiotherapy in Neuro-Oncology: Indications, Advantages, Limitations
Landeskrankhenhaus, Feldkirch, Austria, May 2007

Hug E.
Möglichkeiten der verbesserten Krebstherapie mit Protonen
Handelskammer Hamburg. Kolloquium: Neue Techniken zur effizienten Behandlungen von Krebserkrankungen, 2007

Hug E.
Proton Radiotherapy for Tumors of the Skull Base: Indications, Advantages, Limitations
Pre-Meeting Teaching Course, Particle Therapy Cooperative Group, PTCOG 46, Wanjie, Zibo, China, May 2007

Hug E.
Proton Radiation Therapy for Uveal Melanomas
Pre-Meeting Teaching Course, Particle Therapy Co-Operative Group, PTCOG 46, Wanjie, Zibo, China, May 2007

Hug E.
Proton Radiotherapy
International Conference on the Future of Medical Science,Umberto Veronesi, Milano, Italy, 2007

Hug E.
30 Jahre Protonen Radiotherapie. Erfolge, Versäumnisse, Ausblicke
13. Jahreskongress der Deutschen Gesellschaft für Radioonkologie DEGRO, Hannover, Germany, 2007

Hug E.
Proton Therapy in Pediatric Oncology
International Symposium on Protons, Ions and Neutrons in Radiation Oncology, Technical University, Munich, Germany, July, 2007

Hug E.
Clinical results of proton radiotherapy
Ion Beams in Biology and Medicine Meeting, Heidelberg, Germany, September 2007

Hug E.
30 Jahre Protonen-Radiotherapie: Klinische Resultate und Applikationen
Jahrestagung, der Deutschen, Österreichischen und Schweizerischen Gesellschaften für Hämatologie/Onkologie, Basel, Switzeralnd, October 2007

Hug E.
Protonen-Radiotherapie
Symposium „Energie in der Tumortherapie", Dachau, Germany, November 2007

Hug E.
The pediatric patient
SIRR Monothematic Meeting, Trento, Italy, November 2007

Hug E.
The treatment of ocular diseases
SIRR Monothematic Meeting, Trento, Italy, November 2007

Hug E.
Protonen-Radiotherapie: Indikationen und Stellenwert im Rahmen der Präzisions-Strahlentherapie
Oncology Rounds/Lymphoma Rounds, University Hospital Zurich, Switzerland, December 2007

Hug E.
Multidisciplinary Oncology Conference, CHUV, Lausanne, Switzerland, December 2007

Lomax A.J.
Proton therapy: Is there a point to the Bragg peak?
St Georges Hospital, Sydney, Australia, October 2007

Lomax A.J.
Current challenges in scanned proton therapy
St Georges Hospital, Sydney, Australia, October 2007

Lomax A.J.
Proton therapy: More than a peak in the mountains?
Peter MacCallum Cancer Centre, Melbourne, Australia, October 2007

Lomax A.J.
Intensity Modulated Proton Therapy: More than a peak in the mountains?
University of Adelaide, Australia, October 2007

Lomax A.J.
Intensity Modulated Proton Therapy: Things we have learnt (and are still learning)
University of Adelaide, Australia, October 2007

Lomax A.J.
Intensity Modulated Proton Therapy: Things we have learnt (and are still learning)
Keynote lecture, EPSEM-ABEC, Fremantle, Australia, October 2007

Lomax A.J.
State-of-the-art in Proton Therapy: Modern delivery techniques and current challenges
Keynote lecture, EPSEM-ABEC, Fremantle, Australia, October 2007

Lomax A.J.
Managing treatment interruptions in radical radiotherapy
University Hospital Zurich, Switzerland, September, 2007

Lomax, A.J.
Have we forgotten the ALARA principle in IGRT?
ESTRO physics congress, Barcelona, Spain, September 2007

Lomax A.J.
Proton therapy: Application and Quality assurance
Dreilaendertagung (DGMP/SGSMP/ÖGMP), Bern, Switzerland, September 2007

Lomax A.J.
Curing cancer with protons
Keynote lecture, International Conference on Biomedical Applications of High Energy Ion Beams, University of Surrey, UK, August, 2007

Lomax A.J.
Proton therapy: An Overview
49th AAPM Annual Meeting, Minneapolis, USA, July, 2007

Lomax A.J.
Proton therapy: Past present and future
'La Fisica Medica in Lombardia: 30 anni di esperienza nell'ambito della Scuola di Specializzazione in Fisica Sanitaria, Unversita Degli Studi di Milano, Milan, Italy, May 2007

Lomax A.J.
Advance proton therapy: The physicists eye view
Kantonspital Aarau, Switzerland, May 2007

Lomax A.J.
Active scanning for particle radiotherapy: The chance and the challenge
1st workshop on instrumentation for charged particle therapy, Imperial College London, UK, May 2007

Lomax A.J.
Active scanning for light-ion therapy: The chance and the challenge
National Physical Laboratories, London, UK, May 2007

Pedroni E.
Proton Gantries – design considerations and state of the art
Med-AUSTRON „Gantry Workshop 2007“, Vienna, Austria, March 2007

Pedroni E.
Gantry 2 – the next generation scanning gantry of PSI – an instrument for new technological developments in proton therapy
Dreiländertagung Medizinphysik 2007, (Schweizerische Gesellschaft für Strahlenbiologie und Medizinische Physik), Berne, Switzerland, September 2007

Timmermann B.
Protonentherapie im Kindesalter.
2. Münsteraner Symposium zu Spätfolgen nach Tumortherapie im Kindes- und Jugendalter Münster, Germany, January 2007

Timmermann B.
Innovative Approaches in Radiation Therapy: Stereotactic RT, Cyberknife, Tomotherapy
Barcelona, PROS, Spain, June 2007

TEACHING ACTIVITIES (LECTURES)

Hug E.
Skull base and paraspinal chordomas and chondrosarcomas: Experience 1998-2006, Future directions
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Hug E.
Proton treatment delivery: passive scattering vs. active scanning technique
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Hug E.
Proton radiation therapy for uveal melanoma
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Hug E.
Radiation Therapy for childhood cancer, the issue: cure, complications in the surviving Patient
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007.

Lomax A.J.
Immobilisation and image guidance for proton RT
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Lomax A.J.
Motion management for active scanning: Rescanning and gating
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Lomax A.J.
Treatment planning and pitfalls of active scanning and IMPT
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Lomax A.J.
Clinical application of ion beams: beam delivery using active and passive scattering
1st ESTRO teaching course on Hadron Therapy, Heidelberg, Germany, October 2007

Timmermann B.
Krebserkrankungen bei Kindern und Protonentherapie
VHS-Kurs der Stadt Brugg, Switzerland, Januar 2007

Timmermann B.
Klinische Studien in der Protonentherapie
In der Seminarreihe „Partikeltherapie“ für Ärzte und Studierende an der Universität Marburg, Germany, June 2007

Timmermann B. Lederer L.
Protonen
Fortbildung für MTRAs auf der DEGRO, Hannover, Germany, June 2007

CONFERENCE AND WORKSHOP CONTRIBUTIONS

Ares C., Kahn S., Gruber G., MacArtain A.M., Lutters G., Heuberger J., Bodis S., Lomax A.J.
Postoperative Proton Radiotherapy for Localized and Loco-Regional Breast Cancer: Potential for Clinically Relevant Improvements?
11th Annual Meeting of the SASRO, Aarau, Switzerland, March 2007

Ares C., Kahn S., Gruber G., MacArtain A.M., Lutters G., Heuberger J., Bodis S., Lomax A.J.
Postoperative proton radiotherapy for localized and loco-regional breast cancer: potential for clinically relevant improvements?
ASTRO 2007, Los Angeles, USA, October 2007

Ares C., Khan S., Gruber G., Mac Artain A.M., Lutters G., Heuberger J., Bodis S., Hug E., Lomax AJ.
Intensity-Modulated Proton- versus Photon Radiotherapy for Locoregional. Left sided Breast Cancer: A Dose-Comparison to Heart and Ipsilateral Lung
14th European Cancer Conference, ECCO-ESTRO meeting, Barcelona, Spain, September 2007

Albertini F., Bolsi A., Ares C., Broggi S., Cattaneo M., Lomax A.J.
Effects of metal implants on proton dose distribution
Dreiländertagung Medizinische Physik 2007, Deutschen Gesellschaft für Medizinische Physik, Bern, Switzerland, 2007

Bolsi A., Pasler M., Albertini F., Lomax A.J.
Effects of residual positioning errors on proton dose distributions
10th SASRO Meeting, Aarau, March 2007

Bolsi A., Pasler M., Albertini F., Lomax A.J.
Results of residual dose positioning errors on the dose distributions
SASRO X, Aarau, Switzerland, April 2007

Bolsi A., Lomax A., Goitein G., Hug E.
Experiences with a remote patient positioning procedure for high-throughput proton radiation therapy
Workshop "Patient Positioning in Radiotherapy", Kantonsspital Münsterlingen, Switzerland, May 2007

Bolsi A., Albertini F., Lomax A.J.
Range adaptation with proton scanning technique
ICCR 2007, The radiotherapy Dynamic XVth International Conference on the Use of Computers in Radiation Therapy, Toronto, Canada, June 2007

Bolsi A., Albertini F., Lomax AJ., Hug E.
Effects of Residual Positioning Errors on the Proton dose Distribution
Xth EFOMP Congress (European Federation of Organisations for Medical Physics), Pisa, Italy, September 2007

Bolsi A., Lomax A., Albertini F., Ares C., Boehringher T., Coray A., Pedroni E., Goitein G., Lin S., Rutz H.P., Timmermann B.
Modulazione di intensità (IMPT) con fasci di protoni nella pratica clinica al PSI
V Congresso Nazionale AIFM, Castelvecchio Pascoli, Italy, September 2007

Gates L.L., Gladstone D.J., Kasibhatla J.F., Marshall J.F., Seigne J.D., Hug E.B., Hartford A.C. *Prostate Localization using Serrated Gold Coil Markers*
Accepted for Presentation. 49th Annual ASTRO Meeting, 2007

Grossmann M.
The control system for the spot scanning proton therapy facility at PSI
Proceedings of the 15h IEEE-NPSS Real Time Conference, Fermilab, 2007

Heufelder J., Verwey J., Lomax T., Van Goethem M., Hilbes C., Goitein G., Hug E.
Ein Multiring-Doppelstreusystem für die Protonentherapie von Augentumoren
Dreiländertagung SGSM, SSRPM, SSRFM, Bern, September 2007

Heufelder J., Verwey J., Lomax T., Van Goethem M., Hilbes C., Goitein G., Hug E.
Optis – eine neue Installation zur Bestrahlung von Augentumoren
Dreiländertagung SGSM, SSRPM, SSRFM, Bern, September 2007

Krayenbuehl J., Ciernik I., Oertl S., Davis J.B., Lomax A.J.
Proton radiotherapy versus 3DCRT and IMRT for malignant pleural mesothelioma
SASRO X, Aarau, Switzerland, April 2007

Negreanu C., Stadelmann O., Lomax A.J.
Plan robustness assessment via novel error analysis tools
SASRO X, Aarau, Switzerland, April 2007

Pedroni E.
PSI's next gantry - Gantry 2 – a new instrument for developing advanced beam scanning techniques for proton therapy
Invited to the round table on "Advantages and disadvantages of different types of accelerators in tumors treatments", 18^{th} International Conference on Cyclotrons and their Applications, Cyclotrons 2007 Naxos, Italy, October 2007

Salk J., Lomax T., Pedroni E., Coray D., Albertini F., Boeringer T., Bolsi A., Emert F., Goitein G., Grossmann M., Hilbes C., Jermann M., Lempen D., Rohrer B., Schippers M., Lin S., Stadelmann O., Stäuble H.U., Hug E.
First three months' experience with the clinical operation of the COMET cyclotron at the PSI Gantry 1.
46^{th} Semi-annual Meeting. Particle Therapy Cooperative Group, PTCOG 46, Wanjie, Zibo, China, May 2007

Schippers M., Duppich J., Goitein G., Hug E., Jermann M., Pedroni E.
First operational experience with the SC cyclotron and the new beam lines of the PSI's new proton therapy system
46^{th} Semi-annual Meeting, Particle Therapy Cooperative Group, PTCOG 46, Wanjie, Zibo, China, May 2007

Schippers J.M., Pedroni E., Jermann M., Hug E, Duppich J., Goitein G.
Acceptance, operation, reliability of the SC-cyclotron and beam lines of PSI's proton therapy facility PROSCAN
Dreiländertagung SGSM, SSRPM, SSRFM, Bern, September 2007

Schippers M., Duppich J., Goitein G., Hug E., Jermann M., Mezger A., Pedroni E.
First year of operation of PSI's new SC cyclotron and beam lines for proton therapy
MOXCR04, Cyclotron conference Catania, 2007

Timmermann B., Stadelmann O., Kortmann R.D., Gnekow A.
Rolle der Protonentherapie für die Behandlung von niedrig-gradigen Gliomen (LGG) der Sehbahn im Kindesalter
GPOH-Frühjahrstagung, Berlin, Germany, June 2007

Timmermann B.
Spot-Scanning Proton Therapy for Childhood Malignancies at the Paul Scherrer Institute
Barcelona, PROS, Spain, June 2007

Timmermann B.
Moderne Radiotherapietechniken und Fraktionierungschemata: Einfluss auf Nebenwirkungsprofile
DEGRO, Hannover, Germany, 2007

Timmermann B., Rutz H.P., Bolsi A., Hug E.
Proton Therapy in Childhood Chordoma and Chondrosarcoma
SIOP, Bombay, India, October/November 2007

von Siebenthal M., Lomax A.J., Szekely G., Cattin P.
4DCT with variable respiratory motion generated from static CT and 4DMRI
ESTRO physics congress, Barcelona, Spain, September 2007

NEW ACADEMIC APPOINTMENTS

A. J. Lomax
Professorship, University of Zurich, Switzerland

B. Timmermann
Privatdozentin (PD), Westfälische Wilhelms-Universität Münster, Germany

Synchrotron Radiation and Nanotechnology

LIST OF PUBLICATIONS

UNIVERSITY LEVEL AND OTHER TEACHING

T. Donath
Analyse von Röntgentomogrammen
Sommerschule des Graduiertenkollegs PoreNet, Dresden, Germany 13-15.7.2007

J. Gobrecht, H. Schift
Nanotechnologie für Ingenieure
Fachhochschule Nordwestschweiz, Windisch, SS 2007, HS 2007

J. Gobrecht
Opto – and Nanoelectronics
SMAS-course on Micro- and Nanotechnology, Univ of Appl. Sciences of Western Switzerland

L.J. Heyderman
Magnetic Imaging Techniques
Seminar in Lecture Series 'Magnetism and Spin Dependent Transport' (Prof. Rüdiger), Universität Konstanz, 2.7.2007

L.J. Heyderman
Patterned magnetic thin films
Tutorial 'Domain observations with PEEM', Workshop on Fast magnetic imaging, Kaiserslautern, 10-12.10.2007

L.J. Heyderman
Magnetic Imaging Techniques
Seminar in Lecture Series on Magnetism (Prof. Pescia), ETHZ, 11.12.2007

C. Padeste
Strategies for creating micro- and nanopatterns of functional proteins
Theoretical and practical course at the Middle East Technical University, Biomaterials Research Group, Ankara, Turkey, 1.-9.5.2007

C. Padeste
Bio-functional nanopatterns produced with extreme ultraviolet interference lithography
BioPolySurf summer school on chemical functionalization of surfaces, Ovronnaz, Switzerland, 11.-14.9.07

H. Schift
- *Social and ethical implications of nanotechnology*
- *Panorama of nanopatterning methods*
- *Nanoimprint lithography*

PANAMA Summer School on Emerging Nanopatterning Methods (EU Project NaPa) Toulouse, France, 2.-13.7.2007

H. Schift
Nanoreplication technology
EPFL Summer School, Lausanne, Switzerland, 11.9.2007

H. Sigg
Synchrotron Praktikum
University of Zurich/Basel, Switzerland, 13-16.7.2007

M. Stampanoni, R. Müller
Micro and Nano-Tomography of Biological Tissues
ETH Vorlesung: 151-0965-00 2V+1U

M. Stampanoni
X-ray Tomographic Imaging: a fascinating trip from Macro to Nano
551-1316-00L CIMST: Interdisciplinary Summer School on Bio-medical Imaging, 25.6.-06.7.2007

J.F. van der Veen,
Materials research using synchrotron radiation
Mat. Physics, ETH Zürich, HS07

P.R. Willmott
Laser physics and laser spectroscopy
Physikalisch-Chemisches Institut, Universität Zürich, SS 2007

P.R. Willmott
An introduction to synchrotron radiation and synchrotron radiation techniques
Physikalisch-Chemisches Institut, Universität Zürich, HS 2007

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

Andreasson BP, Janousch M, Staub U, Meijer GI, Delley B
Resistive switching in Cr-doped $SrTiO_3$: An X-ray absorption spectroscopy study
MATERIALS SCIENCE AND ENGINEERING B-SOLID STATE MATERIALS FOR ADVANCED TECHNOLOGY 144, 60 (2007)

Atchison F, Brys T, Daum M, Fierlinger P, Foelske A, Gupta M, Henneck R, Heule S, Kasprzak M, Kirch K, Kotz R, Kuzniak M, Lippert T, Meyer CF, Nolting F, Pichlmaier A, Schneider D, Schultrich B, Sieniroth P, Straumann U
Structural characterization of diamond-like carbon films for ultracold neutron applications
DIAMOND AND RELATED MATERIALS 16, 334 (2007)

Balthazar MV, Pedersen KR, Crane PR, Stampanoni M, Friis EM
Potomacanthus Lobatus Gen. et Sp. Nov., A new flower of probable Lauraceae from the Early Cretaceous (Early to Middle Albian) of Eastern North America
AMERICAN JOURNAL OF BOTANY 94, 2041 (2007)

Barla A, Schmerber G, Beaurepaire E, Dinia A, Bieber H, Colis S, Scheurer F, Kappler J-P, Imperia P, Nolting F, Wilhelm F, Rogalev A, Mueller D, Grob JJ
Paramagnetism of the Co sublattice in ferromagnetic Zn_{1}-$_{x}Co_{x}O$ films
PHYSICAL REVIEW B 76, 125201 (2007)

Beaud P, Johnson SL, Streun A, Abela R, Abramsohn D, Grolimund D, Krasniqi F, Schmidt T, Schlott V, Ingold G
Spatiotemporal stability of a femtosecond hard-X-ray undulator source studied by control of coherent optical phonons
PHYSICAL REVIEW LETTERS 99, 174801 (2007)

Beitlich T, Kuhnel K, Schulze-Briese C, Shoeman RL, Schlichting I
Cryoradiolytic reduction of crystalline heme proteins: analysis by UV-Vis spectroscopy and X-ray crystallography
JOURNAL OF SYNCHROTRON RADIATION 14, 11 (2007)

Bodenthin Y, Schwarz G, Gutberlet T, Geue T, Stahn J, Mohwald H, Kurth DG, Pietsch U
Molecular magnetism in thin metallo-supramolecular films: A combined neutron and soft X-ray reflectometry study
SUPERLATTICES AND MICROSTRUCTURES 41, 138 (2007)

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R. Abela
Shining Light on Europe
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R. Abela
Research Highlights at the SLS
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C. David
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University of Naples, Naples, Italy, 15.06.2007

A. Bendounan
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Internationnal seminar on Strong Correlations and Angle-Resolved Photoemission Spectroscopy, Dresden, Germany, 16.04.2007

O. Bunk, F. Pfeiffer
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H. Dil
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U. Flechsig
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Erschütterungsseminar bei Basler & Hofmann, Zürich, Switzerland, 31.5.2007

A. Fraile-Rodríguez
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Curtin University of Technology, Perth, Australia, 09.10.2007

A. Fraile-Rodríguez
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- Presenting INKA as exhibitor at the Nano-Europe, St. Gallen, Switzerland, 11.–13.9.2007
- Presenting INKA as co-exhibitor at the “K2007” trade fair, Düsseldorf, Germany, 24.–31.10.2007
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T.A. Jung

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T. A. Jung

- *Tailoring Supramolecular Assemblies on a Metal Surface by Specifically Functionalized Porphyrins STM investigations of metallophtalocyanines grown on ferromagnetic Co(0001) thin films Scanning Probe Microscopies and Organic Materials*
  N. Wintjes, University of Basel, Switzerland, (2007)

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AWARDS

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MEMBERSHIPS IN EXTERNAL COMMITTEES

R. Abela

- Chairman of the ESRF Scientific Advisory Committee
- Member of the Diamond Scientific Advisory Committee
- Chairman of the Swiss-Norwegian Foundation for Research with X-Rays
- Member of the STFC In-House Reviews: SRS Review
- Chairman of the ALBA Scientific Advisory Committee
- Member of the PSI-FEL/LEG Advisory Committee

C. David

- Member of the International Program Committee of the Micro- and Nano-Engineering Conference 2007
- 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 International Program Committee of the X-Ray Microscopy Conference Series
- Member of the International Advisory Committee of the Photon Conference Series

U. Flechsig

- Design Review Committee for the COSMIC and MAESTRO beamlines at the Advanced Light Source, Berkeley, USA, May 1st 2007

J. Gobrecht

- Vice Director *Technology* of the Swiss Nanoscience Institute at the University of Basel
- Chair of “KoF-07 Review Panel” for the evaluation of the engineering faculty of Uppsala University, Sweden
- External expert for PhD thesis of G. Lamprecht, *“Identification and sorting of diamond in ore using pulsed laser Raman spectroscopy”*, Tshwane Univ. of Technology, Pretoria, South Africa
- Member of the management team of the Matlife ERU, CCMX Program of the ETH domain
- Member of the Scientific Advisory Board, HeiQ Materials AG, Bad Zurzach, Switzerland
- Member of the advisory board of the “Nano-Convention”, Bern, Switzerland, June 28/29, 2007
- Member of the advisory board of the Nano-Europe Conference, St. Gallen, Switzerland, Sept. 11 – 13, 2007
- Member of the board of directors, Eulitha AG, 5232 Villigen PSI

L.J. Heyderman

- International Program Committee, Micro- and Nano-Engineering Conference MNE2007
- Steering Committee 52nd Magnetism and Magnetic Materials Conference MMM2007
- Intermag 2008 Program Committee
- Member of the Technical Committee of the IEEE Magnetics Society

T.A. Jung

- Scientific Committee for Newly Identified and Emerging Health Risks, (SCENIHR) Health and Consumer Protection Directorate Gener Scientific Commitee advising the European Commission
- Praktischer Umweltschutz and at the Werkstatt fuer Ernaehrung und Gentechnologie
- Membership in Working group (Think Tank) of the Swiss Academies of Arts and Sciences, Zukunft Bildung Schweiz

F. Nolting

- Member of the Proposal Review Committee of Soleil, (France)
- External expert for the Proposal Review Committee of the Canadian Light Source
- Scientific Committee of the 5th International School on Synchrotron Radiation and Magnetism, Mittelwihr (France)

F. Pfeiffer

- Euro-XFEL Detector Committee
- Workgroup BL-13 DIAMOND

C. Quitmann

- Member of the Editorial Board – Journal of Physics: Condensed Matter (Surfaces and Interfaces)
- Member of the advisory committee for the BLADE (I10) and Nanoscience (I6) beamlines at DIAMOND
- Member of the Programm Committee E-MRS Symposium: Materials Research SR & XFEL, Warzawa, Poland, 17.-20.9.2007

H. Schift

- AVS American Vacuum Society, NSTD Nanometer-scale Science and Technology Division, elected board and executive committee member

C. Schulze-Briese

- ESRF Methods and Instrumentation Proposal Review Committee
- ESRF MX-beamline review panel
- Australian Synchrotron PX-beamline advisory panel

H. Sigg

- Advisory Committee, International Conference on Intersubband transition in quantum wells

M. Stampanoni

- Member of Workgroup “Mikrotomographie à SOLEIL”

J. Friso van der Veen

- Science Advisory Committee of Elettra, Trieste
- Scientific Committee for Inorganic and Analytical Chemistry, Science Foundation, Flanders, Belgium
- Chairman of Programme Committee of PSI Summer School on Condensed Matter Research, Zuoz, Switzerland
- Scientific Advisory Committee of HERCULES, Grenoble, France
- Chairman of Science Advisory Committee of the Advanced Light Source, Berkeley, USA
- International Advisory Committee of the International Conference Series on Synchrotron Radiation Instrumentation.
- Science Advisory Committee of Synchrotron SOLEIL, Gif-sur-Yvette, France.
- 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
- Chairman of Panel reviewing the DORIS-III facility, DESY, Hamburg, Germany
- Science Advisory Committee for the Van der Waals-Zeeman Instituut, University of Amsterdam, The Netherlands
- Chairman of ad-hoc panel reviewing data processing at Synchrotron SOLEIL, Gif-sur-Yvette, France
- Expert at UK Light Source Review held by STFC, London, July, 2007
- Evaluation Group reviewing the Institutional Strategy of the University of Goettingen within the framework of the Excellence Initiative, Wissenschaftsrat, Goettingen, Germany, June 2007
- Programme Committee of the International Workshop on Phase Retrieval and Coherent Scattering (‘Coherence 2007’), Asilomar, USA, June 2007
- Advisory Board ‘Structure of Matter’, Forschungszentrum Karlsruhe, Germany

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J. Baumann, C. David, M. Engelhardt, J. Freudenberger, E. Hempel, M. Hoheisel, T. Mertelmeier, F. Pfeiffer, S. Popescu, M. Schuster
Focus-detector arrangement of an X-ray apparatus for generating projective or tomographic phase contrast recordings
Patent # US2007070006020070131

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INVITED TALKS

Kurt Clausen
Is Instrumentation the driver for scientific progress? Lessons I have learned from the ESS
Symposium in honour of Colin Carlile, Sardinia 31 Mai – 1 June, 2007

Rudolf Morf
Light-trapping by diffraction gratings in silicon solar cells
Symposium on Photon management in Solar Cells, Bad Honnef, October 2008

Rudolf Morf
The fractional quantum Hall state at $\nu = \frac{5}{2}$ *: what is so special about it?*
Theory Seminar, Basle, 17. December 2007

LECTURES AND COURSES

Kurt Clausen
1) Accelerator generated Probes as tools for Materials Science
2) Materials and Life Sciences at Spallation Neutron Sources (1)
3) Materials and Life Sciences at Spallation Neutron Sources (2)

IAEA School on Pulsed Neutrons: Characterization of Materials – ICTP, Trieste, Italy 15-26 October 2007

MEMBERSHIP IN EXTERNAL COMMITTEES

Dr. K. Clausen
- Member of the ESS-Scandinavia Science Group (since 2004)
- Member of the Board of NMI3 (since 2004)
- Member of the Scientific Selection Panel of the Berlin Neutron Scattering Centre (since 2005)
- Member of the Science Program Advisory Council for Condenced Matter Physics and Nanoelectronics at Research Centre Jülich, Germany (since 2006)
- Chairman of the BENSC Instrument Committee (since 2006)
- International Advisory Committee for The RIKEN-RAL Muon Facility

Condensed Matter Research with Neutrons and Muons

Laboratory of Neutron Scattering

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Reversal mechanism and suppression of training in an exchange-coupled system
PHYSICAL REVIEW B **76**, 184424 (2007)

Pedrini B, Wessel S, Gavilano JL, Ott HR, Kazakov SM, Karpinski J
Quenching of the Haldane gap in LiVSi2O6 and related compounds
EUROPEAN PHYSICAL JOURNAL B **55**, 219 (2007)

Petrakovskii G, Bezmaternykh L, Bayukov O, Popov M, Schefer J, Niedermayer C, Aleshkevich P, Szymczak R
Magnetic Structure and Magnetic Excitations in the Two-Dimensional Spin System of the Cu3B2O6 Compound
PHYSICS OF THE SOLID STATE **49**, 14315 (2007)

Podlesnyak A, Conder K, Pomjakushina E, Mirmelstein A, Allenspach P, Khomski DI
Effect of light Sr doping on the spin-state transition in LaCoO3
JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS **310**, 1552 (2007)

Podlesnyak A, Karkin A, Conder K, Pomjakushina E, Stingaciu M, Allenspach P
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Podlesnyak A, Pomjakushin V, Pomjakushina E, Conder K, Furrer A
Magnetic excitations in the spin-trimer compounds Ca3Cu3-xNix(PO4)(4) (x=0,1,2)
PHYSICAL REVIEW B **76**, 064420 (2007)

Pomjakushin VY, Furrer A, Sheptyakov DV, Pomjakushina EV, Conder K
Crystal and magnetic structures of the spin-trimer compounds Ca3Cu3-xNix(PO4)(4) (x=0,1,2)
PHYSICAL REVIEW B **76**, 174433 (2007)

Pomjakushin VY, Sheptyakov DV, Conder K, Pomjakushina EV, Balagurov AM
Effect of oxygen isotope substitution and crystal microstructure on magnetic ordering and phase separation in (La1-yPry)(0.7)Ca0.3MnO3
PHYSICAL REVIEW B **75**, 054410 (2007)

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Magnetic structure of the S=1Ni(5)(TeO3)(4)Br-2 layered system governed by magnetic anisotropy
PHYSICAL REVIEW B **76**, 144408 (2007)

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Magnetic excitations near the quantum phase transition in the Ising ferromagnet LiHoF4
PHYSICAL REVIEW B **75**, 054426 (2007)

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PHYSICAL REVIEW LETTERS **98**, 017202 (2007)

