Inside nmi3

Issue 1 - July 2011

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SEVENTH FRAMEWORK PROGRAMME

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Editorial

NMI3: Innovation for the benefit of the user community

Over the past ten years, NMI3 has forged itself an excellent reputation as a main driver of European Research. It is widely recognised as a trademark for successful collaboration in the field of neutron scattering and muon spectroscopy. NMI3 demonstrates that European research infrastructures can collaborate efficiently at times where signs of fatigue are detectable in the European integration process. By supporting NMI3, the European Commission plays an essential and irreplaceable role in nurturing excellence in European neutron and muon research.

NMI3 aspires to incorporate all actors on the European neutron and muon scene. This aspiration is driven by the sole desire to provide a better service to European neutron and muon users. Transnational Access is the most effective tool to achieve this goal. It supports European researchers seeking open access to experimental facilities outside their home country. Joint Research Activities act indirectly on the quality of the service provided, by improving the infrastructures offered to users. They help facilities share costs for technological development and they foster the exchange of expertise. These collaborations are particularly important in the current European conjuncture, as public spending on research is curtailed to help the recovery of public finances. Neutron and muon facilities do not escape from this reality. The costly duplication of efforts thus becomes an even more forbidding exercise than in the past. The third line of action followed by NMI3 concerns the fostering of the user community, with a particular emphasis on training users and on disseminating results.

With its Innovation Union scheme, the European Commission has placed innovation at the heart of its strategy for the next decade. NMI3 has taken up the challenge and will offer innovative services during the years to come. This includes easier access, collaborative research in areas particularly relevant to emerging user communities, and a strong emphasis on training, which is symbolised by the future European Neutron and Muon School, as well as the upcoming e-learning platform.

Good communication lies at the heart of innovation. In 2011, we have decided to boost our communication activities, for the benefit of our users, the scientific community and the general public. *Inside NMI3* aims to keep you informed on the progress of our various activities. Our website (www.nmi3.eu) will be completely redesigned, so that it is as informative and user-friendly as possible.

Communication being a two-way process, we welcome your comments and criticisms, as they will help us to further improve our services.

We hope that you enjoy reading this newsletter as much as we enjoyed writing it.

Helmut Schober and Juliette Savin

Prof. Helmut Schober (schober@ill.fr) is the NMI3 Coordinator. He is a senior staff member at the Institut Laue Langevin (ILL), responsible for the Time-of-Flight and High-Resolution Group.

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Focus on Joint Research Activities

NMI3 currently funds 7 Joint Research Activities (JRAs), whose aim is to bring together experts working on instruments and techniques for neutron scattering and muon spectroscopy. In this issue of *Inside NMI3* we present to you the latest developments in two of our JRAs: the Neutron Optics and the Detectors projects.

Neutron Optics

By Frédéric Ott

The field of Neutron Optics is revolutionising neutron scattering in the same way that telescopes changed astronomy based on observations made with the naked eye. Thanks to technological advances made over the last decade, a number of optical concepts, until recently impossible to exploit, can now be transposed to neutron optics. The aim of the Joint Research Activity in Neutron Optics is to develop new optical components that can be implemented on neutron scattering spectrometers. The neutron scattering field used to be the realm of large samples ($1cm^3$). It is now possible to analyse sub-mm samples and imaging at the µm scale is within reach in the foreseeable future. Here we report on the latest achievements of the Joint Research Project.

High resolution imaging

An elliptic focusing neutron guide was combined with a cold neutron imaging instrument to produce a cone-beam, whose parameters were then characterised both at the focal point and at the detector position. This point source geometry provides improved experimental conditions for tomographic applications, providing a larger beam cross-section and enabling geometric magnification. The experimental data were compared with Monte Carlo simulations and both experiments and simulations demonstrate superior spectral and geometric homogeneity of the cone-beam setup compared to the conventional pinhole geometry.