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In situ neutron diffraction under tensile loading of powder-in-tube Cu/Nb3Sn composite wires: Effect of reaction heat treatment on texture, internal stress state, and load transfer
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Structural relaxation and self-diffusion in covalent amorphous solids: Silicon nitride as a model system
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Schmidt H, Gupta M, Geckle U, Bruns M
Self-diffusion in covalent amorphous solids- a comparative study using neutron reflectometry and SIMS
DEFECT AND DIFFUSION FORUM **263**, 51 (2007)

Schorr S, Wagner G, Tovar M, Sheptyakov D
Comparative Studies of the Structure and Microstructure of Zn2x(CuBIII)1-xX2 Semiconductors (BIII=Ga,In; X=S,Se,Te)
MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS **12**, (2007)

Schuck G, Haas S, Stassen AF, Berens U, Batlogg B
5,11-Bis(4-tert-butylphenyl)-6,12-diphenylnaphthacene (form A)
ACTA CRYSTALLOGRAPHICA SECTION E-STRUCTURE REPORTS ONLINE **63**, 2894 (2007)

Schuck G, Haas S, Stassen AF, Kirner HJ, Batlogg B
5,12-Bis(4-tert-butylphenyl)-6,11-diphenylnaphthacene
ACTA CRYSTALLOGRAPHICA SECTION E-STRUCTURE REPORTS ONLINE **63**, 2893 (2007)

Schwarzenbach D, Birkedal H, Hostettler M, Fischer P
Neutron diffraction investigation of the temperature dependence of crystal structure and thermal motions of red HgI(2)
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Sherstobitova E, Gubkin A, Zakharov A, Teplykh A, Podlesnyak A, Gvasaliya S, Park J, Baranov N, Pirogov A
Neutron Diffraction Investigation of a Metamagnetic Transition in the Tb0.1Tm0.9Co2 Compound
PHYSICS OF THE SOLID STATE **49**, 1305 (2007)

Shigematsu H, Akishige Y, Gvasaliya S, Pomjakushin V, Lushnikov S, Kojima S
Neutron Diffraction Study of the Phase Transition in BaTi25
FERROELECTRICS **346**, 43 (2007)

Singh S, Basu S, Gupta M, Vedpathakz M, Kodama R
Investigation of interface magnetic moment of Fe / Ge multilayer: A neutron reflectivity study
JOURNAL OF APPLIED PHYSICS **101**, 033913 (2007)

Strassle S, Roos J, Mali M, Conder K, Pomjakushina E, Keller H
La-139 NMR and NQR investigations of the superconductor LaBa2Cu3O7-delta
PHYSICA C-SUPERCONDUCTIVITY AND ITS APPLICATIONS **460**, 890 (2007)

Strassle T (Straessle Thierry)
Experimental evidence for a crossover between two distinct mechanisms of amorphization in ice Ih under pressure
PHYSICAL REVIEW LETTERS **99**, 175501 (2007)

Strunz P, Mukherji D, Pigozzi G, Gilles R, Geue T, Pranzas K
Characterization of Core-Shell Nanoparticles by Small Angle Neutron Scattering
APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING **88**, 277 (2007)

Tamonov A, Sumin V, Stuhr U
Neutron diffraction investigation of the residual stress gradient near stainless steel-zirconium alloy interface
ZEITSCHRIFT FUR KRISTALLOGRAPHIE **26**, 361 (2007)

Taran Y, Schreiber J, Balagurov A, Stuhr U, Kockelmann H, Zlokazov V
Triaxal residual stresses in composite tube from austenitic stainless steel with welded ferritic steel cladding
ZEITSCHRIFT FUR KRISTALLOGRAPHIE **26**, 355 (2007)

Tiden N, Alekseev A, Lazukov V, Podlesnyak A, Clementyev E, Furrer A
Magnetic correlations in heavy fermion CeAl3 compound
SOLID STATE COMMUNICATIONS **141**, 474 (2007)

Tripadus V, Gugiu M, Statescu M, Podlesnyak A
Molecular dynamics in ammonium dihydrogen phosphate using incoherent neutron scattering
CHEMICAL PHYSICS **335**, 233 (2007)

Van den brandt B, Glaettli H, Griesshammer H, Hautle P, Kohlbrecher J, Konter A
An Accurate Measurement of the Spin-Dependent Neutron-Deuteron Scattering Length
PROCEEDINGS OF THE 17TH INTERNATIONAL SPIN PHYSICS SYMPOSIUM **CP 915**, 769 (2007)

Vignolle B, Hayden S, Mcmorrow D, Ronnow H, Lake B, Frost C, Perring T
Two energy scales in the spin excitations of the high-temperature superconductor La2-x Srx CuO4
NATURE PHYSICS **AOP**, 546 (2007)

Vitale F, Mirenghi L, Piscopiello E, Protopapa ML, Tapfer L, Giannini C, Guagliardi A, Cervellino A, Pellegrini G, Trave E, Mattei G, Mazzoldi P, Fratoddi I, Russo MV
Synthesis and Microstructural Analysis of Benzylthiol-functionalized Au Nanocrystals
MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS **959E**, 1 (2007)

Wildes AR, Ronnow HM, Roessli B, Harris M, Godfrey KW
Anisotropy and the critical behaviour of the quasi-2D antiferromagnet, MnPS3
JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS **310**, 1221 (2007)

van den Brandt B, Glattli H, Hautle P, Kohlbrecher J, Konter JA, Michels A, Stuhrmann HB, Zimmer O
Creating local contrast in small-angle neutron scattering by dynamic nuclear polarization
JOURNAL OF APPLIED CRYSTALLOGRAPHY **40**, 106 (2007)

INVITED TALKS

A.Bendounan
Study of high temperature superconductors by ARPES Bi2223 and LSCO components,
Experimentelle Physik II, Universität Würzburg, Würzburg, Germany, December 18, 2007, invited talk

A.Bendounan
Etude d'états quasi-bidimensionnels par ARPES et STS,
Institut de physique de Rennes, Université de Rennes I, France, November 6 2007, invited talk

A.Bendounan
Low dimensional electronic structures studied by ARPES and STS ,
Università degli Studi di Napoli, Federico II, Naples, Italy June 15, 2007, invited talk

A.Bendounan
High resolution ARPES on low-dimensional structures ,
CORPES meeting (Strong Correlations and Angle-Resolved Photoemission Spectroscopy), Dresden, Germany, April 16, 2007, invited talk

A. Cervellino
From atoms to pixel counts-a short travel
SLS symposium X-ray and Neutron Diffraction, SLS, PSI, Villigen, Switzerland June 5, 2007, invited talk

A. Cervellino
Metodo di debye per la modellazione di nanoparticelle II. Scuola ARS2,
ELETTRA Synchrotron, Trieste, Italy, April 22-26, 2007, invited talk

A. Cervellino, C. Giannini, A. Guagliardi
Use of the debye formula in the investigations of nanocrystals size,
StrainV - 5th Size-Strain conference 'Diffraction Analysis of the Microstructure of Materials', Garmisch-Partenkirchen, Germany, October 7-9, 2007, invited talk

A. Cervellino, M. Leoni
Analisi del profile di diffrazione metodi a vanzati, II Scuola ARS2,
ELETTRA Synchrotron Trieste, Italy, April 22-26, 2007, invited talk

J. Chang
Low- and high-energy electronic responses in high-temperature Superconductors,
Study of Matter at Extreme Conditions (SMEC2007), Miami, USA, April 16-21, 2007, invited talk

N. B. Christensen, H. M. Rønnow, D. F. McMorrow, A. Harrison, T. G. Perring, M. Enderle, R. Coldea, L.-P. Regnault, G. Aeppli
Quantum dynamics of spins on a square lattice,
DyProSo XXXI, International symposium on dynamical properties of solids, Porto, Portugal, September 25-29, 2007, invited talk

N. B. Christensen, H. M. Rønnow, J. Mesot, R. A. Ewings, N. Momono, M. Oda, M. Ido, M. Enderle, D. F. McMorrow, A. T. Boothroyd
The nature of the spin modulations in the charge-ordered superconductor
$La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$
6th International Conference on New Theories, Discoveries and Applications of Superconductors and Related Materials (New3SC-6), Sydney, Australia, January 9-11, 2007, invited talk

A. Furrer
On higher-order correlations in physics,
Lise-Meitner Colloquium, HMI Berlin, Germany, November 11, 2007, invited talk

A.Furrer
Admixture of an s-wave component to the d-wave gap symmetry in high-temperature superconductors,
International Conference on Dynamics in Complex Systems (DELFS-III), Port Jefferson, USA, May 23-26, 2007, invited talk

A.Furrer
Access to higher-order correlations in neutron scattering experiments,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, invited talk

U. Gasser
Real-space imaging of crystal nuclei in colloidal suspensions,
NAG2007, Conference on Nucleation, Aggregation and Growth, Bangalore, (India), January 29-31 2007, invited talk

S.N. Gvasaliya
Investigations of the relaxor ferroelectrics by neutron scattering,
Abstracts of the 2007 Gatchina PNPI Winter School on the physics of condensed matter, invited talk

T. Gutberlet
Structure and dynamics of model membrane systems,
IMFUFA Seminar, University of Roskilde, Denmark, September 13, 2007, invited talk

T. Gutberlet
Diffusion and collective motions in phospholipd bilayers,
Workshop Perturbation of lipid membrane structure and dynamics induced by doping with amphiphilic molecules, University of Roskilde, Denmark, June 14, 2007, invited talk

J. Hoppeler
Investigation on the magnetic ordering in perovskite-like superconductor / ferromagnet multilayers,
Chalk River, Canada, March 3, 2007, invited talk

F. Juranyi
Approaches for cement studies using neutron scattering methods,
CEMNET Workshop, PSI, Villigen, Switzerland, September 10, 2007, invited talk

M. Kenzelmann
Magnetic inversion symmetry breaking in multiferroic transition metal oxides, MMM/Intermag
Conference, Baltimore, January 7-11, 2007, invited talk

M. Kenzelmann
Magneto-electric multiferroicity in quantum magnetic insulators,
Workshop on Moments and Multiplets in Mott Materials, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, November 5-9, 2007, invited talk

M. Kenzelmann
Multiferroicity on the triangular lattice,
SNS-HFIR User Group Meeting, Oak Ridge, October 8-11, 2007, invited talk

M. Kenzelmann
Magnetically induced ferroelectricity, Perspectives,
DyProSo XXXI, Portugal, September 25-29, 2007, invited talk

M. Kenzelmann
Ferroelectricity in magnetic insulators with competing interactions,
International Symposium on Dynamical Properties of Solids (DyProSo XXXI), Porto, September 25-29, 2007, invited talk

M. Kenzelmann
Quantum magnetism and multiferroic materials,
6th PSI Summer School on Condensed Matter Research, Zuoz, Switzerland, August, 13-18 August 2007, invited talk

M. Kenzelmann
Determination of the magnetic structures in $TbMnO_3$,
Workshop on Representational Analysis of Complex Magnetic Structures, NIST, July 23-26, 2007, invited talk

M. Kenzelmann
Multiferroicity on the triangular lattice, Workshop on Multiferroics
University of Maryland, July 19, 2007, invited talk

M. Kenzelmann
Competing interactions and ferroelectricity in quantum magnetic insulators,
Workshop in Triple-Axis Spectroscopy, HANARO, South Korea, July 13, 2007, invited talk

M. Kenzelmann
Magneto-electric multiferroicity in quantum magnetic insulators,
Pohang University, South Korea, July 11, 2007, invited talk

M. Kenzelmann
Magneto-electric multiferroicity in quantum magnetic insulators,
University of Geneva, May 2, 2007, invited talk

M. Kenzelmann
From quantum magnetism to multiferroicity,
Lujan Center, Los Alamos, March 14, 2007, invited talk

M. Kenzelmann
Multiferroicity in quantum magnetic insulators,
National High Magnetic Field Laboratory, Los Alamos National Laboratory, March 13, 2007, invited talk

M. Kenzelmann
Competing interactions in quantum magnetic insulators,
EPFL, Lausanne, Feburary 27, 2007, invited talk

M. Kenzelmann
Competing interactions in quantum magnetic insulators,
SLS, Paul Scherrer Institute, February 16, 2007, invited talk

M. Kenzelmann
Competing interactions in quantum magnetic insulators,
Rice University, Feburary 7, 2007, invited talk

M. Kenzelmann
Competing interactions in quantum magnetic insulators,
University of California, Davis, February 5, 2007, invited talk

M. Kenzelmann
Competing interactions in quantum magnetic insulators
University of Minnesota, February 1, 2007, invited talk

M. Kenzelmann, G. Lawes, B. Harris, G. Goran, B. Collin, A. Ramirez, G.A. Jorge, M. Jaine, S. Park, A. Ya, Shapiro, A.A. Demianets
Direct transition from a disordered to a multiferroic phase
APS March Meeting, Denver, March 6, 2007, invited talk

J.Kohlbrecher
Pressure induced phase transition in sterically stabilised colloids, A neutron and light scattering study,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, invited talk

J.Kohlbrecher
The polarisation option on SANS-1 at SINQ-PSI, Investigations on magnetic recording materials using SANSPol
TU Muenchen, April 2, 2007, invited talk

J.Kohlbrecher
Some applications of the new polarization and time resolved option at the PSI-SANS,
BARC Institute Mumbai, January 24, 2007, invited talk

J. Mesot
Superconductivity and flux lattice structures,
School on Pulsed Neutrons Characterization of Materials, Trieste, Italy, October 15-26, 2007, invited talk

J. Mesot
Single crystal neutron spectroscopy,
School on Pulsed Neutrons Characterization of Materials, Trieste, Italy, October 15-26, 2007, invited talk

J. Mesot
Dynamical susceptibility in the underdoped regime of LSCO,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 20-28, 2007, invited talk

J. Mesot
SINQ quo vadis, 10 Years celebration,
Paul Scherrer Institut, Villigen, Switzerland, September 21, 2007 , invited talk

J. Mesot
Two-components susceptibility in underdoped cuprates as revealed by neutron scattering,
Gordon Research Conference on Superconductivity, Les Diablerets, Switzerland, September 9-14, 2007, invited talk

J. Mesot
Testing fermi liquid theory in cuprate superconductors ARPES and neutron scattering studies,
Stuttgarter Physikalisches Kolloquium, MPI Stuttgart, Germany, May 22, 2007, invited talk

J. Mesot
Spin- and electron-dynamics in high-temperature superconductors,
Symposium in Honor of Prof. Hans Rudolf Ott, ETH Zurich, Switzerland, May 11, 2007 , invited talk

J. Mesot
Neutron and photoemission investigations of metal-oxides,
seminar ENE Dept, PSI, Villigen, Switzerland, March 5, 2007, invited talk

J. Mesot
Interplay between magnetic and electronic degrees of freedom in high-temperature superconductors,
Seminar TU Delft, Delft, The Netherlands, February 28, 2007 , invited talk

J. Mesot
Electron- and spin-dynamics of unconventional cuprate superconductors,
van der Waals-Zeeman Colloqiuim, Amsterdam, NL, February 27, 2007 , invited talk

J. Mesot
Neutron and photoemission investigations of high-temperature supercondcutors,
Hahn-Meitner-Institute Dept, Berlin, Germany, November 20, 2007 invited talk

J.Mesot
Two energy scales in HTSC from combined neutron and ARPES spectroscopies,
2nd Workshop on Properties of HTSC, Munich, Germany, December 17-18, 2007, invited talk

E. Pomjakushina
Complex metal oxides grown by traveling solvent floating zone method,
EMPA, Dübendorf, Switzerland, May 17th, 2007, invited talk

J. Schefer
Status report and highlights at the Swiss Neutron Spallation Source SINQ
Annual Meeting of the Swiss Society for Crystallography, Villigen PSI, Switzerland, Sept 13, 2007, invited talk

J. Schefer, M.Boehm, B.Roessli, L.Keller, M.Janoschek, P.Fischer, M. Medarde, A.S. Willis, B. Oulladdiaf, E. Lelévre-Berna, G.A. Petrakovskii, L. Bezmaternikh, V. Temerov and D. Velikanov
Magnetic structure investigations with neutrons using the instrumentation at SINQ and at ILL,
Workshop INTAS New Layered 3d Materials for Spintronics, Krasnoyarsk, Russia, March 20-23, 2007, invited talk

D. Sheptyakov
Complementarity of X-Ray and neutron diffraction in crystal structure Analysis,
SLS symposium on X-ray and Neutron Diffraction, SLS, PSI, Switzerland, June 05, 2007, invited talk

D. Sheptyakov
Neutron diffraction study of the crystal and magnetic structures of Na_2RuO_4*,*
EPFL, Lausanne, Switzerland, January 29, 2007, invited talk

Th. Strässle
FOCUS - a versatile cold TOF-spectrometer at PSI and amporphization and polyamorphous transition in ice Ih,
Seminar at ANSTO, Sydney, Australia, February 27, 2007, invited talk

Th. Strässle
Pressure-induced amorphization mechanism(s) in ice Ih probed by inelastic neutron scattering techniques,
Workshop on Advances in High Pressure Crystallography at Large Scale Facilities (organized by IUCr Commission on High Pressure), Oxford, U.K., September 3-7, 2007, invited talk

B. Thielemann, Ch. Rüegg, H. M. Rønnow, J. Mesot, D. F. McMorrow, K. W. Krämer, D. Biner, H.-U. Güdel, K. Kiefer, J. Stahn, S. Gvasaliya, K. Habicht, M. Boehm and B. Grenier
Continuous spin-excitation spectrum in a novel spin-ladder,
High Magnetic Field Laboratory, Research Center Dresden-Rossendorf, Germany, December 4, 2007, invited talk

B. Thielemann, Ch. Rüegg, H. M. Rønnow, J. Mesot, D. F. McMorrow, K. W. Krämer, D. Biner, H.-U. Güdel, K. Kiefer, J. Stahn, S. Gvasaliya, K. Habicht, M. Boehm and B. Grenier
Phase diagram and spin dynamics in a novel organic spin ladder material,
MaNEP Review Panel, University of Geneva, Switzerland, June 14, 2007, invited talk

P. Tregenna-Piggot
Introducing the Inverted-Geometry time-of-flight instrument, MARS, at SINQ,
Copenhagen, Denmark: September 2007, invited talk

P. Tregenna-Piggot
Introducing the Inverted-Geometry time-of-flight instrument, MARS, at SINQ,
ECNS 2007 -Lund Sweden: June 2007, invited talk

A. Wilk
Soft matter – small angle neutron scattering at PSI,
IESL FORTH- Heraklion, Kreta, Greece, January, 12, 2007, invited talk

CONFERENCE, WORKSHOP AND SEMINAR CONTRIBUTIONS

A Bendounan, Y. Sassa, J. Mesot, M. Shi, L. Patthey, P. Xu, M. Grioni, E. Giannini, D. van der Marel
Photoemission investigation on triple-layered BISCCO superconductor,
CORPES meeting, Dresden, Germany, April 16, 2007, poster

A. Bendounan, Y. Sassa, J. Mesot, M. Shi, L. Patthey, P. Xu, M. Grioni, A. Piriou, E. Giannini, D. van der Marel
ARPES study of the Bi-2223 electronic structure,
8th SLS Users Meeting, PSI, Villigen, Switzerland, September 11-12, 2007, poster

A.Bendounan
Character of the valence states in organic monolayer systems PTCDA/Ag(111) and NTCDA/Ag(111) ,
SLS symposium, PSI, Villigen, Switzerland, July 3, 2007, talk

A. Bendounan, Y. Sassa, J. Mesot, M. Shi, L. Patthey, P. Xu, M. Gironi, A. Piriou, E. Giannini, D. Van der Marel
ARPES study of the electronic structure Bi-2223,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 28-30, 2007, poster

O. O. Bernal, D.E. MacLaughlin, J.L. Gavilano, G. Stewart
Disorder effects and quantum criticality in UCu_5*-xNi*$_{x,}$
muSR Users Meeting, PSI, Villigen, Switzerland, January 23-24, 2007, talk

S. Busch, F. Juranyi, T. Gutberlet
Water Dynamics in Phospholipid Model Membrane Systems, MIPP 2007 Membrane Interacting Peptides and Proteins,
Int. Bunsen Discussion Meeting, Halle, Germany, March 28-31, 2007, poster

A. Cervellino, C. Giannini, A. Guagliardi, P.D. Cozzoli
Neutron scattering study of nanoparticles,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

J. Chang
Low- and high-energy electronic responses in high-temperature Superconductors,
CORPES07, Dresden, Germany, April 23-27, 2007, talk

J. Chang
Anisotropic quantum critical scattering in the underdoped to optimally doped regime of $La_{2-x}Sr_xCuO_4$*,*
MaNEP evaluation, Geneva, Switzerland, June 14, 2007, talk

J. Chang,
Low- and high-energy electronic responses in high-temperature superconductors,
Swiss Physical Society - Annual Meeting 2007, University of Zurich, Zurich, Switzerland, February 20-21, 2007, talk

J.Chang
Anisotropic quasiparticle scattering in the underdoped to optimally doped regime of $La_{2-x}Sr_xCuO_4$*,*
Gordon Research Conference Superconductivity, Les Diableret, Switzerland, September 09-14, 2007, poster

J.Chang
Anisotropic quasiparticle scattering in the underdoped to optimally doped regime of $La_{2-x}Sr_xCuO_4$*,*
Swiss Workshop on Materials with Novel Electronic Properties, Les Diableret, Switzerland, September 28-30, 2007, poster

F. Ebert, P. Dillmann, U. Gasser, G. Maret
Dynamical, structural and elastic properties of a 2D colloidal binary mixture of magnetic dipoles, Soft, Complex, and Biological Matter,
Satellite Conference of IUPAP Statphys 23, Citta del Mare, Terrasini Sicily, July 15-19 2007, poster

N. B. Christensen, H. M. Rønnow, J. Mesot, R. A. Ewings, N. Momono, M. Oda, M. Ido, M. Enderle, D. F. McMorrow, A. T. Boothroyd
On the magnetic order in the charge-ordered superconductor $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$,
ECNS 2007- 4th European conference on neutron scattering, Lund, Sweden, June 25-29 2007, poster

U. Dietrich, T. Gutberlet, P. Krüger
Investigation of the interaction of MARCKS protein with DPPC/PIP(2) monolayers,
MIPP 2007 Membrane Interacting Peptides and Proteins, International Bunsen Discussion Meeting, Halle, Germany, March 28.-31, 2007, poster

J.-P. Embs
Dynamics of RTILs by Means of QENS,
1st SPP 1191 workshop, Bamberg, Germany, June 30 – July 5, 2007, talk

J.-P. Embs
Measuring the anomalous dispersion branch of surface waves on ferrofluids,
Universität Bayreuth, Kolloquium Forschergruppe 608 (Nichtlineare Dynamik komplexer Kontinua), Bayreuth, Germany, June 12, 2007, talk

J.-P. Embs
Measuring the anomalous dispersion branch of surface waves on ferrofluids,
27th Dynamics Days Europe Loughborough University / University of Nottingham, Nottingham, U.K., July 9-13, 2007, talk

J.-P. Embs
Dynamics of RTILs by Means of QENS,
1st Annual Meeting of the SPP 1191, Bamberg, Germany, December 12-14, 2007 talk

J.-P. Embs
Neutron and X-ray methods for the characterization of solid oxide fuel cell materials, cells, and stacks,
Swiss Physical Society - Annual Meeting 2007, University of Zurich, Zurich, Switzerland, February 20-21, 2007, poster

J.-P. Embs
Dynamics of RTILs by means of QENS,
1st SPP 1191 workshop, Bamberg, Germany, June 30 – July 5, 2007, poster

J.-P. Embs
QENS measurements on N-alkyl-N-methylpyrrolidinium bis(trifluoromethanesulfonyl)imide ionic liquids,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

J.-P. Embs
Dynamics of hemoglobin and water in human red blood cells and concentrated hemoglobin solutions,
European Biophysics Congress, London, U.K., July 14 – 19, 2007, poster

J.-P. Embs
Dynamics of RTILs by Means of QENS,
1st Annual Meeting of the SPP 1191, Bamberg, Germany, December 12-14, 2007, poster

U. Gasser, D. Reinke, H. Stark, H.-H. von Grünberg, A.B. Schofield, G. Maret
Non-central forces in crystals of charged colloids,
ECIS 2007, 21st Conferernce of the European Colloid and Interface Society, Geneva, Switzerland, September 10-14 2007, talk

U. Gasser, D. Reinke, H. Stark, H.-H. von Grünberg, A.B. Schofield, G. Maret
Non-central forces in crystals of charged colloids, Soft, complex and Biological Matter,
Satellite Conference of IUPAP Statphys 23, Citta del Mare, Terrasini, Sicily, Italy, July 15-19, 2007 poster

J.L. Gavilano, Y. Kawasaki, B. Roessli, D. Andreica, E. Pomjakushina, K. Conder, H.R. Ott
muSR studies of the series $CePd_{2-x}Fe_xIn$ at low temperatures,
muSR Users Meeting, PSI, Villigen, Switzerland, January 23-24 2007, talk

J.L. Gavilano, Y. Kawasaki, L. Keller, B. Roessli, N. Christensen, J. Schefer, T. Ohno, Z. He, Y. Ueda and M. Itoh
Neutron Scattering Studies of $Ba_2V_2CoO_8$,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

S. N. Gvasaliya, B. Roessli 2, R.A. Cowley 3, S. Kojima, S. Lushnikov, G. -M. Rotaru
Neutron Scattering Studies of the Phase Transitions in (1-x) PMN-xPT Relaxor Ferroelectrics,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

S.N. Gvasaliya, B. Roessli, R.A. Cowley, S. Kojima and S.G. Lushnikov
Neutron Scattering Study of the (1-x)PMN-xPT Relaxor Ferro-electrics,
11th European Meeting on Ferroelectricity, Bled, Slovenia, September 3-7, 2007, talk

S.N. Gvasaliya, B. Roessli, R.A. Cowley, S. Kojima, S.G. Lushnikov, and G. Rotaru
Neutron scattering studies of the phase transitions in (1-x)PMN-xPT relaxor ferroelectrics,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

T. Gutberlet, F. Juranyi
Hydration dependent dynamics in model membrane systems,
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T. Gutberlet, K. Wojciechowski, A. Tikhonov, M. Schlossman, J. Buffle
X-ray reflectivity study of the adsorption of azacrown ethers and palmitic acid at the hexane-water interface,
71. Jahrestagung der Deutschen Physikalischen Gesellschaft, Regensburg, Germany, March 26-30, 2007, talk

T. Gutberlet, K. Wojciechowski, A. Tikhonov, M. Schlossman, J. Buffle
X-ray reflectivity study of the adsorption of azacrown ethers and palmitic acid at the hexane-water interface,
Int. Workshop on Scattering on Liquid-Liquid Interfaces, Rodvig, Denmark, June 22-24, 2007, talk

A.R. Hillman, M.A. Mohamoud, A. Glidle, T. Gutberlet
Use of in situ neutron reflectivity-derived solvent profiles in polyaniline films to interpret viscoelastic phenomena,
58th Annual Meeting of the International Society of Electrochemistry, Banff, Canada, September 09.-14, 2007 poster

J. Hoppeler
Giant modulation of the magnetic profile in $Y_{0.6}Pr_{0.4}Ba_2Cu_3O_7/Ba_{2/3}Ca_{1/3}MnO_3$ superlattices,
PhD-seminar LNS, Nov. 8, 2007, talk

J.Hoppeler
Magnetic induction profile in perovskite superconductor / ferromagnet multilayers,
Swiss Physical Society - Annual Meeting 2007, University of Zurich, Zurich, Switzerland, February 20-21, 2007, poster

J.Hoppeler
Superconductivity-induced modulation of the magnetisation profile in $Y_{0.6}Pr_{0.4}Ba_2Cu_3O_7/La_{2/3}Ca_{1/3}MnO_3$ superlattices,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 20-28, 2007, poster

P. Huber, T. Blättler, M. Textor, W. Leitenberger, U. Pietsch, and Th.Geue
Template-directed formation of ordered colloidal assemblies, LB12,
12th International Conference on Organiced Molecular Films, Krakow, Poland, July 1-5, 2007, poster

P. Huber, T. Blättler, M. Textor, W. Leitenberger, U. Pietsch, and Th. Geue
Template-directed formation of ordered colloidal assemblies,
ECIS 2007, 21st Conference of the European Colloid and Interface Society, Geneva, Switzerland, September 10-14, 2007, poster

P. Huber, Th. Geue
X-ray scattering on ordered colloidal assemblies, 7th Autumn School on X-ray scattering from surfaces and thin layers,
Smolenice, Slovakia, October 4-6, 2007, talk

P. Huber, Th. Geue
X-ray scattering on ordered colloidal assemblies, SLS Symposium on complex fluids,
PSI, Villigen, Switzerland, December 04, 2007, talk

X. Jiang, T. Gutberlet, M. Gupta, T. Geue, T. Thurn-Albrecht
Electric field effects on alignment of lamellar structures in diblock copolymer thin films studied by neutron scattering,
71. Jahrestagung der Deutschen Physikalischen Gesellschaft, Regensburg, Germany, March 26.-30, 2007, poster

T. Kaltofen, T. Gutberlet,.M. Wolff, R. Steitz, R. Dahint
Investigation of lubrication in natural joints by neutron reflectometry,
1. Jahrestagung der Deutschen Physikalischen Gesellschaft, Regensburg, Germany, March, 26.-30, 2007, poster

Y. Kawasaki, J.L. Gavilano, B. Roessli, D. Andreica, E. Pomjakushina, K. Conder, H.R. Ott
μSR studies of $CePd_2In$ at low temperatures,
Yamada Conference LXI, Spectroscopy in Novel Superconductors, Sendai, Japan, August 20-24, 2007, poster

L. Keller and U. Filges
Upgrade of the diffractometer DMC at SINQ: Monte Carlo simulations as a tool for design and optimization,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

C. Krämer, H. M. Rønnow, J. Mesot, P. Link, A. Schneidewind, T. Unruh, T.F. Rosenbaum, G. Aeppli, and J. Jensen
Quantum Phase Transition of a Magnet in a Spinbath MaNEP Swiss Workshop on Materials with Novel Electronic Properties,
Les Diablerets, Switzerland, September 20-28, 2007, poster

C. Krämer, H.M.Rønnow, J.Mesot, K.Kiefer, K.Prokes, A.Podlesnyak, T.Strässle, O.Zaharko
Magnetic Properties of $LiErF_4$*, Swiss Physical Society - Annual Meeting 2007,*
University of Zurich, Zurich, Switzerland, February 20-21, 2007, talk

C.Krämer, H.M.Rønnow, J.Mesot, P.Link, A.Schneidewind, T.Unruh, T.F.Rosenbaum, G.Aeppli, J.Jensen
Quantum phase transition of a magnet in a spinbath, Correlated Electron Materials,
6th PSI Summer School on Condensed Matter Research, August 13-19, 2007, Zuoz, Switzerland, poster

C. Landee , F. Xiao , M. Turnbull , N. Tsyrulin , M. Kenzelmann , H. Van Tol
Field dependent ordering temperature in copper pyrazine perchlorate, $Cu(pz)_2(ClO_4)_2$*,*
American Physical Society Meeting; Denver, Colorado, USA; March 6, 2007, talk

M. Meven, J.Schefer, M.Janoschek, V.Pomjakushin, P.Fischer, D.Sheptyakov, L.Keller, B.Roessli, G.Petrakovskii, L.Bezmaternikh, C.Temerov, D.Velikanov
Simultaneous antiferromagnetic Fe^{3+} *and* Nd^{3+} *ordering in* $NdFe_3\,(^{11}BO_3)_4$ *investigated by single crystal neutron diffraction,*
1st FRM-II User Meeting, Garching, Germany, October 30, 2007, talk

C. Niedermayer, H. E. Mohottala, B.O. Wells, J. I. Budnick, W.A. Hines, L. Udby, C. Bernhard
Electronic phase separation in $La_{2-x}Sr_xCuO_{4+y}$*,*
Swiss Workshop on Materials with Novel Electronic Properties Les Diableret, Switzerland, September 28-30, 2007, poster

V. Pomjakushin, A. Furrer, L. Keller, D. Sheptyakov, E.Pomjakushina, K.Conder
Crystal and magnetic structure of novel quantum spin-trimer compounds, $Ca_3Cu_{3-x}Ni_x(PO_4)_4$ *a neutron diffraction study,*
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E. Pomjakushina, K. Conder, M.Stingaciu, A. Podlesnyak
Layered and cubic cobaltites crystal growth, structural, magnetic and transport properties investigation,
2007 Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 28-30, 2007, poster

K. Prsa
The excitation spectrum of $Cu_2Te_2O_5X_2$ *(X=Cl, Br),*
NUM PhD Student's Seminar, PSI, Villigen, Switzerland, September 6, 2007, talk

K. Prsa, O. Zaharko, H. M. Rønnow, M. Jimenez-Ruiz, J. J. Chang, N. B. Christensen, H. Berger and J. Mesot
Temperature evolution of the magnetic excitations in the coupled Cu^{2+} *(S = 1/2) tetrahedra system* $Cu_2Te_2O_5X_2$ *(X=Cl, Br),*
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

J. Rasch
Magnetic properties of 2D layered compounds,
10th Oxford School on Neutron Scattering, United Kingdom. University of Oxford, September 4-14, 2007, talk

J. Rasch
Neutron diffraction studies of layered compounds,
ETH Zürich, Materials Science Seminar, November 5, 2007, talk

J. Rasch
Magnetisation dynamics investigated by inelastic neutron scattering,
ILL Student Lectures Fall 2007, ILL Grenoble, France, December 18, 2007, talk

J. Rasch, M. Boehm, J. Schefer, L. Keller, G.M. Abramova, V.V. Sokolov and G.A. Petrakovskii
Magnetic Properties of the 2D Intercalated Disulfide $CuCrS_2$,
MRS Fall Meeting, November 26-30, Boston, USA, poster

J. Rasch, M. Boehm, J. Schefer, L. Keller, G.M. Abramova, V.V. Sokolov and G.A. Petrakovskii
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J. Rasch, M. Boehm, J. Schefer, L. Keller, G.M. Abramova, V.V. Sokolov and G.A. Petrakovskii
Magnetic properties of the 2D intercalated disulfide $CuCrS_2$,
Correlated Electron Materials, 6^{th} PSI Summer School on Condensed Matter Research, August 13-19, 2007, Zuoz, Switzerland, poster

G. -M. Rotaru, S. N. Gvasaliya, V. Pomjakushin, B. Roessli, Th. Strässle, S. G. Lushnikov, T. A. Shaplygina, and P. Günter
Neutron diffraction study of $PbMg_{1/3}Nb_{2/3}O_3$*under high pressures,*
Swiss Physical Society - Annual Meeting 2007, University of Zurich, Zurich, Switzerland, February 20-21, 2007, talk

G. M. Rotaru, S.N. Gvasaliya, V. Pomjakushin, B. Roessli, Th. Strässle, S.G. Lushnikov, T.A. Shaplygina, and P. Günter
Neutron study of atomic displacements in $PbMg_{1/3}Nb_{2/3}O_3$ *under high pressures,*
ECNS 2007 - 4^{th} European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

Y.Sassa, A. Bendounan, S. Pailhes, L. Patthey, J. Mesot
Pulsed Laser deposition of thin superconducting films for ARPES measurements,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 20-28, 2007, poster

J.Schefer, M.Janoschek, V.Pomjakushin, P.Fischer, D.Sheptyakov, L.Keller, B.Roessli, G.Petrakovskii, L.Bezmaternik, V.Temerov, D.Velikanov
Simultaneous antiferromagnetic Fe^{3+} *and* Nd^{3+} *ordering in* $NdFe_3(^{11}BO_3)_4$ *investiged by single crystal neutron diffraction,*
24^{th} European Crystallographic Meeting, Marrakech, Morocco, August 22-27, 2007, talk

M. Schneider
Multilayers for Neutron Optics and Actively Shielded Magnet for Scattering Methods,
Internal Workshop MaNEP, Neuchâtel, January 23, 2007, talk

M. Schneider
Polarizing multilayers for neutron optics,
Internal Workshop MaNEP, Geneva, Switzerland, June 14, 2007, talk

M. Schneider
Polarizing Neutron reflectivity and magnetic properties of $FeCoV/TiN_x$ *supermirrors,*
Swiss Workshop on Materials with Novel Electronic Properties ’07, September 20-28., 2007, Les Diablerets, Switzerland, talk

G. Schuck, J. Karpinski, Z. Bukowski, D. Chernyshov
Temperature dependent structural studies of beta-pyrochlore KOs_2O_6 *single crystals,*
Jahrestagung der Deutsche Gesellschaft für Kristallographie 2007, Bremen, Germany, March, 5-9, 2007, poster

M. Schneider
Polarized neutron reflectivity and magnetic properties of FeCoV/TiN$_x$ supermirrors,
European Workshop on Neutron Optics NOP '07, March 5.-7. 2007, Villigen, Switzerland., poster

M. Schneider
Multilayer monochromators devoid of selected higher orders,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

G. Schuck, S. Haas, U. Berens and H.-J. Kirner
Crystal structures of two rubrene derivatives
24th European Crystallographic Meeting, European, Crystallographic Association, Marrakech, Morocco, August 22-27, 2007, poster

J. Stahn, T. Gutberlet
Full polarization analysis at the time-of-flight neutron reflectometer AMOR at SINQ/PSI,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

Th. Strässle
Experimental evidence for a cross-over between two distinct mechanisms of amorphization in ice Ih under pressure,
Joint 21st AIRAPT and 45th EHPRG International Conference on High Pressure Science and Technology, Catania, Italy, September 17-21, 2007, talk

B. Thielemann, Ch. Rüegg, H. M. Rønnow, D. F. McMorrow, J. Mesot, K. W. Krämer, D. Biner, H.-U. Güdel, J. Stahn, S. Gvasaliya, K. Habicht, M. Boehm
Magnetic excitations in spin-ladder compounds,
Swiss Physical Society - Annual Meeting 2007, University of Zurich, Zurich, Switzerland, February 20-21, 2007, talk

B. Thielemann, Ch. Rüegg, H. M. Rønnow, D. F. McMorrow, J. Mesot, K. W. Krämer, D. Biner, H.-U. Güdel, K. Kiefer, J. Stahn, S. Gvasaliya, K. Habicht, M. Boehm and B. Grenier
Continuous spin-excitation spectrum in the Luttinger-liquid phase of a novel spin-ladder, Correlated Electron Materials,
6th PSI Summer School on Condensed Matter Research, August 13-19, 2007, Zuoz, Switzerland, poster

B. Thielemann, Ch. Rüegg, H. M. Rønnow, J. Mesot, D. F. McMorrow, K. W. Krämer, D. Biner, H.-U. Güdel, K. Kiefer, J. Stahn, S. Gvasaliya, K. Habicht and M. Boehm
Continuous spin-excitation spectrum in a novel spin-ladder,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, talk

B. Thielemann, Ch. Rüegg, H. M. Rønnow, J. Mesot, D. F. McMorrow, K. W. Krämer, D. Biner, H.-U. Güdel, K. Kiefer, J. Stahn, S. Gvasaliya, K. Habicht, M. Boehm and B. Grenier
Continuous spin-excitation spectrum in a novel spin-ladder,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 20-28, 2007, talk

M. Weller, J. L. Gavilano, A. Sacchetti and H. R. Ott
Low temperature NMR study of CeAl$_3$ under hydrostatic pressure,
The International Conference on Strongly Correlated Electron Systems SCES07, Houston, USA, May 13-18, 2007, poster

M. Zayed
Quantum phase transition(s) in Shastry-Sutherland compound,
Workshop on the Physics of Complex Systems, EPFL, Lausanne, Switzerland, March 17, 2007, talk

M. Zayed, Ch. Rüegg, H. Rønnow, E. Pomjakushina, M. Stingaciu, C. Kazimierz, Th. Strässle, G. Hamel, S. Klotz, A. Lauechli, V. Pomjakushin, A. Schneidewind, P. Link, M. Holzel and M. Jimenez-Ruiz
Pressure induced quantum phase transition in $SrCu_2(BO_3)_2$,
ECNS 2007 - 4th European Conference on Neutron Scattering, Lund, Sweden, June 25-29, 2007, poster

M. Zayed
Pressure and phase transitions in Shastry-Sutherland compound $SrCu_2(BO_3)_2$,
MaNEP Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets, Switzerland, September 20-28, 2007, poster

O. Zaharko, J. Mesot, K. Kiefer, B. Klemke, R. Valenti, A. Salgero, M. Myskiv
Magnetism in delocalized electron isolated tetrahedral system $Cu_4OCl_6L_4$,
International Symposium on Crystalline Organic Metals, Superconductors and FerromagnetsPeńiscola, Spain, 24-29 September 2007, poster

O. Zaharko, J. Mesot, Y. Filinchuk, K. Kiefer, B. Klemke, M. Myskiv
Magnetic exchange in isolated tetrahedral system Cu_4OCl_6(diallylcyanamide)$_4$,
Workshop on Highly Frustrated Magnets and Strongly Correlated Systems, Trieste, Italy, 13-16 August 2007, talk

LECTURES AND COURSES

A. Cervellino
Neutron Diffraction in Materials Science
University of Trento, Italy, Department of Material Engineering and Industrial Technologies Via Mesiano 77, I-38050 TRENTO Cycle of Seminars, February 12-16, 2007, 6 hours

N.Christensen
Neutron Spectroscopy 1
Correlated Electron Materials 6th PSI Summer School on Condensed Matter Research, 1 hour lecture

J.Gavilano
Experimental Studies of Some Strongly Correlated Electron Systems
Institut of Physics, University of Augsburg, Germany
Date: 17 July 2007

T.Gutberlet
Int.School for Scattering for Biologists
Villigen PSI, Switzerland, 23.-26.10.2007
6 Tutorials, each 2.5h

J. Mesot
- Neutronenstreuung in der Festkörperphysik I ETH Zürich, WS 2007
- Neutronenstreuung in der Festkörperphysik II ETH Zürich, SS 2007
- ETH Zürich, Seminars WS 2007
- ETH Zürich, Seminars SS 2007

K.Prsa
Neutron Scattering in Solid State Physics
- ETH Zürich, Summer Semester, 2006/07, part 2.
- The Abdus Salam International Centre for Theoretical Physics, 2007, School and Workshop on Highly Frustrated Magnets and Strongly Correlated Systems.

J.Schefer
Erasmus Mundus-Mamaself: Magnetic Structure Determination with Neutrons (28.09.2007, 5 hours), University Rennes 1, France

Th.Strässle
Practical 'Inelastic Neutron Scattering' (2 days) within the 'International School for "Scattering for Biologists" (MCRT/BIOCONTROL), Villigen PSI, Switzerland, October 23 26, 2007.

B.Thielmann
Teaching assistent for the following courses at ETH Zurich: Physik 1 & 2 für Physiker, Prof. Dissertori, Physik 1 für Maschinenbauer, Prof.Degiorgi

P. Tregenna-Piggot
- University of Bern: September to December 2007. 24 x 1 hour lectures, "Introduction to IDL"

Invited Lectures:
- Copenhagen, Denmark: September 2007, "Introducing the Inverted-Geometry time-of-flight instrument, MARS, at SINQ"
- Lund Sweden: June 2007, "Introducing the Inverted-Geometry time-of-flight instrument, MARS, at SINQ"

M. Zayed
School and Workhop on Highly Frustrated Magnets and Strongly Correlated Systems. Abus Salam International Center for Theoretical Physics.Trieste July- August 2007

AWARDS / NOMINATIONS

Joël Mesot
Chairman of the internal PSI FoKo

Henrik Ronnow
"Tenure-Track" Professor at EPFL

Condensed Matter Research with Neutrons and Muons

Spallation Neutron Source Division

LIST OF PUBLICATIONS (PEER REVIEWED)

Alam MK, Khan MA, Lehmann EH, Vontobel P
Study of the water uptake and internal defects of jute-reinforced polymer composites with a digital neutron radiography technique
JOURNAL OF APPLIED POLYMER SCIENCE **105**, 1958 (2007)

Atchison F, Blau B, Bodek K, van den Brandt B, Brys T, Daum M, Fierlinger P, Frei A, Geltenbort P, Hautle P, Henneck R, Heule S, Holley A, Kasprzak M, Kirch K, Knecht A, Konter J, Kuzniak M, Liu C, Morris C, Pichlmaier A, Plonka C, Pokotilovski Y, Saunders A, Shin Y, Tortorella D, Wohlmuther M, Young A, Zejma J, Zsigmond G
Cold Neutron Energy Dependent Production of Ultracold Neutrons in Solid Deuterium
PHYSICAL REVIEW LETTERS **99**, 262502 (2007)

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Measurement of the Fermi potential of diamond-like carbon and other materials
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION B-BEAM INTERACTIONS WITH MATERIALS AND ATOMS **260** , 647 (2007)

Bleuel M, Lang E, Krist T, Wagner W, Lal J
SANSPOL at a pulsed source
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Slip transfer through a general high angle grain boundary in nanocrystalline aluminum
APPLIED PHYSICS LETTERS **91**, 111914 (2007)

Brandl C, Derlet PM, Van Swygenhoven H
General-stacking-fault energies in highly strained metallic environments: Ab initio calculations
PHYSICAL REVIEW B **76**, 054124 (2007)

Carminati A, Kaestner A, Fluehler H, Lehmann E, Stampanoni M
Hydraulic contacts controlling water flow across porous grains
PHYSICAL REVIEW E **76**, 026311 (2007)

Carminati A, Kaestner A, Hassanein R, Ippisch O, Vontobel P, Fluhler H
Infiltration through series of soil aggregates: Neutron radiography and modeling
ADVANCES IN WATER RESOURCES **30**, 1168 (2007)

Carminati A, Kaestner A, Ippisch O, Koliji A, Lehmann P, Hassanein R, Vontobel P, Lehmann E, Laloui L, Vulliet L, Fluhler H
Water flow between soil aggregates
TRANSPORT IN POROUS MEDIA **68**, 219 (2007)

Cnudde V, Dierick M, Vlassenbroekc J, Masschaele B, Lehmann E, Jacobs P, Hoorebeke LV
Determination of the impregnation depth of siloxanes and ethylsilicates in porous material by neutron radiography
JOURNAL OF CULTURAL HERITAGE **8**, 331 (2007)

Derlet PM, Dudarev SL
Million-atom molecular dynamics simulations of magnetic iron
PROGRESS IN MATERIALS SCIENCE **52**, 299 (2007)

Derlet PM, Nguyen-Manh D, Dudarev SL
Multiscale modeling of crowdion and vacancy defects in body-centered-cubic transition metals
PHYSICAL REVIEW B **76**, 054107 (2007)

Dudarev SL, Derlet PM
Molecular dynamics modelling of radiation defects in ferromagnetic alpha-iron
JOURNAL OF NUCLEAR MATERIALS **367**, 251 (2007)

Dudarev SL, Derlet PM
A 'magnetic' interatomic potential for molecular dynamics simulations (vol 17, pg 7097, 2006)
JOURNAL OF PHYSICS-CONDENSED MATTER **19**, 239001 (2007)

Dudarev SL, Derlet PM, Woo CH
Driven mobility of self-interstitial defects under electron irradiation
NUCLEAR INSTRUMENTS & ; METHODS IN PHYSICS RESEARCH SECTION B-BEAM INTERACTIONS WITH MATERIALS AND ATOMS **256**, 253 (2007)

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Systematic study of disorder induced by neutron irradiation in MgB2 thin films
JOURNAL OF APPLIED PHYSICS **101**, 043903 (2007)

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IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY **17**, 2858 (2007)

Glasbrenner H, Groeschel F
Liquid metal compatibility under irradiation: The LiSoR 5 experiment
JOURNAL OF NUCLEAR MATERIALS **367**, 1590 (2007)

Grünzweig C, Frei G, Lehmann E, Kühne G, David C
Highly absorbing gadolinium test device to characterize the performance of neutron imaging detector systems
REVIEW OF SCIENTIFIC INSTRUMENTS **78**, 053708 (2007)

Ivanov S, Platacis E, Flerov A, Zik A, Ming P, Groeschel F, Dementjev S
Experience of Calculation, Design, Fabrication and Testing of the electromagnetic Pump System for the MEGAPIE Target
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Kaestner A, Hassanein R, Vontobel P, Lehmann P, Schaap J, Lehmann E, Fluehler H
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Energy-selective neutron transmission imaging at a pulsed source
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Lehmann EH, Frei G, Kühne G, Boillat P
The micro-setup for neutron imaging: A major step forward to improve the spatial resolution
NUCLEAR INSTRUMENTS & ; METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT **576**, 389 (2007)

Lehmann EH, Vontobel P, Frei G
The non-destructive study of museums objects by means of neutrons imaging methods and results of investigations
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A strong micropillar containing a low angle grain boundary
APPLIED PHYSICS LETTERS **91**, 131909 (2007)

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PHYSICAL REVIEW LETTERS **99**, 145505 (2007)

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Neutron imaging versus standard X-ray densitometry as method to measure tree-ring wood density
TREES-STRUCTURE AND FUNCTION **21**, 605 (2007)

Menon M, Robinson B, Oswald SE, Kaestner A, Abbaspour KC, Lehmann E, Schulin R
Visualization of root growth in heterogeneously contaminated soil using neutron radiography
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Patorski J, Groeschel F
Investigation of the proton beam entry window cooling of liquid metal target of a spallation neutron source using infrared thermography
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Coupled fluid/structure analyses of the MEGAPIE spallation source target during transients
NUCLEAR ENGINEERING AND DESIGN **237**, 1656 (2007)

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K. Sedlak
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T. Shiroka,
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A. Stoykov,
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  Vorlesung ETHZ, Sommersemester 2007
- Physik mit Myonen: Von der Atomphysik zur Festkörperphysik
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MEMBERSHIP IN EXTERNAL COMMITTEES

A. Amato,
- Swiss Representative COST – Action P16, "Emergent Behaviour in Correlated Matter"
- Facility Subcommittee of the International Society for μSR Spectroscopy (ISMS)
- International Advisory Committee, 11th International Conference on Muon Spin Relaxation, Rotation and Resonance

D. Herlach,
- Secretary, PSI μSR International Research Committee
- Swiss Delegate, International Society for μSR Spectroscopy (ISMS) Europe

R. Khasanov,
- Editorial board, The Open Condensed Matter Physics Journal

H. Luetkens,
- Executive committee member of the International Society for μSR Spectroscopy (ISMS)

E. Morenzoni,
- NCCR MaNEP – Materials with Novel Electronic Properties
- International program committee, International Symposium on Pulsed Neutron and Muon Sciences (IPS08)
- Program Committee, 11th International Conference on Muon Spin Relaxation, Rotation and Resonance

R. Scheuermann,
- ISIS Facility Access Panel

Condensed Matter Research with Neutrons and Muons

Laboratory of Development and Methods

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K. Conder,
Crystal growth of oxides by Optical Floating Zone technique
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K. Conder
Oxygen isotope effect in cuprates and other oxide perovskites
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P. Hautle
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Particles and Matter

Laboratory for Particle Physics

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OUTREACH AND OTHER SCIENTIFIC ACTIVITIES

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mit offizieller Verleihung am ETH-Tag, 17. November 2007

R. Horisberger
Innovation award on synchrotron radiation
for the development of the PILATUS X-ray pixeldetector system bestowed at the BESSY Users's Meeting on 6 December 2007

COMMITTEES

R.Horisberger
- Member of the Photon Science Committee at HASYLAB , DESY Hamburg
- Member of the Advisory Commitee of VERTEX-Conferences
- Member of the PSI Forschungskommission (FOKO)

S. Ritt
- Elected member of the IEEE Nuclear & Plasma Sciences Society Administrative Committee (AdCom)

R. Rosenfelder
- Member of the Research Committee BVR at PSI

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'

Particles and Matter

Laboratory for Radio- and Environmental Chemistry

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A. Ciric
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A. Eichler
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Seminar Radio- und Umweltchemie, Paul Scherrer Institut, Switzerland, 22 June 2007.

H.W. Gäggeler
Neuere Entwicklungen auf dem Gebiet der Radiocarbonanalytik und einige Anwendungen in der Umweltforschung
Universitätsspital INSEL, Bern, Switzerland, 9 March 2007.

H.W. Gäggeler
Radiocarbon determination with micro amounts of carbon, some applications in environmental research
Department of Oceanography, Texas A&M, Galveston, TX, USA, 9 November 2007.

T. Kellerhals
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M. Schläppi, M. Schwikowski, T. Jenk, B. Rufibach, A. Rivera, M. Rodiguez, G. Casassa
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M. Schläppi
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M. Schwikowski
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M. Schwikowski, M. Sigl, E. Isaksson, D. Divine
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M. Schwikowski
Firn/ice core studies by Paul Scherrer Institut in the Andes
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fom Punta Arenas to Puerto Williams, CECS Valdivia, Chile, 14-17 January 2007.

M. Schwikowski
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M. Schwikowski
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M. Schwikowski
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M. Schwikowski
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RADWASTE ANALYTICS

R. Dressler, D. Schumann, S. Shishkin
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J. Neuhausen, F. v. Rohr, N. Aksenov
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J. Neuhausen
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J. Neuhausen, F. v. Rohr, S. Horn, S. Lüthi, D. Schumann
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D. Schumann
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D. Schumann, J. Neuhausen
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D. Schumann
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PROTON IRRADIATION FACILITY

E. Bellm
RHESSI spectral fits of swift GRBs
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W. Hajdas
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W. Hajdas
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Atmospheric scattering background in RHESSI measurements of solar flare polarization
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Standard radiation environment activities at PSI
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ESA/ESTEC, Noordwijk, The Netherlands, 17-18 October 2007.

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Demo model and readout electronics of POLAR – New Gamma Ray Burst Polarimeter
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Irradiation facilities at PSI
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K. Hurley
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Merida, Yucatan, Mexico, 3–11 July 2007.

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S. Scheithauer
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E. Suarez-Garcia
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S. Fahrni, S. Szidat, M. Ruff, L. Wacker, H.W. Gäggeler
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M. Furger, N. Bukowiecki, J. Sandradewi, M.R. Alfarra, P. Lienemann, S. Szidat, A.S.H. Prevot, U. Baltensperger
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J. Mohn, S. Szidat, L. Emmenegger
Determination of fossil fuel in waste incinerators on the gaseous emission of radioactive CO_2
8th International Conference on Emissions Monitoring, Zürich, Switzerland, 5-6 September 2007.

N. Perron, M.N. Wehrli, S. Szidat, J. Sandradewi, A.S.H. Prévôt, U. Baltensperger
Source apportionment of PM10 carbonaceous aerosols in winter 2005/2006 in Swiss rural and urban sites using radiocarbon analyses of the OC and EC fractions
EGU, 4th General Assembly, Vienna, Austria, 10-15 April 2007.

N. Perron, S. Szidat, J. Sandradewi, A.S.H. Prévôt, U. Baltensperger
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Seminar Laboratory of Atmospheric Chemistry, PSI, Switzerland, 18 June, 2007.

N. Perron, S. Szidat, A.S.H. Prévôt, U. Baltensperger
Source apportionment of carbonaceous aerosols using ^{14}C *analyses of the organic and elemental carbon fractions*
First year graduate symposium, University of Berne, Switzerland, 17 September 2007.

N. Perron, S. Szidat, A. S. H. Prévôt, U. Baltensperger
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Seminar Laboratory of Atmospheric Chemistry, PSI, Switzerland, 12 November 2007.

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EUCAARI annual meeting, Helsinki, Finland, 20-23 November 2007.

M. Ruff, H.W. Gäggeler, M. Suter, H.-A. Synal, S. Szidat, L. Wacker
Halbautomatische Messungen mit einer Gasionenquelle
Frühjahrstagung der Deutschen Physikalischen Gesellschaft – Fachverband Massenspektrometie, Düsseldorf, Germany, 19-23 March 2007

M. Ruff
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Seminar Radio- und Umweltchemie, Bern, Switzerland, 02 November 2007.

J. Sandradewi, M.R. Alfarra, A.S.H. Prévôt, E. Weingartner, M. Gysel, R. Schmidhauser, S. Szidat, U. Baltensperger
Wood burning aerosol during winter in an Alpine valley: Aethalometer and the aerosol mass spectrometer measurements
European Aerosol Conference, Salzburg, Austria, 10-14 September 2007.

S. Szidat, M. Ruff, L. Wacker, N. Perron, J. Sandradewi, M.R. Alfarra, A.S.H. Prévôt, M. Hallquist, A.S. Shannigrahi,
U. Baltensperger
Source apportionment of carbonaceous aerosols with radiocarbon
EGU, 4th General Assembly, Vienna, Austria, 10-15 April 2007.

S. Szidat, M.N. Wehrli, M. Ruff, L. Wacker, J. Noda, T. Gustafsson, J. Pettersson, R.M. Volkamer, J.-L. Jimenez, A.S.H. Prévôt, U. Baltensperger
Emission sources of carbonaceous aerosols in Mexico City deduced from radiocarbon analysis
EGU, 4th General Assembly, Vienna, Austria, 10-15 April 2007.

S. Szidat
On the track of environmental carbonaceous aerosols
Seminar at Department of Chemistry and Biochemistry, Universität Bern, Switzerland, 26 April 2007.

S. Szidat, M. Ruff, S. Fahrni, L. Wacker, H.-A. Synal
Ein Kopplungssystem für die automatisierte ^{14}C-Messung mit Beschleunigermassenspektrometrie
GDCh Wissenschaftsforum Chemie 2007, Ulm, Germany, 16-19 September 2007.

S. Szidat, M.N. Wehrli, M. Ruff, N. Perron, J. Sandradewi, M.R. Alfarra, A.S.H. Prevôt, U. Baltensperger, L. Wacker, M. Hallquist
Holzverbrennung: Eine wichtige Quelle von kohlenstoffhaltigem Feinstaub im Winter
GDCh Wissenschaftsforum Chemie 2007, Ulm, Germany, 16-19 September 2007.

S. Szidat
Neueste Resultate der ^{14}C-Analysen in der Schweiz
Wintersmog-Workshop, ETH Zürich, Switzerland, 16 October 2007.

S. Szidat
Potenzial der AMS für die Anwendung kleiner Dosen von ^{14}C in der biomedizinischen Forschung
Seminar Isotope Chemistry & Metabolite Synthesis, Sanofi-Aventis Deutschland GmbH, Frankfurt/Main, Germany, 30 November 2007.

S. Szidat
^{14}C micro-analysis: Applications and challenges of chemical speciation
Seminar Radio- und Umweltchemie, PSI, Switzerland, 7 December 2007.

M. Viana, X. Querol, T.A.J. Kuhlbusch, A. Miranda, M. Vallius, A. Kasper-Giebl, S. Szidat, W. Winiwarter, R.M. Harrison
Overview of source apportionment methods in selected European COST633 action member countries
European Aerosol Conference, Salzburg, Austria, 10-14 September 2007.