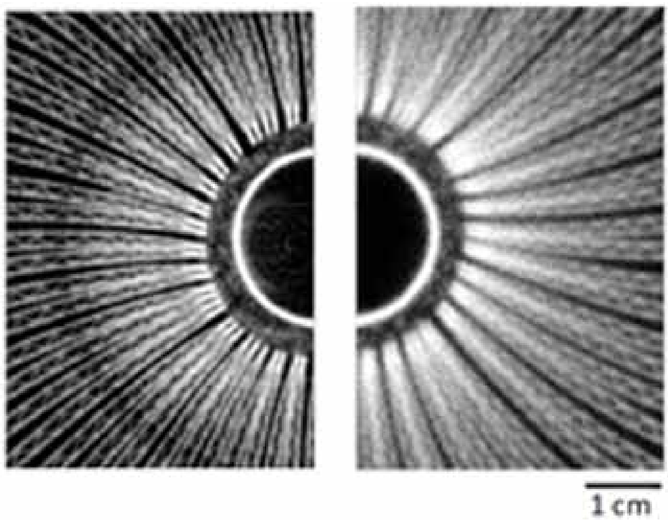

Figure 1. Tomographic slice of the central part of a particle filter measured in the cone-beam geometry (left) and parallel-beam scanning geometry (right). *Neutron tomography using an elliptic focusing guide,* N. Kardjilov, A. Hilger, M. Dawson, I. Manke, J. Banhart, M. Strobl and P. Böni, Journal of Applied Physics 108, 034905 (2010)

Dr. Frédéric Ott works at the LABORATOIRE LEON BRILLOUIN (CEA/CNRS) in Gif-Sur-Yvette, France. He is the coordinator of NMI3´s Neutron Optic Joint Research Activity (JRA).
JRA Partners : ILL (France), TUM (Germany), FZJ (Germany), HZB (Germany), CEA (France), NPI (Czech Republic), CNR (Italy), UCPH (Denmark), EPFL (Switzerland) BNC-RISP (Hungary)

Advanced reflective optics: laterally graded and parabolically bent multilayer

We have designed and built a parabolically-shaped reflector with a Ni/Ti-multilayer coating, graded along the length of the device. The bilayer thickness follows the varying angle of incidence to match the Bragg condition for a beam parallel to the axis of the parabola. As measurements show, this concept leads to a higher reflectivity for monochromatic neutrons compared to a conventional super-mirror coating. With a reflectivity R=96% we measured a gain of 5 when focusing a 8.6mm wide beam of 0.1° divergence down to 1.6mm. The wavelength band was 4.7 A°+/- 5% and the focal point was 250mm behind the device (figure 2).

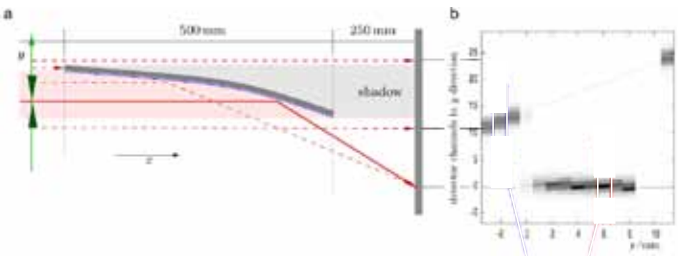

Figure 2. (a) Measurement scheme for the fixed substrate (gray) with coating (blue). The beam (red) was scanned along the y-direction and measured with a position sensitive detector. (b) Intensity map (white means zero, black maximum intensity of 3000 cts) as a function of the incident beam position y and the position on the detector (ordinate, measured in channels of 0.78mm width). The 8.6mm high beam is focussed on a 1.6mm high region.
Focusing of cold neutrons: Performance of a laterally graded and parabolically bent multilayer, M. Schneider, J.Stahn, P.Böni, Nuclear Instruments and Methods in Physics Research A 610 (2009) 530–533

Monte-Carlo modelling

The MCStas development group is making efforts to spread the use of McStas through workshops. A McStas/VITESS user training workshop was organised in May 2010 in Ven, Sweden, by Peter Willendrup, Linda Udby, Klaus Lieutenant, and Emmanuel Farhi (see www.essworkshop.org)

The next MCNSI7 simulators workshop is being organised as a satellite conference to ECNS2011. It will be held 23-24 July in Prague.