LECTURES AND COURSES

Prof. Dr. H.W. Gäggeler
Universität Bern, SS2007:
Bachelor
- Instrumentalanalytik II (with others)
- Allgemeine Chemie (Einführung Radioaktivität) (with others)

Master
- Kolloquium Radio- und Umweltchemie in collaboration with the Paul Scherrer Institut (organized by Dr. R. Eichler)

Universität Bern, HS2007:
Bachelor
- Physikalische Chemie IV (with Prof. H. Siegenthaler)
- Praktikum Phys. Chemie II (with others)
- Biochemische Methoden I (with others)
- Biochemische Methoden (Übungen) (with others)

Master
- Nuclear and Radiochemistry
- Lab course Nuclear and Radiochemistry (with others)
- Lab course Paul Scherrer Institut (with others)
- Environmental Radionuclides and Nuclear Dating (with Dr. S. Szidat)
- Kolloquium Radio- und Umweltchemie in collaboration with the Paul Scherrer Institut (organized by Dr. D. Schumann)

Prof. Dr. U. Krähenbühl
Universität Bern, SS2007:
- Analytische Ergänzungen für Pharmazeuten
- Analytisches Praktikum für Pharmazeuten
- Praktikum Physikalische Chemie II

Universität Bern, HS 2007:
- Allgemeine Chemie für Veterinär Mediziner
- Umweltchemie
- Praktikum Physikalische Chemie II
- Radiochemiepraktikum Master Kurs

PD Dr. M. Schwikowski
Universität Bern, SS2007:
- Instrumentalanalytik II (with others) (3ECTS)

Universität Bern, HS2007:
- Atmospheric and Aerosol Chemistry (3ECTS)

Dr. R. Eichler
Universität Bern, HS2007:
- Kolloquium Radio- und Umweltchemie in collaboration with Paul Scherrer Institut
- Praktikum Phys. Chemie II (with Prof. H.W. Gäggeler)
- Lab course Nuclear and Radiochemistry (with Prof. H.W. Gäggeler)
- Lab course Paul Scherrer Institut (with Prof. H.W. Gäggeler)

Dr. S. Szidat
Universität Bern, HS2007:
- Environmental Radionuclides and Nuclear Dating (with Prof. H.W. Gäggeler)
- Lab course Nuclear and Radiochemistry (with Prof. H.W. Gäggeler and Dr. R. Eichler)

BACHELOR THESIS

Cédéric Clivaz
Bestimmung des terrestischen Alters von Meteoriten über die Messung der Oberflächenurankonzentration mittels ICP-MS
Prof. Dr. U. Krähenbühl / Uni Bern
May 2007

Stefan Schmoker
Untersuchung zweier Megacryometeoren von Habsburg (AG) und Alberswil (LU)
PD Dr. M. Schwikowski / PSI
Prof. Dr. H. W. Gäggeler / PSI & Uni Bern
June 2007

Barbara Leder
Ultratrace determination of palladium in environmental samples by CRI-ICP-MS
Prof. Dr. U. Krähenbühl / Uni Bern
June 2007

MASTER / DIPLOMA THESIS

Meena Zala
Möglichkeiten und Grenzen der CRI Technik in der Massenspektrometrie*
*(*CRI Collision Reaction Interface)*
Prof. Dr. U. Krähenbühl / Uni Bern
March 2007

Elisabeth Dietze
Das Regionalklima und die Isotopensignale von Eisbohrkernen der subtropischen Anden in Normal- und ENSO-Zeiten
Prof. Dr. A. Kleber/TU Dresden / PD Dr. M. Schwikowski/PSI
May 2007

Sarah Biner
Investigation of mercury (Hg) behaviour in seasonal snow cover at the Jungfraujoch
PD Dr. M. Schwikowski / PSI
Prof. Dr. H. W. Gäggeler / PSI & Uni Bern
December 2007

HONORY DEGREE

On 26 May 2007 *Heinz W. Gäggeler* received a honory doctoral degree from the Joint Institute of Nuclear Research (JINR) in Dubna in recognition of his seminal contribution to the chemistry of heavy elements.

Particles and Matter

Laboratory for Ion Beam Physics

PUBLICATIONS

S.A. Ahler, C.M. Johnson, H. Haas and G. Bonani
A Chronology of Middle Missouri Plains Village Sites
in: Smithsonian Contributions to Anthropology, Vol. 47, chapter 5, editor C.M. Johnson, 53-89 (2007).

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Applied Geochemistry **22,** 606-618 (2007).

M. Atarashi-Andoh, C. Schnabel, G. Cook, A.B. MacKenzie, A. Dougans, R.M. Ellam, S. Freeman, C. Maden, V. Olive, H.-A. Synal and S. Xu
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S. Barker, W. Broecker, E. Clark and I. Hajdas
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Paleoceanography **22,** Art. No. PA2205 (2007).

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Surface-exposure ages of Front Range moraines that may have formed during the Younger Dryas, 8.2 cal ka, and Little Ice Age events
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M.J. Bentley, D.J.A. Evans, C.J. Fogwill, J.D. Hansom, D.E. Sugden and P.W. Kubik
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Quaternary Science Reviews **26,** 644-677 (2007).

C.N. Borca, S. Canulescu, F. Loviat, T. Lippert, D. Grolimund, M. Döbeli, J. Wambach and A. Wokaun
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H. Braun, A. Ganopolski, M. Christl and D.R. Chialvo
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INVITED TALKS

H.-A. Synal,
The next Generation of Accelerator Mass Spectrometry for Bioscience and Microdosing
USA, Palm Springs, 30.1.2007, Lab Automation 2007

G. Bonani
Radiokarbondatierung von archäologischen Kleinproben mit der Beschleunigermassenspektrometrie-Methode (AMS)
Schweiz, Basel, 13.2.2007, Institut für Prähistorische und Naturwissenschaftliche Archäologie (IPNA), Universität Basel

M. Suter
Gasionisationszähler für AMS - wo ist noch Potenzial für Verbesserungen
Deutschland, Düsseldorf, 20.3.2007, DPG-Tagung 2007

I. Hajdas
Radiocarbon dating method: new developments and perspectives
Deutschland, Köln, 30.3.2007, Schwarzbach memorial colloquium

M. Christl
10Be-measurements at low energies, Österreich, Wien, 12.-14.4.2007,
Cronus-EU midterm meeting

M. Suter
Recent developments in accelerator mass spectrometry of radiocarbon
Polen, Gliwice, 25.-27.4.2007, 9th International Conference 'Methods of Absolute Chronology'

S. Ivy-Ochs
Exposure dating of the Lateglacial
Deutschland, Bernried, 27.-29.4.2007, AGAQ Alpenvorland Quartär Tagung

I. Hajdas
14C time scale for paleo studies—An overview of recent developments and perspectives
Polen, Gliwice, 25.-27.4.2007, 9th International Conference 'Methods of Absolute Chronology'

S. Ivy-Ochs
Constraining the timing of glacier variations in the Alps with cosmogenic nuclides
Deutschland, Göttingen, 19.6.2007, Kolloqium des Geographischen Instituts der Universität Göttingen

H.-A. Synal
Latest Developments in Low Energy Accelerator Mass Spectrometry
Frankreich, Deauville, 24.-29.6.2007, EMIS 2007 '15th International Conference on Electromagnetic Isotope Separators and Techniques Related to their Applications'

M. Döbeli
Beschleunigermassenspektrometrie und ihre Anwendungen in der Materialforschung
Deutschland, Dresden, 5.-6.7.2007, Seminar Forschungszentrum Dresden

M. Suter
Small versus large AMS systems
Italien, Florenz, 3.-7.9.2007, ECAART '9th european conference on accelerators in applied research and technology'

H.-A. Synal
The PSI/ETH Laboratory of Ion Beam Physics
Germany, Cologne, 20.9.2007, University of Cologne

H.-A. Synal
Recent advances and future perspectives of accelerator mass spectrometry
Switzerland, Zurich, 22.10.2007, ETH Zürich

S. Ivy-Ochs
Surface exposure dating with 36Cl
Deutschland, Köln, 9.-10.11.2007,Universität zu Köln, 1. Nutzer-Workshop 6 MV Hochleistungs-Beschleuniger-Massenspektrometer

M. Christl, L. Wacker
AMS mit Aktiniden - Messung und Anwendungsbeispiele
Deutschland, Köln, 9.-10.11.2007 Universität zu Köln, 1. Nutzer-Workshop 6 MV Hochleistungs-Beschleuniger-Massenspektrometer

G. Gonani
Radiokarbondatierung von Milligrammproben mit der Beschleunigermassenspektrometrie-Methode (AMS)
Schweiz, Basel, 15.11.2007, Institut für Prähistorische und Naturwissenschaftliche Archäologie (IPNA), Universtät Basel

P. Kubik
Grenzen der Expositionsaltersmethode
Deutschland, Köln, 8.-11.11.2007, Universität zu Köln, 1. Nutzer-Workshop 6 MV Hochleistungs-Beschleuniger-Massenspektrometer

H.-A. Synal
Recent advances and future perspectives of accelerator mass spectrometry
Austria, Vienna, 19.12.2007, University Vienna

DISSERTATION

Emanuel von Wartburg
Messung von Isotopenverhältnissen stabiler Spurenelemente mit Beschleuniger-Sekundärionen Massenspektrometrie
Diss. ETH Nr. 17518

LECTURES AND COURSES

Prof. Dr. Martin Suter
ETH Zürich, SS2007:
- Physikpraktikum für Vorgerückte II
- Vorlesung: Fortgeschrittene Physik für Umwelt- und ErdwissenschaftlerInnen

ETH Zürich, HS2007:
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Dr.Susan Ivy-Ochs
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- Lehrveranstaltung: Geochronologie I

UCN - Ultra-Cold Neutrons

PUBLICATIONS

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A treatment of medium-energy particle induced fission for spallation-systems' calculations
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CONTRIBUTIONS TO CONFERENCES AND WORKSHOPS

M. Daum
A new source for ultracold neutrons at PSI
International Workshop "Ultracold Neutron Sources and Experiments "
TRIUMF, Vancouver (Canada), September 13 – 14, 2007

K.Kirch
Testing gravity with muonium
Poster contribution to the Workshop on Precision Measurements at Low Energy
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arXiv: physics/0702143 (2007)

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The PSI ultracold neutron source
14th International Seminar on Interactions of Neutrons with Nuclei
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Search for the muon electric dipole moment using a compact storage ring
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Amorphous carbon coating for ultracold neutron experiments
European Materials Research Society Spring Meeting
Strassbourg, May 28 – June 1, 2007
M. Kuzniak
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Dubna (Russia), May 16 – 19, 2007

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M. Kasprzak
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M. Kasprzak
Measurement of UCN production and CN transmission of D_2, O_2 and CD_4
International Collaboration on Advance Neutron Sources
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M. Kasprzak
Converters for ultracold neutron sources
57. Jahrestagung der OEPG
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Jahrestagung der ÖPG, Haindorf, Langelois (Austria), September 26- 28, 2007

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Merida, Yucatan (Mexico), July 3 – 11, 2007

E. Suarez-Garcia, N. Produit, W. Hajdas, F. Barao, C. Casella, K. Deiters, S. Deluit, C. Leluc, A. Mtchedlishvili, M. Pohl, D. Rapin, Ch. Tao, J.-P. Vialle, Walter R., Wigger C., Zehnder A.
Probing magnetic fields during black hole creation with next X-ray polarimeter
Poster contribution to the Workshop on Precision Measurements at Low Energy
Paul Scherrer Institut, January 18 – 19, 2007

W. Hajdas, F. Burri, Ch. Eggel, K. Egli, A. Mtchedlishvili, A. Mohamadzadeh, M. Pohl, B. Schmitt, H.-J. Schneider
Miniature low energy electron detector for particle environment studies in space
Poster contribution to the Workshop on Precision Measurements at Low Energy
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S. Santra, L.Barron-Polos, J.D.Bowman, T.T.Chupp., C.Crawford, M.Dabaghyan, M.Dawkins, S.J.Freedman, T.Gentile, M.T.Gericke, R.C.Gillis, G.L.Greene, F.W.Hersman, G.L.Jones, Kandes, S. Lamoreaux, B.Lauss, M.B. Leuschner, R. Mahurin, M.Mason, J.Mei, G.S. Mitchell, H.Nann, S.A.Page, S.I.Penttila, W.D.Ramsey, A.Salas Bacci, P.-N.Seo, M.Sharma, T.B.Smith, W.M.Snow, W.S.Wilburn, H.Zhu
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S. Heule, F. Atchison, M. Daum, A. Foelske, R. Henneck, M. Kasprzak, K. Kirch, A. Knecht, M. Kuzniak, T. Lippert, M. Meier, A. Pichlmaier and U. Straumann
Diamond-like carbon coated ultracold neutron guides
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W. Fetscher et al.
Muon decay: Measurment of the transverse e+ polarization and its implications on G(F) and time reversal invariance
Prepared for 17th International Spin Physics Symposium (SPIN06), Kyoto (Japan), October 2 – 7, 2006
AIP Conf. Proc. 915, 240 – 243 (2007)

W. Hajdas, E. Suares-Garcia, A. Mchedlishvili, C. Wigger an A. Zehnder
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INVITED TALKS

M. Daum
Eine neue Quelle für ultrakalte Neutronen am PSI
Seminarvortrag am Institut für Kernchemie, Johannes-Gutenberg-Universität Mainz, October 2007

K. Kirch
Muon EDM
EDMs and CP-violation, University of Washington, Seattle, March 19, 2007

K. Kirch
Neutron EDM experiment
EDMs and CP-violation, University of Washington, Seattle, March 19, 2007

K. Kirch
Experiments with ultracold neutrons and cold neutrons
CHIPP Plenary Meeting, PSI, October 15, 2007

K. Kirch
Towards a measurement of the neutron EDM at PSI
University Geneva, November 14, 2007
K. Kirch
Proposal to measure the muon electric dipole moment with a compact storage ring at PSI
Université Catholique de Louvain, Louvain-la-Neuve, November 22, 2007

K. Kirch
Fun with UCN
Université Catholique de Louvain, Louvain-la-Neuve, November 23, 2007

M. Kasprzak
Ultracold neutron production and cold neutron transmission for deuterium, oxygen and heavy methane
Instiut für Isotopenforschung und Kernphysik, Wien, October 4, 2007

A. Knecht
A direct experimental limit on neutron – mirror neutron oscillations
Search for baryon and lepton number violations, International Workshop
Berkeley (USA), September 20 – 22, 2007

OUTREACH AND OTHER SCIENTIFIC ACTIVITIES

Knecht, M. Kuzniak
Mirror Matter – Experimental search for neutron to mirror neutron oscillations
SPG Mitteilungen: Progress in Physics, Nr. 22 (2007)

COMMITTEES

M. Daum
- Advisory committee ISINN, JINR Dubna (Russia)

K. Kirch
- Member of the committee of the Swiss Physical Society
- Swiss Correspondent for Nuclear Physics News

R. Henneck
- PSI FoKo

LIST OF PUBLICATIONS

Life Sciences

BIOMOLECULAR RESEARCH

UNIVERSITY LEVEL AND OTHER TEACHING

K. Ballmer-Hofer
Molecular virology
University of Basel, HS 2007

K. Ballmer-Hofer
Cellular Signalling
University of Basel, WS 2006/07

Rolf Jaussi
"Gentechnik" for students in medicine
University of Zurich, SS 2007

Rolf Jaussi
"Molekulare Zellbiologie" for students in life sciences
University of Zurich, WS 2006/07

Xiao-Dan Li
Protein Expression
University of Basel, SS 2007

F.K. Winkler
Molecular Biology and Biophysics III: Proteins: Structure, Function and Engineering
ETH Zurich, WS 2006/2007

F.K. Winkler
Grundlagen der Biologie I
ETH Zurich, SS 2007

PUBLICATIONS

S. Baatout, R. Jaussi, Michaux, A. Buset, J. Schoonjans, W. & P. Jacquet
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In Vivo 21, 587 – 592 (2007)

N. Bergman, K.C. Moraes, J.R. Anderson, B. Zaric, C. Kambach, R.J. Schneider, C.J. Wilusz, J. Wilusz
Lsm proteins bind and stabilize RNAs containing 5' poly(A) tracts
Nat. Struct. Mol. Biol. 14, 824 – 831 (2007)

M.J. Conroy, A. Durand, D. Lupo, X.D. Li, P.A. Bullough, F.K. Winkler, M. Merrick
The crystal structure of the Escherichia coli AmtB-GlnK complex reveals how GlnK regulates the ammonia channel.
Proc. Natl. Acad. Sci. USA 104, 1213 – 1218 (2007)

D. Frey, C. Kambach, M.O. Steinmetz, R. Jaussi
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X. Han, A. Studer, H. Sehr, I., Geissbühler, M. Di Berardino, F.K. Winkler, L.X. Tiefenauer
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C. Kambach
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R. Koller-Eichhorn, T. Marquardt, R. Gail, A. Wittinghofer, D. Kostrewa, U. Kutay, C. Kambach
Human OLA1 defines an ATPase subfamily in the Obg family of GTP-binding proteins
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D. Lupo, X.D. Li, A. Durand, T. Tomizaki, B. Cherif-Zahar, G. Matassi, M. Merrick, F.K. Winkler
The 1.3-Å resolution structure of Nitrosomonas europaea Rh50 and mechanistic implications for NH3 transport by Rhesus family proteins
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Nat. Struct. Mol. Biol. (14), 249 – 250 (2007)

N. Scherr, S. Honnappa, G. Kunz, P. Mueller, R. Jayachandran, F.K. Winkler, J. Pieters, M.O. Steinmetz
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Structure-function relationship of CAP-Gly domains
Nat. Struct. Mol. Biol. (14), 959 – 967 (2007)

A.H.M. Zehnder-Fjällman, C. Marty, C. Halin, A. Hohn, R. Schibli, K. Ballmer-Hofer, R.A. Schwendener
Evaluation of anti-VEGFR-3 specific scFv antibodies as potential therapeutic and diagnostic tools for tumor lymph-angiogenesis
Oncology Reports18, 933 – 941 (2007)

CONFERENCE PROCEEDINGS

K. Ballmer-Hofer
The role of neuropilin-1/VEGFR-2 co-receptor complexes in angiogenic signaling by VEGF
7th ESH Euroconference on Angiogenesis, Albufeira, Portugal, May 11 – 14, 2007

K. Ballmer-Hofer
Structure/function analysis of VEGF-E and VEGF-VEGF Receptor complexes
Basel Signaling Workshop, Villa Clavel, April 2, 2007

R. Jaussi, D.Frey, C.Kambach, M.O. Steinmetz
Low-cost high-throughput cDNA amplification from pseudolibraries
Protein Expression Europe, Prague, Czech Republic, September 27 – 28, 2007

M.O. Steinmetz
Structure-function relationship of CAP-Gly domains
FEBS Workshop, The Biology of Modular Protein Domains, Seefeld in Tirol, Austria, September 8 – 13, 2007

A. Studer, F.K. Winkler, L. Tiefenauer
Monitoring ion diffusion and transport across free-standing lipid bilayers
TETHMEM 2007, Schloss Ringberg, Tegernsee, Germany, September 19 – 22, 2007

A. Studer, L.X. Tiefenauer
Stable planar lipid bilayers in nanopores
Biosurf VII: Functional interfaces for directing biological response, Zurich, Switzerland August 29 – 31, 2007

A. Weisbrich, S. Honnappa, O. Okhrimenko, R. Jaussi, I. Jelesarov, F.K. Winkler, A. Akhmanova, M.O. Steinmetz
Key interaction modes of dynamic +TIP networks
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A. Weisbrich, S. Honnappa, R. Jaussi, O. Okhrimenko, D. Frey, I. Jelesarov, A. Akhmanova, M.O. Steinmetz
Structure-function relationship of CAP-Gly domains
European Life Scientist Organisation (ELSO), Dresden, Germany, September 1 – 4, 2007

DISSERTATIONS

R. Studer
Expression and characterization of the extracellular domain of ligand-gated ion channels and structural studies of the oxaloacetate decarboxylase from Vibrio cholerae
ETH Zurich, Diss-ETH Nr. 17099, 12.3.2007

C. Ruch
Structure function analysis of VEGF receptors
ETH Zürich, Diss-ETH Nr. 17030, 2007

INVITED TALKS

K. Ballmer-Hofer
Structural and functional analysis of VEGF-VEGF receptor complexes, implications for the assembly of co-receptor complexes and for angiogenic signaling
Molecular Partners, University of Zurich, Zurich, Switzerland, March 19, 2007

K. Ballmer-Hofer
Structural and functional analysis of VEGF-VEGF receptor complexes; implications for the assembly of co-receptor complexes and for angiogenic signaling
Université Joseph Fournier, Grenoble, France, March 27, 2007

K. Ballmer-Hofer
Angiogenic signaling by VEGF receptors; the role of co-receptor complexes
Department for Molecular Biomedical Research
Flanders Interuniversity Institute for Biotechnology (VIB), Ghent University, Ghent, Belgium, March 9, 2007

K. Ballmer-Hofer
The role of neuropilin-1/VEGFR-2 co-receptor complexes in angiogenic signaling by VEGF
7th ESH Euroconference on Angiogenesis, Albufeira, Portugal, May 11 – 14, 2007

K. Ballmer-Hofer
Structure /function analysis of VEGF-E and VEGF-VEGF RECEPTOR complexes
EMPA Kolloquium, St. Gallen CH, October 18, 2007

M.O. Steinmetz
Key interaction modes of dynamic +TIP networks
Gordon Conference, Motile and Contractile Systems, New London, NH, USA, July 8 – 13, 2007

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Structure-function relationship of CAP-Gly domains
FEBS Workshop, The Biology of Modular Protein Domains, Seefeld in Tirol, Austria, September 8 – 13, 2007

L. Tiefenauer
Nanopore array chips for functional assay systems of membrane proteins
TETHMEM 2007, Schloss Ringberg, Tegernsee, Germany, September 19 – 22, 2007

L. Tiefenauer
Monitoring the integration of peptides in lipid bilayers
Seminar, Univ. Hamburg, Germany, November 19, 2007

F.K. Winkler
Structural biology today: challenges and examples
Annual Meeting of Swiss Society for Crystallography, PSI Villigen, September 12, 2007

F.K. Winkler
Ammonia transport by the Amt/Rh family proteins
Meeting of the Biophysics Section of the Swiss Biochemical Society 2007, Zürich, September 18, 2007

F.K. Winkler
Structure and mechanism of ammonia channels of the Amt/Rh protein family
Center for Membrane Proteomics - Summer School 2007, Frankfurt, September 29, 2007

F.K. Winkler
Single crystal diffraction in protein crystallography
International school for "Scattering for Biologists", PSI, Villigen, October 23 – 26, 2007

BOOK CHAPTERS

K. Ballmer-Hofer, R.A. Schwendener
Antibody-modified Liposome Therapy
In J. Berek & G. Coukos (eds.) *Antibody Therapy of Gynecological Cancer*
Summit Communications, 2007 (in press)

L.X. Tiefenauer
Magnetic nanoparticles as contrast agents for medical diagnosis
In T. Vo-Dinh (ed.) *Nanotechnology in biology and medicine, methods devices, and applications*
CRC Press, Taylor & Francis, Chapt. 29, pp. 1 – 20, 2007

LIST OF PUBLICATIONS

Life Sciences

CENTER FOR RADIOPHARMACEUTICAL SCIENCE OF ETH, PSI AND USZ

TEACHING ACTIVITIES

A. Schubiger, A. Ametamey, R.Schibli
Einführung in die pharmazeutischen Wissenschaften II
ETH Zurich, HS07

A. Schubiger, S. Ametamey, R. Schibli
Radiopharmazeutische Chemie
ETH Zurich, WS07

A. Schubiger
CIMST Interdisciplinary Summer school
ETH Zurich, 2007

S, Ametamey
Einführung in die pharmazeutischen Wissenschaften I
ETH Zurich, WS07

R. Schibli, A. Ametamey
CIMST Interdisciplinary Summer school
ETH Zurich, 2007

R. Schibli
Metal Based Drug and Drug Development
ETH Zurich, SS07

R. Schibli
Practicum Medicinal Chemistry
ETH Zurich, HS07

PUBLICATIONS

E. García Garayoa, R. Schibli, P.A. Schubiger
Peptides radiolabelled with Re-186/188 and Tc-99m as potential diagnostic and therapeutic agents
Nuclear Science and Techniques 18, 88 – 100 (2007)

E. García Garayoa, C. Schweinsnerg, V. Maes, D. Rüegg, A. Blanc, P. Bläuenstein, D. Tourwé, A.G. Beck-Sickinger, P.A. Schubiger
New ^{99m}Tc-bombesin analogues with improved biodistribution for targeting GRP receptor-positive tumors
Q. J. Nucl. Med. 51, 42 – 50 (2007)

E. García Garayoa, D. Rüegg, P. Bläuenstein, M. Zwimpfer, I.U. Khan, V. Maes, A. Blanc, A.G. Beck-Sickinger, D. Tourwé, P.A. Schubiger
Chemical and biological characterization of new $Re(CO)_3$/[^{99m}Tc]$(CO)_3$ bombesin analogues
Nucl. Med. Biol. 34, 17 – 28 (2007)

K. Knogler, J. Grunberg, K. Zimmermann, S. Cohrs, M. Honer, S. Ametamey, P. Altevogt, M. Fogel, P.A. Schubiger, I. Novak-Hofer
Copper-67 radioimmunotherapy and growth inhibition by anti-L1-cell adhesion molecule monoclonal antibodies in a therapy model of ovarian cancer metastasis
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M. Honer, A. Stoffel, L.J. Kessler, P.A. Schubiger, S.M. Ametamey
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A.H.M. Zehnder-Fjällmann, C. Marty, C. Halin, A. Hohn, R. Schibli, K. Ballmer-Hofer, R. A. Schwendener
Evaluation of anti-VEGFR-3 specific scFv antibodies as potential therapeutic and diagnostic tools for tumor lymph-angiogenesis
Oncology Reports 18, 933 – 941 (2007)

C. Müller, P.A. Schubiger, R. Schibli
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Nucl. Med. Biol. 34, 595 – 601 (2007)

C. Müller, R. Schibli, F. Forrer, E.P. Krenning, M. de Jong
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Nucl. Med. Biol. 34, 603 – 608 (2007)

M. Stichelberger, D. Desbouis, V. Spiwok, L. Scapozza, P.A. Schubiger, R. Schibli
Synthesis, in vitro and in silico assessment of organometallic Rhenium(I) and Technetium(I) thymidine complexes
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D. Desbouis, P.A. Schubiger, R. Schibli
Synthesis of tricarbonyl rhenium and technetium complexes of a 5’-carboxamide 5-ethyl-2’-deoxyuridine for selective inhibition of herpes simplex virus thymidine kinase 1
J. Organomet. Chem. 692,(2007) 1340 – 1347 (2007)

T. Mindt, H. Struthers, E. Garcia-Garayoa, D. Desbouis, R. Schibli
Strategies for the development of novel tumor targeting technetium and rhenium radiopharmaceuticals
Chimia 61, 725 – 731 (2007)

Th. L. Mindt, R. Schibli
Cu(I)-Catalyzed intramolecular cyclization of alkynoic acids in aqueous media: A “click side reaction”
Journal of Organic Chemistry 72, 10247 – 10250 (2007)

A. Hohn, K. Zimmermann, E. Schaub, W. Hirzel, P.A. Schubiger, R. Schibli
Production and separation of "non-standard" PET nuclides at a large cyclotron facility: The experience at the Paul Scherrer Institute Switzerland
Q. J. Nucl. Med. 51, 1 – 6 (2007)

S.M. Ametmey, V. Treyer, J. Streffer, M.T. Wyss, M. Schmidt, M. Blagoev, S. Hintermann, Y.P. Auberson, F. Gasparini, U. Fischer, A.. Buck
Human PET studies of metabotropic glutamate receptor subtype5 with [^{11}C]-ABP688
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M.T. Wyss, S.M. Ametamey, V. Treyer, A. Bettio, M. Blagoev, L.J. Kessler, C. Burger, B. Weber, M. Schmidt, F. Gasparini, A. Buck
Quantitative evaluation of ^{11}C-ABP688 as PET ligand for the measurement of the metabotropic glutamate receptor subtype 5 using autoradiographic studies and a beta-scintillator
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V. Treyer, J. Streffer, M. T. Wyss, A. Bettio, S. M. AMETAMEY, U. Fischer, M. Schmidt, F. Gasparini, C. Hock, A. Buck
Evaluation of the metabotropic glutamate receptor subtype 5 using PET and [^{11}C]-ABP688, assessment of methods
J. Nucl Med. 48, 1207 – 1215 (2007)

M.T. Birchler, C. Thuerl, D. Schmid, D. Neri, R. Waibel, P.A. Schubiger, S.J. Stoeckli, S. Schmid, G.W. Goerres
Immunoscintigraphy of patients with head and neck carcinomas, with an anti-angiogenetic antibody fragment
Otolaryngol. Head Neck Surg 136, 543 – 548 (2007)

BOOK CHAPTERS

S.M. Ametamey**,** P. Blauenstein and P.A. Schubiger
PET radiopharmaceuticals-perfusion compounds ^{13}N-ammonia, ^{15}O-water and ^{82}Rubidium and other generator products of clinical relevance
In G. von Schulthess (ed.) Molecular Anatomic Imaging, Lippincott Williams & Wilkins, Chapter 16 (2007)

P.A. Schubiger, L. Lehmann, M. Friebe
PET chemistry, the driving force in molecular imaging
Ernst Schering Research Foundation, Workshop 62 (2007)

INVITED TALKS

P.A. Schubiger
Molecular imaging with (animal) PET- open issues and answers
Universität Münster, SFB Veranstaltungsreihe, June 13, 2007

P.A. Schubiger
Molecular imaging of biochemical function using (small animal) PET
25th Anniversary SGMS Meeting, Beatenberg, October 24 – 26, 2007

P.A. Schubiger
Molecular imaging at the CRS
Shanghai Institute of Applied Physics, September 3, 2007

P.A. Schubiger
Molekulare Bildgebung mit PET
Collegium Helveticum, Forum Molekulare Wissenschaften, May 23, 2007

R. Schibli
Current development of novel radiodiagnostics and radiotherapeutics for tumor targeting at the Center for Radiopharmaceutical Sciences (CRS)
Kolloquium, Forschungszentrum Rossendorf, Dresden, Germany, January 15, 2007

R. Schibli
Radioaktive trojanische Pferde: Entwicklung neuartiger Folsäurederivate für die Tumordiagnose mittels PET und SPECT
Januar-Symposium Radiopharmazie & Nuklearmedizin am Kantonsspital Aarau, January 19, 2007

R. Schibli
"Non-standard" PET nuclides: experience at the Paul Scherrer Institute
Workshop on the Production and Application of "Non-Standard" PET Nuclides, Aachen, Germany, April 29, 2007

R. Schibli
Molecular (radio)therapy: radiopharmaceutical perspectives
European Association of Nuclear Medicine Annual Congress 2007, Copenhagen, Denmark, October 13 – 17, 2007

R. Schibli
New approaches for the development of molecular imaging probes using "click"-chemistry
Gruppo Interdisciplinare di Chimica dei Radiofarmaci, 2°Congresso Nazionale, Roma, Italy, October 5 – 6, 2007

R. Schibli
Die Bedeutung der Radiopharmazie im Zeitalter der molekularen Bildgebung
Kolloquium der Pharmazeutischen Gesellschaft Zürich, Zurich, November 22, 2007

R. Schibli
Radiolabeled vitamin B12: a promising tool for diagnosis of tumors and infections?
Infektiologie und Spitalhygiene, Basel, December 11, 2007

S.M.Ametamey
Glutamat-Rezeptor-Tracer für PET
Januar-Symposium Radiopharmazie & Nuklearmedizin, Aarau, Switzerland, January 19, 2007

S.M. Ametamey
Molecular imaging with PET tracers and animal PET scanner
Swiss Physical Society, Zurich, Switzerland, February 20 – 21, 2007

S.M. Ametamey
Glutamate receptor imaging
10th Anniversary of MipTec, Basel, Switzerland, May 7 – 10, 2007

S.M. Ametamey
PET radioligand development for the imaging of a CNS target
CIMST Summer School, ETH Zurich, Switzerland, June 25 – July 6, 2007

M. Honer
Radiolabeling, in vitro and in vivo evaluation of [^{18}F]-FE-DABP688 as a PET radioligand for the metabotropic glutamate receptor subtype 5 (mGluR5)
AMI/SMI Joint Molecular Imaging Conference, Providence, USA, September 7 – 11, 2007

M. Honer
Small animal PET imaging at the Animal Imaging Center of ETH Zurich
GE User Meeting, Versailles, France, November 15, 2007

CONFERENCE PROCEEDINGS

T.L. Mindt, T. Ross, R. Schibli
Efficient strategy for the parallel development of multiple modality imaging probes using "click chemistry"
17th International Symposium on Radiopharmaceutical Sciences, Aachen, Germany, April 30 – May 4, 2007

T.L. Ross, T. Mindt, S. Baumann, A. Weber, V. Groehn, M. Honer, R. Schibli, P.A. Schubiger, S.M. Ametamey
Radiosynthesis of ^{18}F-labelled folic acid derivatives using a direct method and "click chemistry"
17th International Symposium on Radiopharmaceutical Sciences, Aachen, Germany, April 30 – May 4, 2007

C. Mueller, F. Forrer, R. Schibli, M. Melis, E.P. Krenning, M. De Jong
Effects of the antifolate Pemetrexed on radiofolate uptake and distribution in FR-positive tumors and kidneys
17th International Symposium on Radiopharmaceutical Sciences, Aachen, Germany, April 30 – May 4, 2007

S. Jeger, A. Blanc, K. Zimmermann, S. Cohrs, I. Novak-Hofer, A. Hohn, R. Schibli
Towards single species radioimmunoconjugates using a novel enzymatic antibody functionalization strategy
15. Arbeitstagung der Arbeitsgemeinschaft Radiochemie/Radiopharmazie, Morschach, Switzerland, September, 2007

C Schweinsberg, L Brans, V Maes, T L Mindt, E García Garayoa, P Bläuenstein, D Tourwé, P A Schubiger, R Schibli
'*Click'-chemistry for modification and functionalization of bombesin analogues*
15. Arbeitstagung der Arbeitsgemeinschaft Radiochemie/Radiopharmazie, Morschach, Switzerland, September, 2007

E. Garcia Garayoa, C. Schweinsberg, V. Maes, A. Blanc, P. Bläuenstein, D. Tourwé, R. Schibli, P. A. Schubiger
Improvement of the in vivo distribution of radiolabeled bombesin analogues by glycation
European Association of Nuclear Medicine Annual Congress 2007, Copenhagen, Denmark, October 13 – 17, 2007

E. Garcia Garayoa, C. Schweinsberg, V. Maes, A. Blanc, P. Bläuenstein, D. Tourwé, R. Schibli, P. A. Schubiger
Double targeting of prostate cancer xenografts with radiolabeled neurotensin and bombesin analogues
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"An Uncertainty Assessment Technique for Material Behaviour in Advanced FAST Reactors", OECD/NEA Workshop on Structural Materials for Innovative Nuclear Systems (SMINS), 4-6 June 2007, Karlsruhe, Germany

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"LUCIA & microXAS: Enlightening Environmental Problems", SLS Symposium Series, Paul Scherrer Institut, 6 February 2007, Villigen, Switzerland
[1] LURE, Paris, FR

BORCA C., CANULESCU S., LOVIAT F., LIPPERT T., GROLIMUND D., DOEBELI M., WAMBACH J., WOKAUN A.
"Analysis of the electronic configuration of the pulsed laser deposited $La_{0.7}Ca_{0.3}MnO_3$ thin films", European Materials Research Society – EMRS, 27 May - 1 June 2007, Strasbourg, France

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"Some aspects of the long-term safety of a HLW/SF radioactive waste repository", Invited Talk, Vertiefungskurs Management radioaktiver Rückstände, Nuklear Forum Zurich, 22-23 November 2007, Zürich, Switzerland

BRADBURY M.H., BAEYENS B.
"Correspondence between sorption measured on compacted and dispersed systems and sorption model predictions", Invited Talk, 3rd Int. Meeting on Clays in Natural & Engineered Barriers for Radioactive Waste Confinement, 17-20 September 2007, Lille, France

BURGHERR P.
"Schwere Unfälle im Energiesektor", Invited Talk, Risk Solution Network AG, 28-29 June 2007, Martigny, Switzerland

BURGHERR P.
"Security and safety aspects in the oil and gas energy chains", Invited Talk, Working Group 1 on Energy Infrastructure Security, 5th EAPC/PfP Workshop on Critical Infrastructure Protection and Civil Emergency Planning: Comprehensive Views on Resilient Infrastructures, 1-3 October 2007, Zurich, Switzerland

BURGHERR P.
"Threats and risks of critical infrastructure elements in O&G energy chains", Invited Talk, IPC Seminar 2007: security of supply and the protection of gas critical infrastructure, Industrial Planning Committee (IPC) of NATO in EAPC (Euro-Atlantic Partnership Council) Format, Industrial Planning Committee, 6-7 November 2007, Bucharest, Romania

BURGHERR P., HIRSCHBERG S.
"Severe accidents in the oil chain with emphasis on oil spills", Invited Talk, Conf. on Petroleum Supply Chain and Safety & Security of Energy Infrastructures in a Comparative View (PETROSEC & SEIF-CV), 16-19 September 2007, Salzburg, Austria

BURGHERR P., HIRSCHBERG S.
"Severe accidents in the energy sector", Keynote Address – energy security, 5th EAPC/PfP Workshop on Critical Infrastructure Protection and Civil Emergency Planning: Comprehensive Views on Resilient Infrastructures, 1-3 October 2007, Zurich, Switzerland

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CAVEDON J.M.
"Nucléaire, une énergie du présent…et du futur", Invited Talk, Séminaire Energie, economiesuisse, 21 June 2007, Lausanne, Switzerland

CAVEDON J.M.
"Nuclear reactors as seen by a physicist", Invited Talk, Materials for Generation IV Nuclear Reactors, NATO Advanced Study Institute, 24 September - 6 October 2007, Cargese, France

CAVEDON J.M.
"Closed fuel cycles and new reactor concepts", Invited Talk, Vertiefungskurs Management radioaktiver Rückstände, Nuklearforum Schweiz, 22-23 November 2007, Zurich, Switzerland

CHURAKOV S.
"Ab initio modelling of cement phases", Invited Talk, EMPA, 22 May 2007, Dübendorf, Switzerland

CUI D.[1], PURANEN A.[2], SCHEIDEGGER A.M., WIELAND E., SPAHIU K.[3]
"Se-Tc immobilization on the iron canister material under near field conditions", 11th Int. Conf. on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere: Migration 2007, 26-31 August 2007, Munich, Germany
[1] Studsvik Nuclear AB, Nyköping, SE
[2] KTH, Stockholm, SE
[3] SKB, Stockholm, SE

DÄHN R.

"Investigations of the cement heterogeneity by scanning transmission X-ray microscopy", Invited Talk, CEMNET Meeting, University of Berne, 14 March 2007, Berne, Switzerland

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"Investigations of the cement heterogeneity using scanning X-ray microscopy (STXM)", Invited Talk, CEMNET Workshop on Cement Research at Large-Scale Facilities, Paul Scherrer Institut, 10 September 2007, Villigen, Switzerland,

DANG V.N.
"PSA scenario modeling and representation — a view based on dynamic PSA research", Next Generation PSA Software, Declarative Modeling and Model Representation Standards, Open PSA Initiative, 12 June 2007, Däniken, Switzerland

DANG V.N.
"Comparison Process and Results — Identification of Driving Factors"; "Overall methodology of the Empirical HRA Study", Workshop on the International Empirical HRA Study, USNRC, 23-25 October 2007, Bethesda, USA

DEGUELDRE C.
"Colloids studies by single particle analysis and single-site modeling", Invited Talk, McGill University, 20 June 2007, Montreal, Canada

DEGUELDRE C.
"Study of corrosion layers at the nanoscale using non-invasive techniques", Univ. of Toronto, 22 June 2007, Toronto, Canada

DEGUELDRE C.
"Colloid analysis by single particle inductively coupled plasma – mass spectroscopy", Euro Analysis XIV, 9-14 September 2007, Antwerp, Belgium

DEGUELDRE C.
"Analysis of colloids by ICP-MS in a single particle mode: results on Al_2O_3, gold, and UO_2 colloids", Invited Talk, University of California, Berkeley, 3 October 2007, Berkeley, USA

DEGUELDRE C.
"Modelling and testing the colloid generation/elimination dynamic processes toward a pseudo-equilibrium", Colloid Workshop, KTH, 15-16 November 2007, Stockholm, Sweden

DONES R.
"Life-Cycle Assessment (LCA): PSI Studies and Applications in Comprehensive Assessment of Energy Systems", Invited Talk, Consultancy: managing the paradigm shift from end-of-the-pipe remediation to life-cycle management, IAEA, 29 October 2007, Vienna, Austria

DURIEZ C.[1], STEINBRÜCK J.[2], OHAI D.[3], MELEG T.[3], BIRCHLEY J., HASTE T.
"Separate-Effect Tests on Zirconium Cladding Degradation in Air Ingress Situations", European Review Meeting on Severe Accident Research (ERMSAR2007), FZK, 12-14 June 2007, Karlsruhe, Germany
[1] IRSN, Aix-en-Provence, FR
[2] FZK, Karlsruhe, DE
[3] INRNE, Sofia, RO

EPINEY A., PELLONI S., CODDINGTON P., CHAWLA R.
"Comparative Analysis for the Initial Cycle of two Generation IV GCFR Cores (600 MWth) Operating with Innovative CERCER Type Fuel", 9th IEM on Actinide and Fission Product Partitioning and Transmutation, OECD, 25-29 September 2007, Nimes, France

FELDER R., DONES R.
"Ecological impacts of Synthetic Natural Gas (SNG) from wood used in current heating and car systems.", Poster, 3rd Int. Conf. on Life Cycle Management – from analysis to implementation, 27-29 August 2007, Zurich, Switzerland

FERROUKHI H., HOLLARD J.M., ZERKAK O., CODDINGTON P.
"PWR Cell Calculations using APOLLO-2 within the NURESIM Benchmark Framework", Winter Meeting, American Nuclear Society, 11-15 November 2007, Washington D.C., USA, Vol. 97, 703-704, 2007

FOSKOLOS K.
"Renaissance der nuklearen Fernwärme?", Invited Talk, Fernwärme-Fachtagung, 18 January 2007, Biel, Switzerland

FOSKOLOS K.
"Kernenergie: Technologie für die nächsten 100 Jahre", Invited Talk, Rotary Club Zürich-West, 13 March 2007, Zürich, Switzerland

FOSKOLOS K.

"Innovation in Nuclear Energy Technology", Invited Talk, OECD/NEA Nuclear Development Committee, 21 June 2007, Paris, France

FOSKOLOS K.
"Nuclear Fuel Cycle and Generation IV Perspectives in Switzerland", 10th SAC Seminar of Int. Sci. and Techn. Centre (ISTC): Advanced Nuclear Fuel Cycle for the 21st Century, 26 September 2007, Nizhny Novgorod, Russia

FOSKOLOS K.
"Kernenergie in der Schweiz: das Volk entscheidet", Invited Talk, Kiwanis Club Wädenswil, 21 November 2007, Wädenswil, Switzerland,

FRISCHKNECHT R.[1], ALTHAUS H.J.[2], DONES R., HISCHIER R.[3], JUNGBLUTH N.[1], NEMECEK T.[4], PRIMAS A.[5], WERNET G.[6]
"Renewable Energy Assessment within the Cumulative Energy Demand Concept: Challenges and Solutions", Poster, 14th European Case Studies Symposium of the Society of Environmental Toxicology and Chemistry (SETAC), 3-4 December 2007, Göteborg, Sweden, 51-54, 2007.
[1] ESU-Services, Uster, CH
[2] EMPA, Dübendorf, CH
[3] EMPA, St. Gallen, CH
[4] Agroscope FAL, Reckenholz, CH
[5] Basler & Hofmann, Zurich, CH
[6] ETHZ, Zurich, CH

FROIDEVAL A., DEGUELDRE C., SEGRE C.[1], POUCHON M.A., GROLIMUND D.
"XANES study of niobium in the corrosion layer of cladding materials", 8th SLS Users' Meeting 2007, Paul Scherrer Institut, 11-12 September 2007, Villigen, Switzerland
[1] IIT, Chicago, US

FROIDEVAL A., IGLESIAS R., SAMARAS M., SCHUPPLER S.[1], GROLIMUND D., VICTORIA M.[2], HOFFELNER W.
"Element-resolved magnetic and structural study of Fe-Cr alloys: PEEM-XMCD and EXAFS investigations versus ab initio calculations", Hercules Specialized Course (HSC-4) on Application of neutron and synchrotron radiation to magnetism, Marie Curie conferences and training courses (ESRF/EMBL/ILL), 6-12 May 2007, Grenoble, France
[1] FZK, Karlsruhe, DE
[2] Polytech. University of Madrid, ES

FROIDEVAL A., IGLESIAS R., SAMARAS M., SCHUPPLER S.[1], NAGEL P.[1], GROLIMUND D., VICTORIA M.[2], HOFFELNER W.
"Relation between local structure and Fe orbital and spin moments in Fe-Cr alloys: PEEM, XMCD and EXAFS investigations", 3rd CHIRALTEM Workshop — bringing together two communities: magnetic dichroism by electrons and photons, TASC-INFM-CNR, 31 May - 1 June 2007, Trieste, Italy
[1] FZK, Karlsruhe, DE
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"Element-resolved magnetic and structural study of Fe-Cr alloys", Eur. Congr. and Exhibition on Advanced Materials and Processes (EUROMAT 2007), 10-17 September 2007, Nuremberg, Germany
[1] FZK, Karlsruhe, DE
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"Compositional dependence of structure and magnetism in Fe-Cr alloys: PEEM-XMCD and EXAFS experiments versus ab initio calculations", 8th SLS Users' Meeting 2007, Paul Scherrer Institut, 11-12 September 2007, Villigen, Switzerland
[1] FZK, Karlsruhe, DE
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"Magnetic and structural properties of Fe-Cr alloys: PEEM-XMCD and EXAFS experiments versus ab initio calculations", 6th ANKA Users' Meeting 2007, FZK, 1-2 October 2007, Karlsruhe, Germany
[1] FZK, Karlsruhe, DE
[2] Polytech. University of Madrid, ES

FROIDEVAL A., IGLESIAS R., SAMARAS M., SCHUPPLER S.[1], NAGEL P.[1], GROLIMUND D., VICTORIA M.[2], HOFFELNER W.
"The interplay between magnetism and structure in Fe-Cr alloys: PEEM-XMCD, EXAFS and ab initio calculations", 13th Int. Conf. on Fusion Reactor Materials, CEA, 10-14 December 2007, Nice, France
[1] FZK, Karlsruhe, DE
[2] Polytech. University of Madrid, ES

GAVILLET D.
"Analysis of complex nuclear materials with the PSI shielded analytical instruments", European Working Group on Hot Laboratories and Remote Handling, 20-21 September 2007, Bucharest, Romania.

GIMMI T.

“DR experiment Mont Terri: model comparisons and comparisons with first data”, Int. Meeting on Mont Terri DI-A, DR field scale experiments, ANDRA, 11-13 June 2007, Bure, France

GLAUS M., MÜLLER W., VAN LOON L.R.
“Diffusion of iodide and iodate through Opalinus Clay: monitoring of the redox state using an anion chromatographic technique”, Int. Workshop on Mobile Fission and Activation Products in Nuclear Waste (MOFAP), 16-19 January 2007, La Baule, France

GLAUS M., ROSSÉ R., VAN LOON L.R.
“Diffusive properties of stainless steel filter discs before and after use in diffusion experiments with compacted clays”, 3rd Int. Meeting on Clays in Natural & Engineered Barriers for Radioactive Waste Confinement, 17-20 September 2007, Lille, France

GLAUS M., VAN LOON L.R., SCHWYN B.[1], VINES S.[2], WILLIAMS S.[3], LARSSON P.[3], PUIGDOMENECH I.[3]
“Long-term predictions of the concentration of α-isosaccharinic acid in cement pore water”, 31st Int. Symp. on the Scientific Basis for Nuclear Waste Management (MRS 2007), 16-21 September 2007, Sheffield, United Kingdom
[1] NAGRA, Wettingen, CH
[2] NDA, Harwell, UK
[3] SKB, Stockholm, SE

GONZALÉZ F., JURANYI F., GIMMI T., VAN LOON L.R., UNRUH T.[1]
“Translational diffusion of water in charged and uncharged clays”, 4th European Conf. on Neutron Scattering, 25-29 June 2007, Lund, Sweden
[1] Forschungsneutronenquelle Heinz Maier-Leibnitz, Garching, DE

GROLIMUND D.
“Synchrotron-based 2D imaging using X-ray fluorescence and absorption”, Invited Talk, European training school on the analysis of ancient artefacts using synchrotron radiation, SOLEIL Synchrotron Source, 12-16 March 2007, Paris, France

GROLIMUND D., JANOUSCH M., NACHTEGAAL M.
“The XAS beamlines at the Swiss Light Source (SLS)”, Invited Talk, 2nd Int. Workshop on X-ray spectroscopic and microscopic methods, Paul Scherrer Institut, 28 February - 1 March 2007, Villigen, Switzerland

GROLIMUND D., VAN LOON L.R., BORCA C., GÜNTHER D.[1], BARMETTLER K.[1], WERSIN P.[2], HEALD S.[3]
“Contaminant transport in complex heterogeneous geological media: retardation — new insights through micro-imaging and micro-spectroscopy”, Int. Meeting on Mont Terri DI-A, DR field scale experiments, ANDRA, 11-13 June 2007, Bure, France
[1] ETHZ, Zurich, CH
[2] NAGRA, Wettingen, CH
[3] PNC-CAT, Chicago, US

GUENTAY S., TROMM W.[1], MIASSOEDOV A.[1]
“Phänomene schwerer Unfälle”, Schulungskurs, Paul Scherrer Institut, 27-28 November 2007, Villigen, Switzerland
[1] FZK, Karlsruhe, DE

GÜNTHER-LEOPOLD I., KIVEL N., KOBLER WALDIS J., WERNLI B.
“ICP-MS as a perfect tool for the characterization of nuclear fuel samples?”, European Winter Conference on Plasma Spectrochemistry, ICP Information Newsletter Inc., 18-23 February 2007, Taormina, Italy,

HARDEGGER P.
“Energieforschung und das PSI”; “Zukunft der Kernenergie in der Schweiz”, Invited Talks, Risk Solution Network AG, 28-29 June 2007, Martigny, Switzerland

HASTE T., BIRCHLEY J., LIAO Y.
“Progress with understanding of zircaloy/air oxidation: status August 2007”, CSARP and MELCOR MCAP Technical Review Meetings, NRC, 18-20 September 2007, Albuquerque, USA

HASTE T., GIORDANO P.[1], HERRANZ L.[2]
“Overview of SARNET Activities in the Source Term Area”, European Review Meeting on Severe Accident Research (ERMSAR2007), FZK, 12-14 June 2007, Karlsruhe, Germany
[1] IRSN, St Paul lez Durance, FR
[2] CIEMAT, Madrid, ES

HECK T.
“China’s energy supply and its environmental impacts”, Invited Talk, Swiss Physical Society (SPS) Annual Meeting, Uni Zurich, 20-21 February 2007, Zurich, Switzerland

HERMANN A., YAGNIK S.K.[1], GAVILLET D.
“Effect of Local Hydride Accumulations on Zircaloy Cladding Mechanical Properties”, 15th Int. Symp. on Zirconium in the Nuclear Industry, American Society for Testing and Materials (ASTM), 24-28 June 2007, Sunriver, USA
[1] EPRI, Palo Alto, US

HIRSCHBERG S.
"The Potential of Nuclear Energy. Global Perspectives on Energy Security Conference", Invited Talk, Swiss Re Centre for Global Dialogue, 8-9 March 2007, Rüschlikon, Switzerland

HIRSCHBERG S.
"Stakeholder Preference Analysis and Survey Programme", Invited Talk, NEEDS Second Policy Workshop, 9 March 2007, Ljubljana, Slovenia

HIRSCHBERG S.
"Can Sustainability of Energy Systems be Measured?", Invited Talk, Studiengruppe Energieperspektiven, 22 March 2007, Baden, Switzerland

HIRSCHBERG S.
"Electricity Supply Options in Focus: Sustainability and Perspectives for the Future", Invited Talk, EMPA-Kolloquium, EMPA, 24 April 2007, Dübendorf, Switzerland

HIRSCHBERG S.
"Comparative Perspective on Current and Future Energy Supply", Invited Talk, ETHZ Seminar, 8 May 2007, Zurich, Switzerland

HIRSCHBERG S.
"Kernenergie im Vergleich mit anderen Stromerzeugungstechnologien", Invited Talk, Forum in Berlin, 11 June 2007, Berlin, Germany,

HIRSCHBERG S.
"Impact of Efficiency Improvements on the Overall Energy System", Energy Trialog Workshop, Paul Scherrer Institut, 20-22 June 2007, Villigen, Switzerland

HIRSCHBERG S.
"NEEDS Status with Emphasis on Technology Roadmap and Stakeholder Perspectives", Invited Talk, Axpo MCDA Workshop, 26 June 2007, Böttstein, Switzerland

HIRSCHBERG S.
"Versorgungsicherheit: Technologische Alternativen und ihre Charakteristika", Invited Talk, AGORA-Tagung, 28 June 2007, Solothurn, Switzerland

HIRSCHBERG S.
"Energy Externalities: Approaches, Insights, Limitations and Security of Supply Issues", Invited Talk, NEEDS FORUM 2: Energy Supply Security – Present and Future Issues, 5-6 July 2007, Krakow, Poland

HIRSCHBERG S.
"Die Energieversorgung der Schweiz in der Zukunft", Invited Talk, Rotary Club Zurzach-Brugg, 22 October 2007, Zurzach, Switzerland

HIRSCHBERG S.
"Einschätzung konkreter Energieeffizienz-Potentiale", Invited Talk, Trialog I Event, Energy Trialog, 26-27 November 2007, Baden, Switzerland

HOGAN K.[1], LIAO Y., VIEROW K.[1], COLE R.[2], GAUNT R.[2]
"Implementation of a New Diffusion Layer Model for Condensation with Non-Condensible Gas into MELCOR", 2007 ANS/ENS Int. Meeting and Nuclear Technology Expo, 11-15 November 2007, Washington, USA
[1] Texas A&M University, College Station, US
[2] SNL, Albuquerque, US

HORVATH M.I., GUILLONG M., IZMER A., KIVEL N., RESTANI R., GÜNTHER-LEOPOLD I., HELLWIG C., GÜNTHER D.[1]
"Characterisation of the Fission Gas Distribution in High Burn-Up Fuel", European Winter Conference on Plasma Spectrochemistry, ICP Information Newsletter Inc., 18-23 February 2007, Taormina, Italy
[1] ETHZ, Zurich, CH

HUMMEL W.
"Organics & Strategy of TDB update", Meeting of the TDB III ad-hoc group for the preparation of a new phase of NEA TDB, Int. Workshop on Mobile Fission and Activation Products in Nuclear Waste (MOFAP), 16-19 January 2007, La Baule, France

HUMMEL W.
"Tschernobyl und die Folgen aus umweltchemischer Sicht", Habilitationsvortrag, ETHZ, 26 January 2007, Zurich, Switzerland

HUMMEL W.
"Geochemische Aspekte in der Sicherheitsanalyse des Schweizer Projekts Opalinuston", Invited Talk, Workshop des Verbundprojektes Wechselwirkung und Transport von Actiniden im natürlichen Tongestein unter

Berücksichtigung von Huminstoffen und Tonorganika, 3. Actinidenverbund-Projekttreffen, 11-12 October 2007, Saarbrücken, Germany,

HUMMEL W.
"Nukleare Umweltchemie: Wissenschaft im Schatten von Tschernobyl?", Antrittsvorlesung, ETHZ, 17 October 2007, Zurich, Switzerland

IGLESIAS R., SAMARAS M., FROIDEVAL A., VICTORIA M.[1], HOFFELNER W.
"Spin and orbital surface and bulk magnetism of Fe-Cr alloys", 3rd CHIRALTEM Workshop, TASC-INFM-CNR, Elettra, Basovizza, 31 May - 1 June 2007, Trieste, Italy
[1] Polytech. University of Madrid, ES

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"Spin and Orbital Magnetism in Fe-Cr Alloys", EUROMAT, 2007 European Congr. on Advanced Materials and Processes, Federation of European Materials Societies (FEMS), 10-13 September 2007, Nuremberg, Germany
[1] Polytech. University of Madrid, ES

IZMER A.[1], CARUSO S.[2], KIVEL N., RESTANI R., HORVATH M.I., GÜNTHER-LEOPOLD I.
"Determination of the caesium distribution in high burnup fuel samples with different analytical techniques", European Winter Conference on Plasma Spectrochemistry, ICP Information Newsletter Inc., 18-23 February 2007, Taormina, Italy
[1] Trent University, Peterborough, CA
[2] KKB, Döttingen, CH

JUNGBLUTH N.[1], DONES R., FRISCHKNECHT R.[1]
"Life-Cycle Assessment of Photovoltaics: Update of the ecoinvent Database", 2007 Materials Research Society (MRS) Fall Meeting, 26-30 November 2007, Boston, USA
[1] ESU-Services, Uster, CH

KAPULLA R.
"Optische Strömungsmesstechnik", Invited Talk, Gemeinschaftslabor für Elektronenmikroskopie, Aachen University of Technology, 11-12 January 2007, Aachen, Germany

KAPULLA R.
"PIV-Grundlagen", 4. PIV/LIF User Meeting, Dantec Dynamics GmbH, 15-16 May 2007, Cologne, Germany

KAPULLA R.
"PIV-Grundlagen und Anwendungen am Paul Scherrer Institut", Informationsveranstaltung Strömungs- und Turbulenzmesstechnik, Dantec Dynamics GmbH, 26 June 2007, Zürich, Switzerland

KAPULLA R., TRAUTMANN M., HERNANDEZ SANCHES S., CALVO ZARAGOZA S., HOFSTETTERE S., HÄFELI C., GUENTAY S.
"Droplet Size Distribution Measurements Using Phase-Doppler Anemometry and Shadowgraphy: Quantitative Comparison", German Assoc. for Laser Anemometry (GALA), 15. Fachtagung Lasermethoden in der Strömungstechnik, University of Rostock, 4-6 September 2007, Rostock, Germany

KHVOSTOV G., ROMANO A., ZIMMERMANN M.A.
"Modeling the effects of axial fuel relocation in the IFA-650.4 LOCA simulation test", 2007 Enlarged Halden Project Group Meeting, 11-16 March 2007, Storefjell, Norway, CD-ROM, 2007

KHVOSTOV G., ZIMMERMANN M.A., STOENESCU R.
"Analysis of KKL High Burn-up Fuel Behaviour During Power Ramps Performed within the SCIP Project", SCIP Workshop on Modelling of Fuel Rod Behaviour, Studsvik Scandpower, 18-19 June 2007, Nyköping, Sweden

KIVEL N., GUILLONG M.[1], GÜNTHER-LEOPOLD I., HELLWIG C.
"Analysis of thin platinum layers by laser ablation ICP-MS", European Winter Conference on Plasma Spectrochemistry, ICP Information Newsletter Inc., 18-23 February 2007, Taormina, Italy
[1] ETHZ, Zurich, CH

KOSAKOWSKI G.
"Stirbt das Tote Meer?", Habilitationsvortrag, Universität Tübingen, 20 June 2007, Tübingen, Germany

KOSAKOWSKI G.
"Modellierung des Radionuklidtransports: von der Nanometer zur Kilometerskala", Antrittsvorlesung, Universität Tübingen, 2007, Tübingen, Germany

KOSAKOWSKI G., GONZALÉZ F., JURANYI F., GIMMI T.
"Molecular modelling of water diffusion in clays: comparison of simulated and measured quasi-elastic neutron scattering (QENS) spectra", Poster, 11th Int. Conf. on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere, Migration 2007, 26-31 August 2007, Munich, Germany

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"Water diffusion in clays: modelling quasi-elastic neutron scattering spectra (QENS)", Poster, 11th Int. Conf. on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere, Migration 2007, 26-31 August 2007, Munich, Germany

KULIK D.
"GEM-Selektor code package: history and perspectives in GEM chemical thermodynamic modeling", Invited Talk, Nanocem Workshop on Chemical Thermodynamic Modelling, EMPA, 19-20 November 2007, Dübendorf, Switzerland

KULIK D., TITS J., WIELAND E.
"Aqueous-solid solution model of strontium uptake in C-S-H phases", Invited Talk, Goldschmidt Conference 2007, 19-24 August 2007, Cologne, Germany

KULIK D., TITS J., WIELAND E.
"Extension of the C-S-H aqueous — solid solution model for GEM calculations on strontium retention in cementitiois media", 11th Int. Conf. on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere, Migration 2007, 26-31 August 2007, Munich, Germany

KUSTER D., WIESE H., POERSCHKE P., BOUTELLIER V.
"Fuel rod profilometry with a laser scan micrometer", European Working Group on Hot Laboratories and Remote Handling, 20-21 September 2007, Bucharest, Romania.

KYPREOS S.
"Discounting, Risk Aversion and Willingness to Pay: a Monte Carlo Analysis with MERGE", Invited Talk, Int. Workshop on Uncertainty and Discounting in Integrated Assessment, 8-10 November 2007, Berne, Switzerland,

LIAO Y., VIEROW K.[1], HAN J.[2]
"MELCOR Assessment against PUMA Drain-Line Break and GDCS Line Break Integral Tests", CSARP and MELCOR MCAP Technical Review Meeting, NRC, 18-20 September 2007, Albuquerque, USA
[1] Texas A&M University, College Station, US
[2] NRC, Washington, US

MAGNÉ B.
"Discussion on the paper 'On design of global refunding and climate change' of Gersbach, H., Winkler, R.", Invited Talk, Int. Workshop on Uncertainty and Discounting in Integrated Assessment, 8-10 November 2007, Berne, Switzerland

MANDALIEV P., WIELAND E., DÄHN R., TITS J., CHURAKOV S.
"Investigation of lanthanide binding mechanisms in crystalline C-S-H phases", Workshop on X-ray absorption spectroscopy and theory of XAS, Paul Scherer Institut, 28 February - 1 March 2007, Villigen, Switzerland

MANDALIEV P., WIELAND E., DÄHN R., TITS J., CHURAKOV S.
"Macroscopic and microscopic investigations of the Nd(III) binding mechanism in calcium silicate hydrates (C-S-H)", CEMNET Workshop on Cement Research at Large-Scale Facilities, Paul Scherer Institut, 10 September 2007, Villigen, Switzerland

MANDALIEV P., WIELAND E., DÄHN R., TITS J., CHURAKOV S.
"Nd(III) interaction with cementitious materials", 6th ANKA Users Meeting, 1 October 2007, Karlsruhe, Germany

MANDALIEV P., WIELAND E., TITS J., DÄHN R., CHURAKOV S.
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AXPO NATURSTROMFONDS

Projektleiter: S.M.A. Biollaz
Holz - Brennstoffzelle

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Graskraftwerk

Projektleiter: F. Vogel
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BBW

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Projektleiter: Ch. Ludwig
MOPSID Monitoring of process gases with a surface ionization detector

Projektleiter: A. Meier
IEA-SolarPACES (International Energy Agency – Solar Power and Chemical Energy Systems)
IEA Implementing Agreement

Projektleiter: A. Meier
Solar Thermal Production of Zinc – Final Steps Toward Scale-up
Research Project

Projektleiter: A.S.H. Prévôt
Erweiterte Partikelanalytik für Holzfeuerungsabgase

Projektleiter: G.G. Scherer, L. Gubler
Protonen-leitende Polymermembranen für Brennstoff- und Elektrolysezellen

Projektleiter: F. Vogel
Biogenes Methan durch hydrothermale Vergasung von Biomasse

Projektleiter: Ch. Wieckert
Solarchemische Beiträge zur Reduktion des CO_2-Ausstosses

BFE/BAFU

Projektleiter: S. Andreani, J. Keller, A.S.H. Prévôt
Modellierung der Luftqualität mit CAMx für drei Episoden

Projektleiter: S. Andreani, A.S.H. Prévôt
Ozon in der Schweiz 1985 – 2010

Projektleiter: U. Baltensperger, A.S.H. Prévôt
AEROWOOD (Aerosols from Wood Burning)

Projektleiter: A.S.H. Prévôt
Messungen von fossilem und nichtfossilem Kohlenstoff in Feinstaubproben

Projektleiter: A.S.H. Prévôt, U. Baltensperger,
Aerosolmassenspektrometer-Messungen in Zürich

CCEM

Projektleiter: S.M.A. Biollaz
Woodgas SOFC, Task leader: Development of GC/SCD for S- and N-species measurement

Projektleiter: F.N. Büchi, S. Ulli-Beer
*hy.muve: Development of **hy**drogen powered **mu**nicipal **ve**hicle*
with EMPA Dübendorf and Industrial Partners

Projektleiter: I. Mantzaras
Technologies for gas turbine power generation with CO_2 mitigation

Projektleiter: S. Stucki
Second generation biogas

Projektleiterin: S. Ulli-Beer
Transition to Hydrogen Based Transportation
Project Task: Dynamics of transportation technology development in collaboration with MIT (Alliance for Global Sustainability)

Projektleiter: F. Vogel
HEFD-HY Hydrogen-enriched fuel on demand for future hybrid powertrains

Projektleiter: F. Vogel, S.M.A. Biollaz; Projektkoordinator: S. Stucki
Second generation biogas

Projektleiter: J. Wochele
Woodgas SOFC, WP leader: Wood gas analysis diagnostics

Projektleiter: A. Wokaun
Transition to Hydrogen Based Transportation
in collaboration with MIT (Alliance for Global Sustainability)

Projektleiter: M. Zimmermann, S. Ulli-Beer
Advanced Energy-Efficient Renovation of Buildings
Project Task: Diffusion dynamics of energy efficient renovations in collaboration with an IEA project

EOARD

Projektleiter: T. Lippert
Polymers used as fuel in laser plasma thruster in small satellites

Projektleiter: T. Lippert
Polymers as fuel for laser plasma thruster: viscous polymers and test for nanoparticle emission

ETH-RAT

Projektleiter: S. Stucki, A. Wokaun
ECOGAS
novatlantis – Nachhaltigkeit im ETH Bereich

Projektleiter: A. Wokaun, S. Lienin
Erlebnisraum Nachhaltige Mobilität Basel
novatlantis – Nachhaltigkeit im ETH Bereich

Projektleiter: A. Wokaun,
Erlebnisraum Erdgas-/Biogasfahrzeuge
novatlantis – Nachhaltigkeit im ETH Bereich

EU

Projektleiter: U. Baltensperger, J. Dommen
EUROCHAMP (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, J. Dommen
POLYSOA (Polymers in secondary organic aerosols)

Projektleiter: U. Baltensperger, A.S.H. Prévôt, E. Weingartner
EUCAARI (European Integrated project on Aerosol Cloud Climate and Air Quality Interactions)

Projektleiter: P. Jansohn
HERCULES (High efficiency engine R&D on combustion with ultra low emissions for ships)

Projektleiter: A.S.H. Prévôt
CIRCE (Climate change and Impact Research: The Mediterranean Environment

Projektleiter: M. Saurer
MILLENIUM, (European climate of the last millennium)

Projektleiter: I.A. Schneider
NanoGlowa (Nano membranes against Global Warming)
(Diagnostics workpackage)

Projektleiter: E. Weingartner, M. Gysel
QUANTIFY (Hygroscopic properties of ship exhaust particles)

Projektleiter: E. Weingartner, M. Gysel
GeoMon (Global Earth Observation and Monitoring of the atmosphere)

EU-PROJEKTE (6. FWP)

Projektleiter: S.M.A. Biollaz
RENEW

Projektleiter: S.M.A. Biollaz
BIOCELLUS

Projektleiter: T. Schildhauer
AER-Gas II

Projektleiter: S. Stucki
Bio-SNG

GEBERT RUEF STIFTUNG

Projektleiter: F.N. Büchi
SIMPEM (Simulation von Polymer Elektrolyt Brennstoffzellen und Stapeln)
ZHAW, Winterthur

HSK

Projektleiter: F. Gassmann
ADPIC- Aktualisierung

INDUSTRY

Projektleiter: F.N. Büchi, M. Reum
Diagnostics of polymer electrolyte fuel cells
Automotive Industry

Projektleiter: O. Kröcher, R. Althoff[1]
Development of new metal-exchanged zeolites for NH_3/urea-SCR
Süd-Chemie GmbH, Germany
[1] Süd-Chemie GmbH

Projektleiter: O. Kröcher
Thermoanalytic investigation of the urea decomposition
Abgaszentrum der Automobilindustrie, Germany

Projektleiter: O. Kröcher
Investigation of new reducing agents for the SCR process
Alzchem, Germany

Projektleiter: O. Kröcher, P. Hirth[1]
Investigation of the influence of ammonia on the soot oxidation in Diesel particulate filters
Emitec GmbH, Germany
[1] Emitec GmbH

Projektleiter: O. Kröcher, A. Johansson[1]
Development and parameterization of a model for a V_2O_5/WO_3-TiO_2 SCR catalyst
Swenox AB, Sweden
[1] Swenox AB, Sweden

Projektleiter: P. Maire
Electrochemical characterization of polymeric organic active materials
Ciba, Basel

Projektleiter: P. Novák
Industrieprojekt
Industriepartner

Projektleiter: G.G. Scherer
Diagnostics of polymer electrolyte fuel cells
- Automotive Industry
- Nissan Motor Co. Ltd., Yokohama, Japan

Projektleiter: N. Tran, W. Märkle
Graphite für die negative Elektrode der Lithiumionen-Batterie
TIMCAL SA, Bodio

Projektleiter: J. Ufheil
Rechargeable magnesium batteries
Nissan Motor Co. Ltd., Yokohama, Japan

Projektleiterin: S. Ulli-Beer
Innovative Fahrzeugflotte Basel
novatlantis – Nachhaltigkeit im ETH Bereich

Projektleiter: F. Vogel
Gasoline reforming kinetics
Toyota central research and development laboratories, Inc.

Projektleiter: F. Vogel
Kinetik der präferentiellen Oxidation von CO
Umicore AG

Projektleiter: A. Wokaun, S.F. Lienin, S. Ulli-Beer, C. Bach
Erlebnisraum Mobilität: Aufbau einer sozio-technologischen Feldversuchsumgebung
novatlantis – Nachhaltigkeit im ETH Bereich

KANTON WALLIS

Projektleiter: A.S.H. Prévôt
Studie der PM10 im Kanton Wallis

KTI

Projektleiter: F.N. Büchi
Brennstoffzellenstapel mit erweiterter Funktionalität
CEKA AG, Wattwil und FH Bern

Projektleiter: I. Mantzaras
Sequential combustion technology for gas turbine power generation with CO_2 mitigation

METEO SCHWEIZ

Projektleiter: U. Baltensperger, E. Weingartner, M. Gysel
GAW (Global Atmosphere Watch) Programme: Aerosol Research at the Jungfraujoch

Projektleiter: U. Baltensperger, E. Weingartner, M. Gysel
CCNC (Development of a Cloud Condensation Nuclei Counter)

MIT

Projektleiter: F. Vogel
Ecogas: Nutrient salt recovery during conversion of wet biomass into methane

NATIONALFONDS

Projektleiter: U. Baltensperger
Sources, Formation and Composition of Particulate Organic Carbon in the Lower Troposphere

Projektleiter: Ch. Körner[1], R.T.W. Siegwolf
Swiss Canopy Crane Project: CO_2–enrichment
[1] University of Basel

Projektleiter: P. Novák
Synthesis and characterization of advanced electroactive materials for electrodes of rechargeable lithium-ion batteries

Projektleiter: P. Novak, R. Kötz, T. Lippert, R. Nesper[1]
Advanced materials for efficient portable energy supplies
PSI und ETHZ
[1] ETH Zürich

Projektleiter: F. Nüesch, M. Nagel[1], T. Lippert, A. Wokaun
Patterned polymer multilayer light-emitting device fabrication using laser induced forward transfer
[1] EMPA Dübendorf

Projektleiter (CCMX): J. Rupp[1], L. Gauckler[1], T. Lippert, K. Conder[1], 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 (MaNEP): L. Schlapbach[1], A. Weidenkaff[1], T. Lippert, A. Wokaun
Plasma enhanced anionic substitution (PEAS) for the generation of perovskite phases with different properties
[1] EMPA Dübendorf

Projektleiter: F. Vogel
Salt particle formation in near- and supercritical water

Projektleiter: E. Weingartner, U. Krieger[1], T. Peter[1], U. Baltensperger
Hygroscopicity of organic aerosols
[1] ETH Zürich

Projektleiter: A. Wokaun
NCCR-Climate
Project Task 4.1: Energy Technology Strategies

Projektleiter: A. Wokaun, T. Lippert
Thin metal oxide films by PLD: “Tracing” the oxygen and understanding its role

Projektleiter: A. Wokaun, T. Lippert
Laser ablation of inorganic materials and thin film deposition studied by mass spectrometry and in-situ surface analysis

NATO

Projektleiter: M. Dinescu[1], E. Verona[2], T. Lippert
Polymers based piezoelectric sensor array for chemical warfare agents detection
[1] National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania
[2] CNR - Istituto di Acustica "O.M. Corbino", Roma, Italy

OSTLUFT

Projektleiter: A.S.H. Prévôt
Mobile Aerosolmasspectrometer-Messungen im Rheintal und in Zürich

PSI

Projektleiter: E. Weingartner, P. Villani[1]
Development of new Differential Mobility Analyzers
[1] Laboratoire de Météorologie Physique, University of Clermont-Ferrand, France

SBF

Projektleiter: P. Novák
ALiSTORE (Advanced lithium energy storage systems based on the use of nano-powders and nano-composite electrodes/electrolytes)
EU-Projekt (Network of Excellence)

SNF

Projektleiter: G. Knopp, P. Beaud, A. Wokaun
Investigation of ultrafast molecular dynamics of combustion relevant species by time resolved non-linear Raman spectroscopy

Projektleiter: I. Mantzaras
Direct numerical simulation of catalytic combustion

Projektleiter: P. Radi, M. Tulej, A. Wokaun
Characterization of vibrationally and rotationally excited molecules by two-color resonant four-wave mixing

SWISSELECTRIC RESEARCH

Projektleiter: S. Biollaz
Methan aus Holz

Projektleiter: J. Wochele, Ch. Ludwig
Spurenelemente in Produktgasen (TREPGAS)

UGZ

Projektleiter: E. Weingartner, J. Brunner[1]
Entwicklung eines SMPS-Systems für den kontinuierlichen Einsatz
[1] Amt für Umwelt- und Gesundheitsschutz, Zürich

UNIVERSITIES

Projektleiter: A. Bödi
Threshold photoelectron photoion coincidence studies of organometallic compounds at the VUV beamline of the Swiss Light Source
Prof. T. Baer, University of North Carolina, USA

Projektleiter: G.Knopp
Fs CARS on benzene and toluene in liquid and gas phase
Prof. A. Materny, Jacobs University Bremen, Germany

Projektleiter: P.P. Radi
REMPI and photoelectron-spectroscopy on formaldehyde
Prof. F. Merkt, ETH Zürich

Projektleiter: P.P. Radi
DFWM and TC-RFWM spectroscopy on transient molecules and radicals
Prof. J.P. Maier, Universität Basel

Projektleiter: P.P. Radi
Unimolecular dissociation of formaldehyde
Prof. R. Marquardt, Université Louis Pasteur 4, Strasbourg, France

Projektleiter: P.P. Radi
Detection of weak overtone and combination band of methane
Dr. D. Kozlov, General Physics Institute, Moscow, Russia

VELUX STIFTUNG

Projektleiter: Ch. Ludwig
Hydrothermal methane from microalgae (the SunChem process)

TEACHING ACTIVITIES

University Level Teaching

Prof. Dr. U. Baltensperger, Prof. Dr. H. Burtscher, Dr. C. Marcolli
Aerosole II
ETH Zürich, SS 2007.

Prof. Dr. U. Baltensperger, Prof. Dr. H. Burtscher, Dr. C. Marcolli
Aerosole I
ETH Zürich, HS 2007.

Prof. Dr. K. Boulouchos[1], Dr. O. Kröcher, Dr. Ph. Dietrich
Oekologische Aspekte der individuellen Mobilität
ETH Zürich, SS 2007
[1] ETH Zürich

Dr. J. Dommen
Sekundäre organische Aerosole: Von der Smogkammer zur realen Atmosphäre
Universität Innsbruck, June 2007.

Dr. P. Jansohn
Verbrennung in Gasturbinen (Vorlesung für höhere Semester in den Studiengängen Maschineningenieurwissenschaften und Energy Science & Technology)
ETH Zürich, SS 2007.

PD Dr. T. Lippert
Mikro- und Nanostrukturen: Laseranwendungen in Industrie und Forschung
Vorlesung für höhere Semester in den Studiengängen Chemie und Chemieingenieurwissenschaften
ETH Zürich, HS 2007.

Prof. Dr. Ch. Ludwig
Advanced solid waste treatment
EPF Lausanne, WS 2006/07 and SS 2007.

Prof. Dr. Ch. Ludwig (gemeinsame Vorlesung mit Prof. Dr. J.-L. Scartezzini, Dr. D. Robinson
Prof. Dr. A.G. Dumont, Dr. J-J. Hefti, Prof. Dr. A. Mermoud, Prof. Dr. R. Schlaepfer, Dr. M. Soutter)
Quartiers urbains, infrastructures et aménagements durables
EPF Lausanne, SS 2007.

PD Dr. I. Mantzaras, Dr. C. Frouzakis[1]
Theoretical and Numerical Combustion
ETH Zürich, WS 2006/07
[1] ETH Zürich

Dr. M. Nachtegaal
Cook and Look: Synchrotron techniques.
Vorlesung Master Vertiefung: Biogeochemistry and Pollution Dynamics
ETH Zürich, WS 2006/07.

PD Dr. P. Novák, Prof. Dr. A. Wokaun
Technische Elektrochemie
ETH Zürich, HS 2007.

Dr. A.S.H. Prévôt, Prof. J. Staehelin
Tropospheric Chemistry
ETH Zürich, SS 2007.

Dr. G.G. Scherer
Brennstoffzellen
Beiträge zur Vorlesung „Energie und Klima“, Prof. Dr. G. Ganteföhr, Universität Konstanz, SS 2007.
Dr. R.T.W. Siegwolf, Dr. M. Saurer
Einsatz stabiler Isotope in der Oekologie und Physiologie der Pflanzen I
University of Basel, SS 2007.

Dr. R.T.W. Siegwolf, Dr. M. Saurer
Stabile Isotope in der Oekologie
University of Basel, HS 2007/2008.

Dr. R.T.W. Siegwolf, Dr. M. Saurer
Stabile Isotope in der Oekologie
University of Zürich, WS 2006/07 and HS 2007/08.

Prof. Dr. A. Steinfeld, Prof. Dr. R. Abhari
Energy Systems and Power Engineering
ETH Zürich, SS 2007.

Prof. Dr. A. Steinfeld, Prof. Dr. R. Abhari
Thermodynamics III
ETH Zürich, HS 2007.

Prof. Dr. A. Steinfeld
Energieübertragung durch Wärmestrahlung
ETH Zürich, HS 2007.

Prof. Dr. A. Steinfeld, Prof. Dr. A. Wokaun
Renewable Energies Technologies I
ETH Zürich, HS 2007.

Dr. S. Ulli-Beer
Modeling and Simulation with System Dynamics: Tools for Dealing with Complexity
Institut für Betriebswirtschaftslehre, Universität St. Gallen, HS 2007.

Dr. F. Vogel (gemeinsam mit Prof. Dr. Ph. Rudolf von Rohr)
Einführung in die Verfahrenstechnik (Vorlesung 5. Semester Maschinenbau und Verfahrenstechnik)
ETH Zürich, HS 2007.

Prof. Dr. A. Wokaun, Dr. G.G. Scherer, Prof. Dr. K. Boulouchos
Renewable Energies Technologies II
ETH Zürich, SS 2007

Contributions to Courses at Universities, FHL, and Other Institutes

Dr. W. Durisch
Photovoltaik - Strom aus Sonnenlicht
- ABB University Switzerland, Lerncenter Business Processes and Power System Management, Baden, November 9, 2007.
- Energietechnische Aus- und Weiterbildung für nichttechnische Fach- und Führungskräfte, ABB Technikerschule, Baden, May 16, 2007.

Dr. F. Gassmann, Prof. Dr. F. Stähli[1]
Wege zu einer nachhaltigen Energiezukunft
FHNW Brugg-Windisch, HS 2007/08.
[1] FHNW, Brugg-Windisch

Dr. F. Gassmann
Von den Grenzen des Wachstums zu einer nachhaltigen Entwicklung
Grundkurs Ökologie, HTA Luzern, Horw, March 5, 2007.

PD Dr. T. Lippert
UV Laserbearbeitung. Lithographie. Laser in der Mikroelektronik
Weiterbildungslehrgang Laserfertigung der FHNW, Brugg-Windisch, February 2007.

Prof. Dr. Ch. Ludwig
Kursblock „Vom Leitbild zur nachhaltigen Abfallwirtschaft“
FHNW, Brugg-Windisch, SS 2007

Dipl. Ing. M.Sc. L.O. Schunk
Erneuerbare Energien – Heute und Morgen
Tech Day, Kantonsschule Limmattal, Urdorf, October 30, 2007.

A. Steinfeld
Solar Chemicals and Fuels
Universidad Menendez Pelayo, Madrid, Spain, November 23, 2007.

Dr. S. Ulli-Beer
Systeme, Komplexität – und wie Menschen damit umgehen können
Einführung in Allgemeine Ökologie - Systemansätze, Interfakultäre Koordinationsstelle für Allgemeine Ökologie, Universität Bern, November 26 – December 3, 2007.

T. Schildhauer
Renewable energy technologies (biomass, biofuels)
Two lectures, ETH Zürich, 2007.

PUBLICATIONS

Books and Reviewed Book Chapters

S. Andreani-Aksoyoglu, J. Keller, A.S.H. Prévôt
Aerosol modelling with CAMx4 and PMCAMx: a comparison study
C. Borrego and A.-L. Norman, Air Pollution Modelling and its Application XVII, Banff, Canada, Springer, 247-256, ISBN 978-0-387-28255-8 (2007).

S. Andreani-Aksoyoglu, J. Keller, A.S.H. Prévôt, U. Baltensperger
Differences in SOA in the north and the south of the Alps: a modelling study
Editors: J. Burrows, T. Cox, D. Fowle, C. Granier, I. Isaaksen, P. Monks, C. O'Dowd, P. Borell, Volatile Organic Compounds in the polluted atmosphere. The 3rd ACCENT Barnsdale Expert Meeting, Keele Graphic Services, 162-165 (2007).

S. Andreani-Aksoyoglu, J. Keller, A.S.H. Prévôt, U. Baltensperger, J. Flemming
Modelling of secondary aerosols in Switzerland in summer 2003
Editors: C. Borrego and E. Renner, Air Pollution Modeling and its Application XVIII, Amsterdam, Elsevier, 75-84 (2007).

T.E. Dawson, R.T.W. Siegwolf
Stable isotopes as indicators of ecological change
Editors: T.E. Dawson, R.T.W. Siegwolf, Academic Press, Pages 417, Terrestrial Ecology Series, ISBN: 978-0-12-373627-7 (2007).

T.E. Dawson, R.T.W. Siegwolf
Using stable isotopes as indicators, tracers and recorders of ecological change: some context and background
Editors: T.E. Dawson, R.T.W. Siegwolf, Stable Isotopes as Indicators of Ecological Change, Academic Press, 3-18 (2007).

W. Durisch, K.-H. Lam[1], J.Close[1]
Performance, yield and degradation of copper indium diselenide modules under outdoor conditions
Recent Developments in Solar Energy, Ed.: T. P. Hough, Nova Science Publishers, Inc., New York, USA, ISBN 13: 978-1-60021-631-0 (2007).
[1] University of Hong Kong, China

J. Keller
Retrieval of aerosol optical properties using the Multi-angle Imaging Spectro-radiometer (MISR)
P.B. John Burrows, Measuring tropospheric trace constituents from space. ACCENT-TROPOSAT-2 in 2005-6, Urbino, ACCENT Secretariat, 125-126 (2007).

O. Kröcher
Past and present in DeNOx catalysis - from molecular modelling to chemical engineering, studies in surface science and catalysis
Elsevier, Amsterdam **171**, ISBN 978-0-444-53058-5 (2007).

M.J. Montenegro, T. Lippert
Films for electrochemical applications
Pulsed Laser Deposition of Thin Films-Applications-Led Growth of Functional Materials, Ed. R.W. Eason, John Wiley & Son Inc. 563-584 (2007).

M. Saurer, R.T.W. Siegwolf
Human impacts on tree-ring growth reconstructed from stable isotopes
Editors: T.E. Dawson, R.T.W. Siegwolf, Stable Isotopes as Indicators of Ecological Change, Academic Press, 49-62 (2007).

A. Steinfeld
Editor-in-Chief
ASME Journal of Solar Energy Engineering **129**, Issues 1, 2, 3, 4 (2007).

L. Urech, T. Lippert
Designed polymers for ablation
Invited chapter in Laser Ablation and its Applications, Springer Series in Optical Sciences, Ed. C. Phipps, Springer 281-297 (2007).

Peer Reviewed Papers

M.R. Alfarra, A.S.H. Prévôt, S. Szidat, J. Sandradewi, S. Weimer, V.A. Lanz, D. Schreiber, M. Mohr, U. Baltensperger
Identification of the mass spectral signature of organic aerosols from wood burning emissions
Environ. Sci. Technol. **41**, 5770-5777 (2007).

S. Alkan Gürsel, H. Ben youcef, A. Wokaun, G.G. Scherer
Influence of reaction parameters on grafting of styrene into poly(ethylene-alt-tetrafluoroethylene) films
Nucl. Instr. and Meth. in Phys. Res. **265**, 198-203 (2007).

S. Ansumali, S. Arcidiacono, S.S. Chikatamarla, N.I. Prasianakis, A.N. Gorban, I.V. Karlin
Quasi-equilibrium lattice Boltzmann method
Europ. Phys. Journal **56**, 135-139 (2007).

S. Ansumali, I. V. Karlin, S. Arcidiacono, A. Abbas, N. I. Prasianakis
Hydrodynamics beyond Navier-Stokes: exact solutions to the lattice Boltzmann hierarchy
Phys. Rev. Lett. **98**, 124502 (2007).

S. Arcidiacono, I.V. Karlin, J. Mantzaras, C. E. Frouzakis
Lattice Boltzmann Model for the simulation of multicomponent mixtures
Phys. Rev. **76**, 046703 (2007).

F. Atchison, T. Brys[1,4], M. Daum, P. Fierlinger[1,3], A. Foelske, M. Gupta, R. Henneck, S. Heule[1,3]
M. Kasprzak[1,5], K. Kirch, R. Kötz, M. Kuzniak[1,6], T. Lippert, C. F. Meyer[2], F. Nolting, A. Pichlmaier,
D. Schneider[2], B. Schultrich[2], P. Siemroth[2], U. Straumann[3]
Structural characterization of diamond-like carbon films for ultracold neutron applications
Diamond & Relat. Mater. **16**, 334-341 (2007).
[1] Paul Scherrer Institut, Villigen PSI
[2] Fraunhofer Institut, Dresden, Germany
[3] Universität Zürich
[4] ETH Zürich
[5] Austrian Academy of Sciences, Vienna, Austria
[6] Jagellonian University, Cracow, Poland

G. Aymoz, J.L. Jaffrezo, D. Chapuis, J. Cozic , W. Maenhaut
Seasonal variation of PM10 main constituents in two valleys of the French Alps. I: EC/OC fractions
Atmos. Chem. Phys. **7,** 3, 661-675 (2007).

M.S. Bae, K.L. Demerjian, J.J. Schwab, S. Weimer, J. Hou, X.L. Zhou, K. Rhoads, D. Orsini
Intercomparison of real time ammonium measurements at urban and rural locations in New York
Aerosol Sci. Technol. **41**, 329-341 (2007).

M.S. Bae, J.J. Schwab, Q. Zhang, O. Hogrefe, K.L. Demerjian, S. Weimer, K. Rhoads, D. Orsini,
P. Venkatachari, P.K. Hopke
Interference of organic signals in highly time resolved nitrate measurements by low mass resolution aerosol mass spectrometry
J. Gephy. Res. **112,** D22305, doi:10.1029/2007JD008614 (2007).

V.L. Barrio[1], G. Schaub[2], M. Rohde[2], S. Rabe, F. Vogel, J.F. Cambra[1], P.L. Arias[1], M.B. Güemez[1]
Reactor modeling to simulate catalytic partial oxidation and steam reforming of methane. Comparison of temperature profiles and strategies for hot spot minimization
Int. J. Hydrogen Energy **32**, 1421-1428 (2007).
[1] School of Engineering (UPV/EHU), Bilbao, Spain
[2] Engler-Bunte-Institut, Uni Karlsruhe, Germany

G. Battipaglia, P. Cherubini, M. Saurer, R.T.W. Siegwolf, S. Strumia, M.F. Cotrufo
Volcanic explosive eruptions of the Vesuvio decrease tree-ring growth but not photosynthetic rates in the surrounding forests
Global Change Biology **13**, 1122-1137 (2007).

A. Bödi, B. Sztáray[1,2], T. Baer[2], M. Johnson, T. Gerber
Data acquisition schemes for continuous two-particle time-of-flight coincidence experiments
Rev. Sci. Instrum. **78**, 084102-1 – 084102-7 (2007).
[1] University of Budapest, Hungary
[2] University of North Carolina, USA

T. Boettger, M. Haupt, K. Knoller, S.M. Weise, J.S. Waterhouse, K.T. Rinne, N.J. Loader, E. Sonninen,
H. Jungner, V. Masson-Delmotte, M. Stievenard, M.T. Guillemin, M. Pierre, A. Pazdur, M. Leuenberger,
M. Filot, M. Saurer, C.E. Reynolds, G. Helle, G.H. Schleser
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[1] EPFL and PSI
[2] EPFL

S. Regenspurg[1], M.E. Malmström[2]
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[1] EPFL and PSI
[2] Industrial Ecology, Royal Institute of Technology (KTH), Stockholm, Sweden

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L.O. Schunk, P. Häberling, S. Wepf, D. Wuillemin, A. Meier, A. Steinfeld
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M.C. Seemann, S.M.A. Biollaz, S. Stucki
Thermo-chemical analysis of the production of SNG from wood
15th European Biomass Conference & Exhibition, Berlin, Germany, May 7-11 (2007).

P. Siewert, P. Griebel, P. Jansohn
Influence of pressure on flame front corrugation and turbulent flame speed: fractal analysis of lean premixed methane/air flames
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J.J. Sloan, S. Taghavi, S. Nikzad, Z. He, S. Andreani-Aksoyoglu, J. Keller, J. Brook
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W.J. Tobler, W. Durisch
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E. Weingartner, J. Cozic, B. Verheggen, U. Baltensperger, S. Mertes, S. Walter, J. Schneider, J. Curtius
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A. Wokaun
Ziele formulieren und realisieren
Bulletin VSE **16**, 58 (2007).

HABILITATIONS

J. Mantzaras
Interplay of transport and hetero-/homogeneous chemistry
ETH Zürich, MAVT Department, August 2, 2007.

DISSERTATIONS

P. Bodek
Design, construction and characterization of a coaxial nozzle to study reaction kinetics
Ph.D. Thesis, No. 17123, ETH Zürich, March 21, 2007.

T. Brys
Extraction of ultracold neutrons from a solid deuterium source
Ph.D. Thesis, No. 17350, ETH Zürich, July 18, 2007.

D. Cannavò
Production and characterization of small sized Zn_xO_y molecules in the gas phase
Ph.D. Thesis, No. 17031, ETH Zürich, January 24, 2007

J. Cozic
Aerosol properties of the free troposphere and their interference with mixed-phase clouds
Ph.D. Thesis, University of Bern, October 11, 2007.

R. Felder
Well-to-wheel analysis of renewable transport fuels: Synthetic natural gas from wood gasification and hydrogen from concentrated solar energy
Ph.D. Thesis, No. 17437, ETH Zürich, September 26, 2007.

T. Kowalski
Evaluating a surface ionisation detector for measuring alkalis in biomass gasification
Ph.D. Thesis, No. 17067, ETH Zürich, February 14, 2007.

D. Kramer
Mass transport aspects of polymer electrolyte fuel cells under two-phase flow conditions
Ph.D. Thesis, Technische Universität Bergakademie Freiberg, March 27, 2007.

M. Kuhnke
Fabrication and characterization of micro-structured glassy carbon electrodes for miniaturized fuel cells
Ph.D. Thesis, No. 17309, ETH Zürich, June 27, 2007.

M. Neracher
Anwendung der Methode der zeitaufgelösten laserinduzierten Gitter für die Diagnostik von Strömungen und zur Analyse molekularer Relaxationen
Ph.D. Thesis, No. 17037, ETH Zürich, January 24, 2007.

J. Pecho
Oxygen transfer materials with catalytic properties for biomass gasification
Ph.D. Thesis, No. 17302, ETH Zürich, June 27, 2007.

A. Reiner
Die Platinkatalysatorschicht in Polymerelektrolyt-Brennstoffzellen
Beiträge zum Verständnis und zur Optimierung
Ph.D. Thesis, No. 17127, ETH Zürich, March 21, 2007.

C.E. Reynolds-Henne
Climate-isotope relationships in trees under non-limiting climatic conditions from seasonal to century scales
Ph.D. Thesis, University of Bern, March 22, 2007.

A. Schneider
Experimental and numerical investigation of the catalytic partial oxidation of methane to synthesis gas for power generation applications
Ph.D. Thesis, No. 17183, ETH Zürich, April 24, 2007.

Th. Schulz
Intermediate steps towards the 2000-Watt society in Switzerland: An energy-economic scenario analysis
Ph.D. Thesis, No. 17314, ETH Zürich, June 27, 2007.
S. Sjogren
Hygroscopic properties of organic and inorganic aerosols
Ph.D. Thesis No. 17260, ETH Zürich, June 1, 2007.

L. Urech
Design and characterization of energetic polymers applied in laser space propulsion
Ph.D. Thesis No. 17068, ETH Zürich, February 14, 2007.

M. Waldner
Catalytic hydrothermal gasification of biomass for the production of synthetic natural gas
Ph.D. Thesis, No. 17100, ETH Zürich, March 21, 2007.

BACHELOR-/ DIPLOMA-/ MASTER-THESES

G. Albisetti
Carbothermic reduction of MgO using C and CH_4 as reducing agents
PSI and ETH Zürich, March 2007.

A. Brambilla, D. Colzani
Solar Thermochemical Process: Investigation of Zinc Separation from a Zn/O_2 Mixture
Politecnico di Milano, ETH Zürich, and PSI Villigen, March 2007.

M. Brandenberger
Catalyst dissolution and biomass gasification studies under hydrothermal conditions
PSI and EPFL, August 2007.

B. Breiten
ETFE based radiation grafted membranes for the DMFC
PSI and Heinrich Heine Universität, Düsseldorf, Germany, March 2007.

T. Fellmann
Modellierung des Verhaltens von Spurenelementen im Drehrohr bei der thermischen Behandlung von Abfällen
PSI and ETH Zürich, 2007.

D. Fonjallaz
Investigation of complex formation of arsenic with organic matter in ground water (China)
PSI, EPFL and Chinese Academy of Sciences, Beijing, China, 2007.

M. Kohl
Katalysatoren für die Sauerstoffreduktion in Polymerelektrolyt-Brennstoffzellen: Platinfilme auf Cobaltpartikeln
PSI and Fachhochschule Amberg-Weiden, March 2007.

P. Loonker
A mathematical model approach to estimate and forecast electronic waste: case studies of Delhi and Switzerland
PSI, EMPA, EPFL and Indian Inst. of Technol. Delhi, Indian, 2007.

J. Luterbacher
Process development and environmental systems analysis of a catalytic hydrothermal methane production process
PSI, EPFL and MIT, USA, February 2007.

K. Marketos
Experimental Testing of a Catalytic, Mesoscale, Propane-Fueled Combustor for Mesoscale Gas Turbine
PSI and ETH Zürich, October 2007.

F. Meier
Solar thermochemical cycle for ammonia production based on aluminium-based redox reactions
PSI and ETH Zürich, March 2007.

A. Pedroni
Solar thermal steam-gasification of carbonaceous materials
PSI and ETH Zürich, June 2007

C. Pitta
Investigation of tar reforming employing a catalytic partial oxidation catalyst
PSI and ETH Zürich, March 2007.

R. Rosen
Katalysatoren für die Sauerstoffreduktion in Polymerelektrolyt-Brennstoffzellen: Aktivität und Stabilität von Core-shell PtCo3/C-Katalysatoren
PSI Villigen and Fachhochschule beider Basel (Nordwestschweiz), December 2007.
N. Rotering
Investigation of the decomposition rate of ZnO particles under direct solar irradiation in a solar thermogravimeter
Bachelor Thesis, PSI and ETH Zürich, July 2007.

D. Ruch
Experimental investigation on the steam-gasification of carbonaceous materials
PSI and ETH Zürich, September 2007.

J. Schaller
Kinetic analysis of the steam gasification of carbonaceous materials
PSI and ETH Zürich, October 2007.

M. Schisslbauer
Untersuchungen zur Degradation von strahlengepfropften Membranen in der Polymerelektrolyt-Brennstoffzelle
PSI and Fachhochschule Amberg-Weiden, October 2007.

B. Steubing
E-Waste Generation in Chile – situation analysis an estimation of actual and future computer waste quantities using material flow analysis
PSI, EMPA and EPFL, 2007.

S. Suquet
Influence of Ni and Ru on microalgae growth and productivity
PSI and EPFL, 2007.

P. Vielle
Heliostat field calculations of central receiver systems for hydrogen production using the ZnO/Zn cycle and Life cycle assessment on solar steam-gasification of carbonaceous materials
PSI and ETH Zürich, October 2007.

SEMESTER THESES

K. Cuche
Experimental investigation of the quench unit for Zn/O_2 separation
PSI and ETH Zürich, July 2007.

F. Echard
Contribution to production of improved metal-exchanged zeolite catalysts
Université Orléans, April 1 – August 31, 2007.

D. Fonjallaz
Pollution assessment at Smokey Mountain Landfill, Manila, SIE project EPFL
PSI and EPFL, 2007

M. Gasser
Energietransportoptionen – Ein Vergleich zwischen Wasserstoffpipeline und Hochspannungs-Gleichstrom-Übertragung
PSI and ETH Zürich, March 2007.

V. Gianini
CFD on of an aerosol flow reactor for H_2 generation by Zn-hydrolysis
PSI and ETH Zürich, 2007.

N. Gross
Aus der Forschung in die Praxis: Erste Schritte einer Förderinitiative für ein kommerzielles „Methan aus Holz“-Kraftwerk im Laufental.
PSI and ETH Zürich, June 2007.

E. Guglielmini
ZnO/Zn Thermochemical Cycle: CFD modeling of the quench unit for Zn/O_2 separation
PSI and ETH Zürich, July 2007.

I. Hischier
Cyclic experimental study f the 2-step Al2O3/AlN thermochemical cycle for ammonia production
PSI and ETH Zürich, March 2007.

D. Kronenberg
Experimental investigation of the solar thermal dissociation of ZnO in a rotary reactor
PSI and ETH Zürich, March 2007.

L. Läubli
Stabile Isotope – Werkzeuge zur Rekonstruktion des Klimas
PSI, August 2007.

F. Lienhard
Energietransportoptionen. Ein Vergleich zwischen Wasserstoffpipeline und Hochspannungs-Gleichstrom-Übertragung
PSI and ETH Zürich, March 2007.

C. Lohri
Parametric study of a polymer electrolyte fuel cell
PSI and ETH Zürich, June 2007.

D. Ruch
Evaluierung von verschiedenen Standorten für die Syngasproduktion mittels konzentrierter Sonnenstrahlen
PSI and ETH Zürich, January 2007.

C. Suter
CFD Modeling of a Solar Reactor for the Thermal Decomposition of Zinc Oxide
PSI and ETH Zürich, July 2007.

D. Tehlar
Status of combined heat and power (CHP) technology in Europe
PSI and ETH Zürich, June 2007.

TALKS

Invited Talks

I. Alxneit
Aerosol synthesis including chemical reaction(s)
Department of Physics, University of Milano, Italy, June 14, 2007.

U. Baltensperger
Secondary organic aerosols: recent results from the PSI smog chamber
California Institute of Technology, Pasadena, USA, December 4, 2007.

U. Baltensperger
The POLYSOA Project
COST-633, Particulate Matter: Properties Related to Health Effects, Barcelona, Spain, October 22-24, 2007.

U. Baltensperger
The Aerosol SAG
First Session of OPAG-EPAC JSSC, WMO, Geneva, April 11-12, 2007.

U. Baltensperger
Organic aerosol: Primary, secondary, anthropogenic, biogenic
Gordon Research Conference on Atmospheric Chemistry, Big Sky, Montana, USA, August 26-31, 2007.

U. Baltensperger
Physical properties and chemical composition of atmospheric aerosols
ESF - INTROP Workshop on Aerosols - Properties, Processes, Climate, Crete, Greece, April 21-24, 2007.

U. Baltensperger
Introduction and summary of the POLYSOA project
International Society for Aerosol in Medicine Congress, Tours, France, June 16-20, 2007.

U. Baltensperger
Organic aerosols in the atmosphere: Primary versus secondary and biogenic versus anthropogenic
Atmosphärisch-Chemisches Kolloquium des ICG Forschungszentrum Jülich, Germany, May 23, 2007.

U. Baltensperger
Aerosole: Die Wirkung auf unser Klima und unsere Gesundheit
Vortragsabend Klima und Atmosphäre, Kernkraftwerk Leibstadt, November 8, 2007.

U. Baltensperger
Secondary organic aerosols from biogenic precursors: What can we learn from combined chamber and field experiments?
VOCBAS - INTROP Meeting, Montpellier, France, October 2-5, 2007.

U. Baltensperger
Secondary organic aerosols: what can we learn from combined field and smog chamber studies?
Carnegie Mellon University, Pittsburgh, USA, August 24, 2007.

U. Baltensperger
European integrated project on aerosol cloud climate and air quality interaction (EUCAARI)
4th EU-Japan Workshop on Climate Change Research, Brussels, Belgium, March 12-13, 2007.

U. Baltensperger
Aerosol properties of the free troposphere and their interferences with mixed-phase clouds
HFSJG Board Meeting, Zermatt, September 6, 2007.

U. Baltensperger
Secondary organic aerosols: recent results from lab and field experiments
University of California Riverside, USA, November 28, 2007.

S.M.A. Biollaz
Science and development aspects of the PSI fluidised bed methanation technology
Int. Seminar on Gasification and Methanation, Göteborg, Sweden, September 21-22, 2007.

M. Bosshardt
European Fleet Model – structure, assumptions and first results
CONCAWE, Brussels, Belgium, August 9, 2007.

F.N. Büchi
Neue Treibstoffe und Antriebe - Aussichten für eine effiziente individuelle Mobilität
EMPA Dübendorf, Wissensapéro, July 9, 2007.

F.N. Büchi
Inhomogeneous cell polarization
From Physical Understanding to Novel Architectures of Fuel Cells, Trieste, Italy, May 23, 2007.

F.N. Büchi
Insights from sub-mm current density measurements in PEFC
Workshop on Fuel Cell Modeling, Aachen, Germany, March 7, 2007.

P. Coray, J. Petrasch[1], A. Meier, P. Häberling, D. Wuillemin, S. Wepf, A. Steinfeld
The PSI's High-Flux Solar Simulator for high-temperature thermochemical research
10. Kölner Sonnenkolloquium, DLR, Köln-Porz, Germany, June 21, 2007.
[1] ETH Zürich

I. Czekaj, J. Wambach, F. Raimondi, F. Loviat
Combination of experimental and theoretical methods for understanding reactions on heterogeneous catalysts
SLS Symposium on “Surface Science”, PSI, July 3, 2007.

I. Czekaj, J. Wambach, A. Wokaun
Electronic structure of the Ni/γ-Al_2O_3 Catalyst: DFT cluster model study
Swiss Chemical Society - Fall Meeting, Computational Chemistry Session, EPFL, September 12, 2007.

J. Dommen
Examples of particle analysis by mass spectrometry from PSI smog chamber experiments
3rd PTR-MS Conference, Obergurgl, Austria, January 28, 2007.

J. Duplissy
Hygroscopic properties of SOA formed in a smog chamber
California Institute of Technology-Chemical Engineering-John H. Seinfeld, Los Angeles - Pasadena, USA, December 17, 2007.

P. Farquet
Nanostructured polymer brushes by EUV-radiation grafting
International Nano Student Conference (INASCON), Silkeborg, Denmark, July 7-10, 2007.

F. Gassmann
Das globale Klima als komplexes System
Tagung des Bioforum Schweiz, Seminar- und Kulturhotel Möschberg, Grosshöchstetten, January 16, 2007.

F. Gassmann
Die Herausforderung CO_2 aus globaler Perspektive
AXPO Management Meeting, Seedamm Plaza, Pfäffikon SZ, January 23, 2007.

F. Gassmann
Vorstellungen über die Atome von den Alten Griechen bis heute
Volkshochschule der Region Zurzach, PSI, September 20 und 27, October 4 und 11, 2007.

F. Gassmann
Unser Klima im Wandel
KKW Beznau, Döttingen, October 31, 2007.
T. Gerber
Combustion research with spectroscopic measurement techniques
Seminary, University Neuchâtel, March 26, 2007.

D. Gstoehl, A. Steinfeld
Solar hydrogen production via the ZnO/Zn water-splitting thermochemical cycle
16th Int. Symposium on the Reactivity of Solids, Minneapolis, USA, June 3-6, 2007.

L. Gubler
Strategy for aging tests of fuel cell membranes
US DoE High Temperature Membrane Working Group Meeting (joint session with CARISMA), October 10, 2007.

M. Gysel
Hygroscopic and CCN properties of aerosols - linking laboratory studies with field experiments
Forschungszentrum Jülich, Germany, December 13-14, 2007.

M. Gysel
Activation behaviour of aerosol particles in mixed phase clouds at the high alpine research station Jungfraujoch
Special Symposium on Atmospheric Observations and Advanced Measuring Techniques in the Remote Areas within the Asian Aerosol Conference 2007, Kaohsiung, Taiwan R.O.C., August 26-29, 2007.

P. Jansohn
Erneuerbare Energien und Energieeffizienz
5. Unternehmensforum Baden-Württemberg - Zürich, Stuttgart, Germany, July 20, 2007.

J. Judex, S.M.A. Biollaz
Conceptual analysis for a grass fired IGCC plant
2nd International Freiberg Conference on IGCC and XTL Technologies, Freiberg, Germany, May 8-12, 2007.

M. Kalberer
Investigation of health effects of organic aerosol particles: first results using a new particle deposition chamber
NOSA - Nordic Aerosols Society Annual Meeting 2007, Helsingør, Denmark, November 7-9, 2007.

M. Kalberer
Ultra-high resolution mass spectrometry as a tool to advance organic aerosol characterization
NOSA - Nordic Aerosols Society Annual Meeting 2007, Helsingør, Denmark, November 7-9, 2007.

R. Kötz
Carbon-based electrochemical capacitors – drawbacks and opportunities
Plenary Lecture, 2007 International Conference on Advanced Capacitors (ICAC2007) Kyoto, Japan, May 28-30, 2007.

R. Kötz
Supercapacitors
Umicore Materials for Sustainable Energy Workshop, Mechelen / Brussels, Belgium, June 27, 2007.

R. Kötz
Fuel cell – supercapacitor hybrids
f-cell, Die Brennstoffzelle / 7. Forum für Produzenten und Anwender, Stuttgart, Germany, September 24-26, 2007.

R. Kötz
A 250 V supercapacitor module for a hybrid fuel cell supercapacitor vehicle
Advanced Energy Storage Technologies Symposium 2007, Euro Capacitors 2007, Cologne, Germany, November 5-8, 2007.

R. Kötz
Supercaps – Elektrochemische Doppelschichtkondensatoren
Hoppecke Batterien, F&E Kolloquium, Brilon, Germany, November 26, 2007.
A. Kress
Praxisorientiertes Feuermanagement im Biosphärenreservat Pedjari (Benin, Westafrika)
Geographentag 2007, Bayreuth, Germany, 2007.

O. Kröcher
SCR an Fe-Zeolithen im Dieselabgas
Universität Karlsruhe, Germany, November 16, 2007.

O. Kröcher
Chemical challenges in the development of urea-SCR systems
- International CTI Forum SCR-System, Karlsruhe, Germany, May 9-10, 2007.
- Volkswagen AG, Wolfsburg, Germany, September 20, 2007.
- 2nd International CTI Forum SCR-System, Stuttgart, Germany, October 15-16, 2007.

O. Kröcher
Challenges in the Urea-SCR Process
Abgaszentrum der Automobilindustrie, Weissach, Germany, June 13, 2007.

O. Kröcher
Urea-Decomposition in the Urea-SCR Process
erphi electronic (BOSCH), Holzkirchen, Germany, May 15, 2007.

O. Kröcher
New challenges for urea-SCR systems: From vanadia-based to zeolite-based SCR catalysts
- 1st Conference: $MinNO_x$ – Minimization of NO_x Emissions through Exhaust Aftertreatment, Berlin, Germany, February 1-2, 2007.
- Swenox AB, Göteborg, Sweden, April 3, 2007.

T. Lippert
Laser-induced Backside Wet Etching: from Fundamentals to Applications
Politecnico di Milano, Materials Day (Centre of Excellence "NanoEngineered MAterials and Surfaces – NEMAS), Milano, Italy, February 2007.

T. Lippert
Interactions of photons with surfaces: structuring, modification, and applications
Institute for Chemistry and Technology of Organic Materials, Graz University of Technology, Graz, Austria, April 2007.

T. Lippert
Interactions of photons with surfaces: structuring, modification, and applications
Leibniz Institute-IOM, Leipzig, Germany, April 2007.

T. Lippert
Laser-based deposition of thin films: methods and process analysis
University of Linz, Austria, Department of Applied Physics, July 2007.

T. Lippert
Thin films prepared by pulsed laser deposition for renewable energy application
– LASERION, Tegernsee, Germany, July 2007.
– University of Caen, Laboratoire CRISMAT, France, October 2007.

T. Lippert
Polymers designed for laser application
Max-Born Institut, Berlin, Germany, August 2007.

Ch. Ludwig
Energy and materials from waste and biomass
ETH Zürich, August 23, 2007.

Ch. Ludwig, L. Hermann[1]
Die Ressource Abfall - rohstofflich oder energetisch nutzen ?
Vortragsabend Studiengruppe Energieperspektiven Baden, August 30, 2007
[1] ASH DEC, Wien, Austria

J. Mantzaras
Hetero-/homogeneous combustion at the microscale
Keynote Lecture, Australian Combustion Symposium 2007 (ACS 2007), Sydney, Australia, December 11, 2007.

J. Mantzaras
Catalytic combustion: from microreactors to large power generation systems
Zentrum für Innovationskompetenz Virtuhcon, TU Freiberg, Germany, October 18, 2007.

A. Meier, A. Steinfeld
A close look at the potential of renewable energy sources
SPS Annual Meeting, Zürich, February 20, 2007.

A. Meier, A. Steinfeld
The ultimate goal: Solar hydrogen production from water
World Solar Power 2007, Seville, Spain, October 26, 2007.

A. Metzger
Influence of sulfur dioxide on nucleation, growth and yield of secondary organic aerosol of 1,3,5-trimethylbenzene
California Institute of Technology-Chemical Engineering-John H. Seinfeld, Los Angeles - Pasadena, USA, December 17, 2007.

P. Novák
Interface electrochemistry - the scientific key to long-lasting lithium-ion batteries
Seminar at the Department of Chemistry, Seoul National University, Seoul, Korea, June 14, 2007.

P. Novák
In situ Raman spectroscopy of insertion electrodes for lithium-ion batteries and supercapacitors
The 14th International Symposium on Intercalation Compounds ISIC-14, Seoul, Korea, June 12, 2007.

P. Novák
Materials and interfaces in lithium-ion batteries
National Institute of Advanced Industrial Science and Technology, Osaka, Japan, June 8, 2007.

A.S.H. Prévôt
Ozone research at PSI
BAFU Seminar, Bern, June 11, 2007.

A.S.H. Prévôt
Bisherige Resultate zur Quellenzuordnung des Feinstaubes in der Schweiz: Aerowood und mehr
BAFU Seminar, Bern, October 29, 2007.

A.S.H. Prévôt
Sources and processes influencing the chemical composition of ambient particles in Central Europe
Nano Science Seminar, Göteborg, Sweden, September 18, 2007.

A.S.H. Prévôt
Meteorologische Einflüsse auf Feinstaub
DACH Meteorologentagung, Hamburg, Germany, September 10-14, 2007.

A.S.H. Prévôt
Primäre versus sekundäre Komponenten im Feinstaub. Übersicht über die Aerosolmassenspektrometermessungen im Rahmen von Aerowood und generell in der Schweiz
Workshop-Wintersmog 2007, Zürich, October 16, 2007.

A.S.H. Prévôt
Fine and ultrafine particle measurements in Switzerland at various stations and on different roads
Ultrafine Particles in Urban Air, Dresden, Germany, October 23-24, 2007.

S. Ramesohl[1], S. Stucki
Biomethane as a transportation fuel - substitution potential of conventional and second generation biogas
ICR International Conference Transport and Environment: A global challenge, Technological and policy Solutions, Milano, Italy, March 21, 2007.
[1] Wuppertal Institute for Climate Environment Energy, Germany

M. Saurer
Isotope signals in ecosystem research
Joint Research Centre, Ispra, Italy, November 12-13, 2007.

G.G. Scherer
Electrochemical conversion and storage systems - chances and obstacles on the way to the market place
Swiss Physical Society, Annual Meeting 2007, Session 7 *Challenges of Future Energies,* Universität Zürich – Irchel, February 23, 2007.

G.G. Scherer
Polymermembranen als Festelektrolyte für Brennstoffzellen
FHNW, Windisch-Brugg, March 28, 2007.

G.G. Scherer
Polymer membranes as solid electrolytes for fuel cells
Workshop on Fuel Cells, ICCMP, University of Brasilia, Brasil, April 9–13, 2007.

G.G. Scherer
Combined in situ characterization methods for polymer electrolyte fuel cells
Workshop on Fuel Cells, ICCMP, University of Brasilia, Brasil, April 9–3, 2007.

G.G. Scherer
Materials research for polymer electrolyte fuel cells - activities at Paul Scherrer Institut
NRC Institute for Fuel Cell Innovation , Vancouver, Canada, September 5, 2007.

G.G. Scherer
What can we learn from combined locally resolved in situ diagnostic methods for PEFCs?
NRC Institute for Fuel Cell Innovation, Vancouver, Canada, September 5, 2007.

G.G. Scherer
Combined locally resolved in situ diagnostic methods for PEFCs – our approach at Paul Scherrer Institut
Ballard Power Systems, Vancouver, Canada, September 6, 2007.

G.G. Scherer
Combined locally resolved in situ diagnostic methods for polymer electrolyte fuel cells
University of Victoria, Institute for Integrated Energy Systems, Victoria, Canada, September 7, 2007.

G.G. Scherer
Influence of crosslinking on irradiated ETFE based grafted membranes
58th Annual Meeting, International Society of Electrochemistry, Banff, Canada, September 9–14, 2007.

G.G. Scherer
Elektrochemische Wandler- und Speichersysteme für automobile Anwendungen
GDCH-Wissenschaftsforum Chemie 2007, Universität Ulm, Germany, September 17–19, 2007.

G.G. Scherer
From Hy-Light to Hupd platinum nanoparticles for electrochemical energy conversion
Electrochemistry in the Nanoregime, Bunsen Kolloquium dedicated to Prof. Dr. Dieter M. Kolb on the occasion of his 65th birthday, Kloster Roggenburg, Germany, December 12-14. 2007.

T.J. Schildhauer
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[1] EMPA Dübendorf
[2] National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania
[3] PSI und ETH Zürich

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– EUCAARI yearly meeting 2007, Helsinki, Finnland, November 19-23, 2007,
– EMPA PhD Symposium, Dübendorf, November 21, 2007,
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A. Metzger, B. Verheggen, J. Duplissy, J. Dommen, E. Weingartner, A.S.H. Prévôt, U. Baltensperger
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[1] ETH Zürich
[2] EMPA Dübendorf
[3] Behr GmbH, Stuttgart, Germany

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Ch. Wieckert
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CONFERENCES, WORKSHOPS & EXHIBITIONS

F. Ackermann
Analyzing and applying cognitive mapping in complex strategy building environment
Workshop, Universität Bern, August 28–29, 2007.
Organizer: Silvia Ulli-Beer, Stephan Grösser

S. Andreani-Aksoyoglu
International Symposium on Air Quality Management at Urban, Regional and Global Scales
Scientific Advisor

U. Baltensperger
Wintersmog-Workshop 2007
ETH Zürich, October 16, 2007.
Member of the Organizing Committee

W. Durisch
World Renewable Energy Congress
Steering Committee Member

M. Furger
DACH2007 - Deutsch-Österreichisch-Schweizerische Meteorologentagung
September 10-14, 2007.
Conference Organisation, Member of the Scientific Committee, Member of the Programme Committee, Session Convener

M. Furger
J*ahrestagung der Schweizerischen Gesellschaft für Meteorologie*
5th Swiss Geoscience Meeting 2007, Session 'Meteorology and Climatology', Geneva, November 16-17, 2007
Member of the Programme Committee, Session Convener, and Session Chair

M. Furger
Swiss Geosciences Meeting 2007
Member of the Programme Committee

T. Gerber
Towards Clean Diesel Engines
Steering Committee

P. Jansohn
Forschungsprogramm "Kraftwerk 2020" (Jahrestagung)
Bundesamt für Energie (BFE), Bern, August 23, 2007.
Organisator/Programmleiter

P. Jansohn, S. Renz, K. Boulouchos
Verbrennungsforschung in der Schweiz
PSI, Villigen, November 5, 2007.
Veranstalter

P. Jansohn
Leonhard Euler Center (LEC) – Swiss ERCOFTAC Pilot Center (2007 Annual Meeting)
PSI, December 14, 2007.
Mit-Veranstalter/Gastgeber

R. Kötz
58th Annual Meeting of the International Socity of Electrochemistry, Banff, Canada
Co-Organizer Symposium 2: Energy Storage and Energy Conversion Systems, September 9-14, 2007.

R. Kötz
Member of the International Advisory Committee, ICAC2007, International Conference on Advanced Capacitors, May 28-30, 2007.

Ch. Ludwig
R'07 World Congress, Davos, September 3-5. 2007
Member of the core management group, steering committee, organizing committee, scientific panel, and poster award committee

Ch. Ludwig
REWAS 2008, Global Symposium on Recycling, Waste Treatment and Clean Technology, October 12-15, 2008 Cancun, Mexico
Co-chair of the conference

P. Novák
58th Annual Meeting of the International Society of Electrochemistry

Banff, Canada, September 9-14, 2007.
Organizing Committee

A.S.H. Prévôt
Wintersmog-Workshop 2007
ETH Zürich, October 16, 2007.
Member of the Organizing Committee

P.P. Radi
European Conference on Nonlinear Optical Spectroscopy
Steering Committee

G.G. Scherer, R. Kötz
23. Tagessymposium – Electrocatalysis
Paul Scherrer Institut, May 03, 2007
Organizers

G.G. Scherer
BFE Impulseday – Hydrogen and Fuel Cell
Paul Scherrer Institut, November 30, 2007.
Co-Organizer

A. Steinfeld
HYSYDays 2nd World Congress of Young Scientists on Hydrogen, *Italy*
Scientific Committee

A. Steinfeld
4th Int. Conf. Solar Generation of Electricity and Hydrogen, *Spain*
Scientific Committee

A. Steinfeld
4th European Congress on Economics and Management of Energy, Portugal
Scientific Committee

A. Steinfeld
2nd IASTED Africa Conference on Power and Energy Systems, *Botswana*
Scientific Committee

S. Weimer
Empa PhD Symposium
EMPA Dübendorf, November 27, 2007.
Member of the Organizing Committee

R. Zah[1], Ch. Ludwig
Workshop "Biofuels – from Waste or Agriculture ?"
R'07 World Congress, Davos, September 4th, 2007.
Moderator
[1] EMPA Dübendorf

MEMBERSHIPS IN EXTERNAL COMMITTEES

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Umweltforschung der Forschungszentrum Jülich GmbH
Wissenschaftlicher Beirat, Vorsitzender
Wissenschaftlich-Technisches Ausschuss Mitglied

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Center of Excellence in Analytical Chemistry, ETH Zürich
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sc nat Commission, Atmospheric Chemistry and Physics
President

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Scientific Advisory Group for Aerosol within Global Atmosphere Watch
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WMO/IUGG International Aerosol-Precipitation Science Assesment Group (IAPSAG)
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ESF Programme, Interdisciplinary Tropospheric Research: from the Laboratory to Global Change (INTROP)
Scientific Steering Committee

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Atmospheric Chemistry and Physics
Editorial Board

U. Baltensperger
COST633, Particulate matter: Properties related to health effects
Management committee member

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Prüfungskommission für die Lehrlinge des Laborantenberufes des Kantons Zürich
Prüfungsexperte

W. Durisch
International Energy Foundation, IEF
Advisory Committee Member and Under Secretary Science and Technology

M. Furger
Meteorologische Zeitschrift
Editor

M. Furger
Schweizerische Gesellschaft für Meteorologie
President

M. Furger
Landeskomitee IUGG
Member
National Representative of the International Association for Meteorology and Atmospheric Sciences (IAMAS)

F. Gassmann
Naturama, Aarau
Vice President of Geschäftsleitung

F. Gassmann
Naturforschende Gesellschaft in Zürich
Member of editing committee of Vierteljahrsschrift, Neujahrsblatt and treasurer of the Society
F. Gassmann
Maturakommission für die Kantonsschulen Baden und Wohlen
Experte für Mathematik und Physik

P. Jansohn
International Energy Agency (IEA), Implementing Agreement on Energy Conservation and Emission Reduction in Combustion
Collaborative Task Leader

P. Jansohn
VDI-Gesellschaft Verfahrenstechnik und Chemieingenieurwesen (GVC), Fachausschuss „Hochtemperaturtechnik“
Berufenes Mitglied

P. Jansohn
European Turbine Network (ETN), Conference Advisory Committee
Member

R. Kötz
Electrochimica Acta
Member of the Advisory Board

R. Kötz
International Society of Electrochemistry
Member of the Publications Committee

T. Lippert
Board of Delegates E-MRS
Board

T. Lippert
Journal of Laser Micro/Nanoengineering (JLMN)
Co-Editor

T. Lippert
Laser Chemistry
Associate Editor

Ch. Ludwig
EU Commission
Member of expert group for the evaluation of EU research proposals

Ch. Ludwig
BFE-Projekt: Bewertungsmethode für Technologien zur Nutzung von biogenen Abfällen
Experte und Mitglied der Begleitgruppe

A. Meier
International Energy Agency SolarPACES
Operating Agent

A. Meier
SOLLAB – Alliance of European Laboratories on Solar Thermal Concentrating Systems
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P. Novák
International Society of Electrochemistry
Member of Executive Committee (Treasurer) and Council

P. Novák
International Society of Electrochemistry
Member of Scientific Meeting Committee

P. Novák
The Electrochemical Society, Inc.
Member of the Technology Award Committee of the Battery Division

P. Novák
Electrochimica Acta
Guest Editor

A.S.H. Prévôt
sc nat Commission, Atmospheric Chemistry and Physics
Scientific secretary

P.P. Radi
Journal of Raman Spectroscopy
Guest-Editor

M. Saurer
Association for Tree-Ring Research
Advisory Council

M. Saurer
Dendrochronologia
Associate Editor

G.G. Scherer
Beirat Forschungsallianz Brennstoffzelle Baden-Württemberg, Germany
Deputy Speaker

G.G. Scherer
Maturitätsprüfungskommission der Kantonsschulen Baden, Wettingen und Wohlen
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Scientific Steering Committee for the Stable Isotope in Biospheric - Atmosphere Exchange (SIBAE), an ESF Scientific Programme
Member

R.T.W. Siegwolf
Tree Physiology
Editorial Review Board

R.T.W. Siegwolf
German Association for Stable Isotope Research (GASIR)
Stellvertretender Vorsitzender der Arbeitsgemeinschaft

A. Steinfeld
SOLLAB – Alliance of European Laboratories on Solar Thermal Concentrating Systems
Steering Committee

A. Steinfeld
IMDEA-Energía, *Spain*
Scientific Council

E. Weingartner
Fachgruppe zum Thema: Partikelzählung / Partikelgrössenanalyse
Ziel: Erarbeiten von Empfehlung zum Einsatz von Partikelzählern und Partikelgrössenanalysatoren bei Aerosolen
Member

Ch. Wieckert
Hydropole-Swiss Hydrogen Association
Board Member
A. Wokaun
Schweiz. Akademie der Technischen Wissenschaften (SATW)
Einzelmitglied

A. Wokaun
Wissenschaftlicher Beirat des Hahn-Meitner-Institut, Berlin
Mitglied

A. Wokaun
European Climate Forum
Member of Council

A. Wokaun
novatlantis – Nachhaltigkeit im ETH-Bereich
Mitglied der Projektleitung

A. Wokaun
Studiengruppe Energieperspektiven
Präsident

A. Wokaun
CORE
Mitglied

A.Wokaun
Advisory Group on Energy (AGE), European Union
Mitglied

AWARDS

H. Ben youcef, S. Alkan Gürsel, L. Gubler, A. Wokaun, G.G. Scherer
Effect of crosslinker concentration on performances and properties of styrene grafted onto ETFE based membranes
Best Poster, 3rd International Symposium on Reactive Polymers in Inhomogeneous Systems, in Melts and at Interfaces, Dresden, Germany, September 23-26, 2007.

P. Boillat, D. Kramer, B.C. Seyfang, G. Frei, E. Lehmann, G.G. Scherer, A. Wokaun, Y. Tasaki[1], Y Ichikawa[1], K. Shinohara[1]
Application of high resolution neutron imaging in polymer electrolyte fuel cell (PEFC) diagnostics
Best Poster, "From Physical Understanding to Novel Architectures of Fuel Cells", International Center for Theoretical Physics, Trieste, Italy, May 21-25, 2007.
[1] Nissan Motor Co., Ltd., Yokosuka-shi, Japan

S. Bruppacher, S. Ulli-Beer, S. Grösser, M. Müller, F.d. Simoni, R. Kaufmann-Hayoz
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Best Poster Award at the 8th Swiss Global Change Day, April 4, 2007.

P. Griebel, E. Boschek, P. Jansohn
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Best Technical Paper Award 2006, Combustion & Fuels Committee, ASME International Gas Turbine Institute, ASME Turbo Expo, Montreal, Canada, May 14-17, 2007.

S. Karagiannidis, J. Mantzaras, G. Jackson, K. Boulouchos[1]
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Distinguished Paper Award
[1] ETH Zürich

A. Kress
Umweltpreis der Sparkassenstiftung Karlsruhe
Karlsruhe, Germany, May 15, 2007.

J.S. Luterbacher[1], M. Fröling[2], F. Maréchal[1], F. Vogel, J.W. Tester[2]
High Yield Methane Generation from Wet Biomass and Waste
Poster Prize Award, AGS Annual Meeting, Barcelona, Spain, March 18-21, 2007.
[1] EPFL
[2] MIT, USA

F. Meier
Solar thermochemical cycle for ammonia production based on aluminium-based redox reactions
ETH Medal to M.Sc. Thesis of ETH Zurich.

L.O. Schunk, P. Häberling, S. Wepf, D. Wuillemin, A. Meier, A. Steinfeld
A rotary receiver-reactor for the solar thermal dissociation of zinc oxide
Best Paper Award, ASME Energy Sustainability Conference 2007, Long Beach, California, USA, June 27-30, 2007.

A. Steinfeld
University of Minnesota
Founders Lecture Award

S. Stucki, F. Waser, S.M.A. Biollaz, M. Schaub[1]
Methan aus Holz. Ein nachhaltiger Biokraftstoff und mehr
Bank Sarasin, Basel; Moppert-Preis 2007.

[1] CTU Winterthur

LIST OF PUBLICATIONS

Large Research Facilities and PSI-XFEL Project

UNIVERSITY LEVEL AND OTHER TEACHING

A. Adelmann
Statistics and Probability Theory
University of Applied Science Zurich, Switzerland, Spring Semester 2007

R. Bakker
An introduction to FELs
CERN Accelerator School - Daresbury, UK, September 25, 2007

M. Dehler
Real Time Control of Beam Parameters
CERN Accelerator School on Digital Signal Processing, Sigtuna, Sweden, May 31 - June 9, 2007

D. Kiselev
Aktuelle Experimente am Beschleuniger zur Kern- und Nukleonenstruktur
University of Basel, Switzerland, Spring Semester 2007

B. Krusche, D. Kiselev
Einführung in die Kern- und Teilchenphysik
University of Basel, Switzerland, Autumn Semester 2007

B. Krusche, D. Kiselev
Proseminar: Kern- und Teilchenphysik
University of Basel, Switzerland, Autumn Semester 2007

L. Rivkin
Introduction to Particle Accelerators
EPFL Lausanne, Autumn Semester 2007

Th. Schilcher
Digital Signal Processing in RF Applications
CERN Accelerator School on Digital Signal Processing, Sigtuna, Sweden, May 31 - June 9, 2007

M. Schneider
Grundlagen der Elektronik
Technikerschule HF, Zürich, Switzerland, Winter Semester 2006/07, Summer Semester 2007, Autumn Semester 2007

U.D. Straumann, U. Langenegger, M. Dittmar, K. Müller, O. Steinkamp, A. Streun
Experimental Methods of Particle Physics
Joint lecture University and ETH Zürich, Switzerland, Autumn Semester 2007/08

PEER REVIEWED PAPERS

F. Atchison, B. Blau, K. Bodek, B. van den Brandt, T. Brys, M. Daum, P. Fierlinger, A. Frei, P. Geltenbort, P. Hautle, R. Henneck, S. Heule, A. Holley, M. Kasprzak, K. Kirch, A. Knecht, J.A. Konter, M. Kuźniak, C.-Y. Liu, C.L. Morris, A. Pichlmaier, C. Plonka, Y. Pokotilovski, A. Saunders, Y. Shin, D. Tortorella, M. Wohlmuther, A. R. Young, J. Zejma, G. Zsigmond
Cold Neutron Energy Dependent Production of Ultracold Neutrons in Solid Deuterium
Phys. Rev. Letters **99**, 262502 (2007)

P. Beaud, S.L. Johnson, A. Streun, R. Abela, D. Abramsohn, D. Grolimund, F. Krasniqi, T. Schmidt, V. Schlott, G. Ingold
Spatiotemporal Stability of a Femtosecond Hard X-ray Undulator Source studied by control of coherent optical Phonons
Phys. Rev. Lett. **99**, 174801 (2007)

R. Dölling, S. Lin, P.-A. Duperrex, G. Gamma, B. Keil
Beam Diagnostics for the Proton Therapy Facility PROSCAN
Proc. AccApp 2007, Pocatello, USA, 152 (2007)

G. Heidenreich, B.D. Patterson
A rotating filter for the wiggler beamline at the Swiss Light Source
Nucl. Instr. and Meth. A **577**, 751 (2007)

G. Hiller, M. Knecht, F. Legger, T. Schietinger
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P.A. Schmelzbach
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INVITED TALKS

A. Adelmann
IBS at very Low Beam Energies
IBS 2007, Cockcroft Institute Daresbury, UK, August 28-29, 2007

A. Adelmann
High intensity ring cyclotron without flat-top: dream or realistic approach?
Cyclotrons 2007, Giardini Naxos, Italy, September 30 - October 5, 2007

R. Bakker
Current developments in the field of FELs
CNR, Dept. of Physics, Monte Rotondo, Italy, October 16, 2007

M. Böge
Design and Performance of the Fast Global Orbit Feedback at the SLS
NSLS-II Stability Workshop, BNL, USA, April 18-20, 2007
M. Dehler
Kicker Design for the EXFEL Intra Bunch Train Feedback
3rd PSI/XFEL Collaboration meeting, Hamburg, Germany, June 25-27, 2007

M. Dehler
Status of the pickup development for the EXFEL Intra Bunch Train Feedback
3rd PSI/XFEL Collaboration meeting, Hamburg, Germany, June 25-27, 2007

M. Dehler
Requirements for Tune, Coupling and Chromaticity Feedbacks for Light Sources
5th workshop in the framework of CARE-N3-HHH-ABI, Novel Methods for Accelerator Beam Instrumentation, Chamonix, France, December 11-13, 2007

R. Dölling
Beam Diagnostics for the Proton Therapy Facility PROSCAN
AccApp 2007, Pocatello, Idaho, USA, July 30 - August 2, 2007

J. Duppich, W. Wagner
The SINQ Neutron guide system, Design Principles, Technical Layout and Performance
KAERI Hanaro, Daejeon, South Korea, November 19-23, 2007

J. Duppich & the PROSCAN Team
Treatment of over 5000 patients with particle therapy at PSI – From a parasitic user to a stand-alone facility
ICANS XVIII 2007, Dongguan, Guangdong China, April 25-29, 2007

R. Ganter
Field Emission Cathodes
Workshop on New and Emerging Sources of intense beams of particles and short wavelength radiation, Lund, Sweden, June 11-13, 2007

W. Joho
The PSI Accelerator Facilities
Physics Institute, Mexico City, Mexico, January 25, 2007

W. Joho
The PSI Cyclotrons
Workshop on FFAG accelerators, Grenoble, France, April 13, 2007

W. Joho
The PSI Cyclotrons
Institute for Atomic Energy, Beijing, China, June 17-21, 2007

B. Keil
BPMs at PSI
DIPAC 2007, Venice, Italy, May 21, 2007

B. Keil
A Transverse Intra-Bunchtrain Feedback System for the European XFEL: Topology, Specifications, Subsystems
3rd PSI/XFEL Collaboration Meeting, Hamburg, Germany, June 25-27, 2007

B. Keil
The PSI DSP Carrier (PDC) Board: A Digital Signal Processing Back-End for the XFEL Intra-Bunch Train Feedback System
3rd PSI/XFEL Collaboration Meeting, Hamburg, Germany, June 25-27, 2007

B. Keil
Digital Beam Diagnostics and Feedback Systems at PSI
MAMI Accelerator Seminar, Mainz, Germany, June 28, 2007

D. Kiselev
Vector and tensor analysing powers of the H(vec(d),γ ^{3}He) capture reaction
11th Int. Conference on Meson-Nucleon Physics and the structure of the Nucleon, IKP, FZ Jülich, Germany, September 10-14, 2007

S.C. Leemann
The PSI X-FEL Project & the 100 keV Gun Test Stand
MAX-lab, Lund, Sweden, August 9, 2007

A. Lüdeke
Top-up experience at the SLS
15 th Europ. workshop on Synchrotron Light sources, Oxfordshire, UK, November 22-23, 2007

A. Lüdeke
Operation information management at the Swiss Light Source
6th Int. workshop on Accelerator Operation, Trieste, Italy, September 24-28, 2007

M. Negrazus
PROSCAN – Der neue Protonen Therapie Beschleuniger am PSI
MAMI Seminar, Institut für Kernphysik, University of Mainz, Germany, November 15, 2007

A. Oppelt
Towards a low emittance X-ray FEL at PSI
FEL 2007, Budker INP, Novosibirsk, Russia, August 26 – 31, 2007

B. Oswald, P. Leidenberger
3-dimensional finite element time domain analysis of an optical near-field configuration
3rd Workshop on Numerical Methods for Optical Nano Structures, ETH, Zurich, Switzerland, July 9-10, 2007

J.M. Schippers
Beam delivery techniques for hadron therapy and the PROSCAN project
Regionale Refereeravond Radiotherapie, University Medical Center, Groningen, the Netherlands, 31 May 2007

J.M. Schippers
The PROSCAN project, cyclotron design and solutions
Joint Symposium on Medical Accelerators, Med Austron, TFZ Wiener Neustadt, Austria, June 4, 2007

J.M. Schippers
Proton therapy at PSI: from sharing the beam of the ring cyclotron to a dedicated facility with a superconducting cyclotron
TRIUMF, Vancouver BC, Canada, August 22, 2007

J.M. Schippers
Beam production and delivery techniques for hadron therapy,
ESTRO 2007, Barcelona, Spain, September 8-13, 2007

P.A. Schmelzbach
Upgrade of the PSI Proton Accelerator Facility to 1.8 MW
5th Int. Workshop on Utilisation and Reliability of High Power Proton Accelerators, „HPPA5", Mol, Belgium, May 5-9, 2007

P.A. Schmelzbach
Concluding Remarks
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M. Schneider
Status report of RF-system for proton accelerator facilities at PSI
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M. Seidel
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M. Seidel
High Power Beam Operation at PSI
Conference on the SPIRAL 2 project, GANIL, Caen, France, November 26-30, 2007

F. Stulle
Turn Around Loop, Phase Correction and final Bunch Compression for the CLIC Drive Beam
European LC Workshop, CCLRC, Daresbury, England, January 8-11, 2007

F. Stulle
Latest results for the final CLIC Main Beam Bunch Compressor
European LC Workshop, CCLRC, Daresbury, England, January 8-11, 2007

F. Stulle
Impact of new CLIC parameters on Bunch Compressors and Turn Around Loop
CLIC Meeting, CERN, Geneva, Switzerland, July 20, 2007

F. Stulle
Bunch Compressors and Turn Around Loop for the CLIC Main Beam
CLIC Workshop, CERN, Geneva, Switzerland, October 16-18, 2007

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CLIC Workshop, CERN, Geneva, Switzerland, October 16-18, 2007

D.M. Treyer
Low-Latency High-Resolution Single-Shot Beam Position Monitors
DIPAC 2007, Venice, Italy, May 20 - 23, 2007

A.F. Wrulich
Overview of Synchrotron Light Sources
APAC 2007, Indore, India, January 28 – February 3, 2007

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The PSI-XFEL Project
The use of X-Ray Free Electron Lasers, SNF, Bern, Switzerland, April 20, 2007

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SSLS Synchrotron Radiation Workshop and Users Meeting, Singapore, June 12, 2007

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The PSI-Free Electron Laser Project
EW-MRS Fall Meeting, Warsawa, Poland, September 18-20, 2007

A.F. Wrulich
A Cost Optimized Free Electron Laser at PSI
3rd Swiss-Taiwanese Workshop in Nano-Sciences and Bio-Imaging, Zermatt, Switzerland, October 17-19, 2007

WORKSHOPS

A. Adelmann
Co-Organizer
HPC Workshop
ETH Zurich, Switzerland, September 3-4, 2007

V. Schlott
Co-Organizer
PSI / DESY Collaboration Meeting on Beam Stabilization and Intra Bunch Train Feedback Systems for the European XFEL
DESY, Hamburg, Germany, June 25-27, 2007

MEMBERSHIPS IN EXTERNAL COMMITTEES

A. Adelmann
- CSCS "Horizon Project" Steering Commitee
- Expert for Mathematics "Maturitaets Exams"
- Int. Super Computing Conference (ISC), Program Committee
- Member of the Project Group "Swiss National Strategic Plan for High Performance Computing and Networking”
- Swiss National Science Foundation, Referee
- DOE for HPC, Referee
- Speedup society, treasurer

R.J. Bakker
- Program Committee of the 2007 International FEL Conference, Novosibirsk Russia
- Member of the European Physical Society, Accelerator Physics (NOT EPAC08 organization)

M. Böge
- TPS Machine Advisory Committee, NSRRC, Taiwan
- NSLS-II Stability Workshop and Review, Committee Member, BNL, USA
- NSLS II Technical Review on Accelerator Physics, Committee Member, BNL, USA
- Physical Review Special Topics - Accelerators and Beams, Referee

T. Garvey
- STFC (UK) Accelerator Science and Technology Advisory Board
- Linear Accelerator Conference, Int. Organising Committee

T. Korhonen
- Review of NSLS II – Control Systems, Committee Member

L. Rivkin
- CERN Accelerator School, Advisory Committee
- DAPNIA Scientific Review Committee, CEA, France
- DESY, Machine Advisory Committee (Chairman)
- European Physical Society Accelerators Group, Prizes Selection Committee Chairman
- Joint Universities Accelerator School, Program Committee
- PAC2007 Program Committee
- Stanford Synchrotron Radiation Laboratory, Scientific Advisory Committee

W. Roser
- Swiss Society for Radiation Biology and Medical Physics, Board Member
- Comité Electrotechnique Suisse (CES), Member of TC 62

V. Schlott
- ALBA Spanish Light Source, Machine Advisory Committee, Bellaterra, Spain
- CERN Accelerator School on Beam Diagnostics, Programme Committee
- CARE Governing Board
- DIAMOND Light Source, Technical Advisory Committee
- DIPAC Scientific Programme Committee
- EuroFEL Advisory Board (Chairman)
- In Kind Review Committee for the European XFEL (Chairman)
- Scientific and Technical Issues Working Group for the European XFEL (XFEL-STI)

P.A. Schmelzbach
- Int. Conferences on Cyclotrons and their Applications: Int. Organizing Committee and Program Committee
- European Cyclotron Progress Meetings, Scientific Committee
- OECD/NEA Int. Workshops on the Utilisation and Reliability of High Power Proton Accelerators, Int. Scientific Advisor

Th. Schietinger
- European Committee for Future Accelerators (ECFA), member

Th. Schilcher
- Review Committee for LLRF system based on ATCA standard for the European X-FEL, DESY

J.M. Schippers

- Review committee for the new cyclotron and beam lines Centre de Protonthérapie Orsay, Orsay, France
- Advisory committee of a new Hadrontherapy facility, Erasmus University Medical Center, Rotterdam, Netherlands
- Advisory committee of the Groningen Particle Therapy Facility, University Medical Center Groningen, Groningen, Netherlands

M. Seidel

- Review committee on accelerator lattices for the FAIR project

A. Streun

- NSLS II Technical Review on Accelerator Physics, Committee Member, BNL, USA
- Physical Review Special Topics - Accelerators and Beams, Referee

D. Vermeulen

- Int. Conference on Accelerator and Large Experimental Physics Controls Systems, Scientific Advisory Committee

A.F. Wrulich

- CNAO, I, Comitato Tecnico
- DIAMOND, UK, Technical Advisory Committee, Chair
- ELETTRA, I, Machine Advisory Committee, Chair
- MAX-lab, S, Scientific Advisory Committee
- NSLS-II, US, Project Advisory Committee
- SESAME, Jordan, Technical Advisory Committee, Chair
- VisCo, Singapore, Visiting Committee for the SSLS
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Logistics

LIST OF PUBLICATIONS

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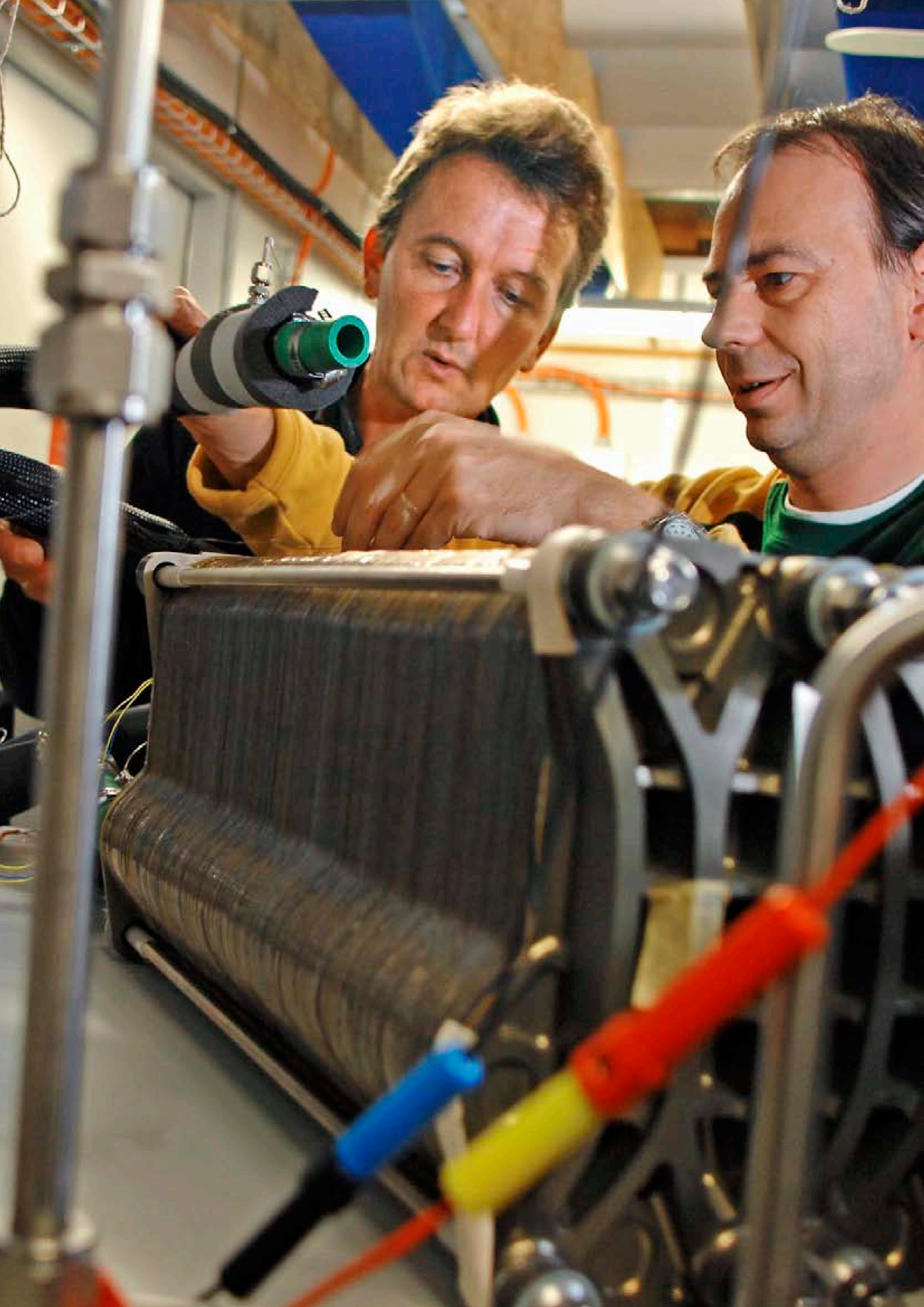

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