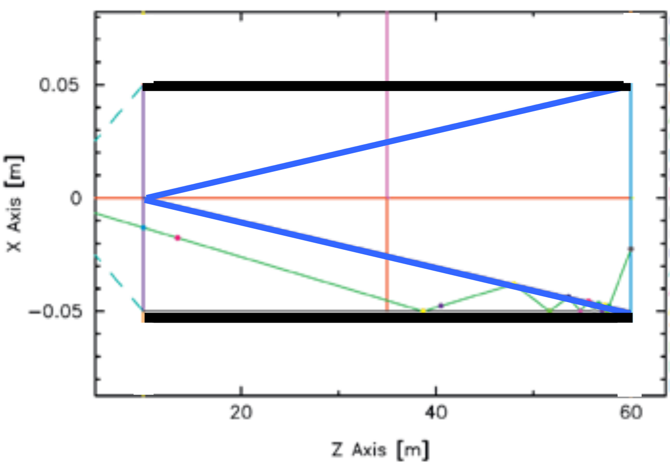

Figure 3. Meta-components have been introduced in McStas so as to be able to build complex optical elements from simple optical elements.
Example of a neutron ray travelling through a mirror guide (thick black lines) with inserted wedge mirrors (thick blue line). Neutron path in green, reflecting on the guide wall, the inserted wedge, and eventually being transmitted. *Using McStas for modelling complex optics, using simple building bricks.* Peter K. Willendrup, Linda Udby, Erik Knudsen, Emmanuel Farhi, Kim Lefmann, Nuclear Instruments and Methods in Physics Research A 634 (2011) S150–S155

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Detectors

By Karl Zeitelhack

Grand challenges for neutron detection

In view of the upcoming new generation of powerful spallation sources, the benefit of a higher neutron flux relies on the development of new, fast and highly efficient neutron detection systems. From a physical point of view, the detection is based on the absorption of the neutron and the subsequent recording of either the electrical charge generated or the light emitted through the absorption process. The best performance so far has been achieved using ^{3}He gas as absorbing material, both in terms of detection efficiency and an optimal signal to noise ratio. On the other hand, scintillation counters based on solid converters such as Li-glass, which detect the emitted light, are capable of faster detection: they can record more neutrons per detection area and achieve a better time resolution if required.

Six European partners (CNR, FZ Jülich, ILL, LIP, STFC, TUM) have teamed up in a Joint Research Activity to develop a detector in which both of the effects described above are combined. In this so called Gaseous Scintillation Proportional Counter (GSPC), primary photons are created when the neutron is absorbed and secondary photons are emanating from the ion cloud created after the absorption, in the charge amplifying region of a micro pattern device.

Spatial precision of detection is very important for modern neutron applications. In the GSPC detector, this is achieved by using several detectors of light called Photo Multiplying Tubes (PMT) in a particular array. Investigating this new detection process and developing adequate readout electronics are the main tasks of this JRA project. The aim is to demonstrate the feasibility of this new kind of detector within a 20 x 20 cm^2 active area, capable of achieving a 0.5 mm position resolution together with a 1 MHz count rate capability.

Gaseous Scintillation Proportional Counters

Micro pattern charge amplifying structures like MicroStrip Gas Counters (MSGC) have been shown to be very efficient for the production of fast scintillation light. When a neutron is detected in a GSPC filled with a gas mixture of ^{3}He-CF_4,it gives rise to two light pulses with wavelengths between 150nm and 750nm. A 'primary' light pulse following the absorption of the neutron in the nuclear reaction with ^{3}He, and a much brighter 'secondary' pulse when the charge released in the gas reaches the charge amplifying region of the micro pattern device are generated. Spectral response and photon yield are strongly dependent on the CF_4 partial pressure and the electric field applied in the detector.

A series of precise studies performed at LIP in Coimbra and the ILL have confirmed the release of ultraviolet and visible light in the emission band of CF_4.

They have also shown decay times as short as 15 ns and 25 ns for primary and secondary scintillation light, respectively. With rising CF_4 pressure, the photon yield increases up to 0.16 photons / secondary electron at 5 bar. Apart from the scintillation properties, the performance of a potential GSPC

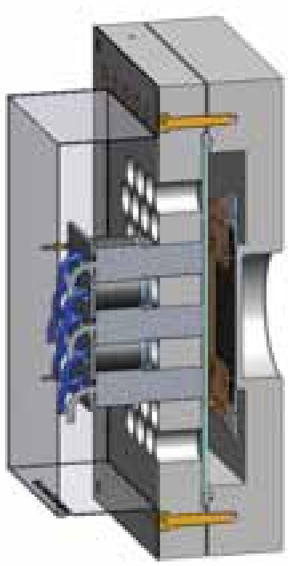

Figure 1. Schematic view of the 20x20cm^2 prototype in fabrication at ILL. It will be equipped with 19 PMTs for preliminary tests.

mainly depends on the light readout scheme as well as optical and geometrical parameters, such as photon detection efficiency, readout pixel geometry and position reconstruction. All these parameters have been taken into account in ANTS, the comprehensive simulation package developed at LIP Coimbra, which now allows the evaluation of potential GSPC detector designs and predicts their performance.

Based on these calculations and the studies performed with small prototypes, the detector group at the ILL has started to build a 20 x 20 cm^2 prototype capable of withstanding a fill pressure of 10bar. It is read out by an Anger Camera array consisting of 1"- PMTs. When applying the Anger camera principle, the position resolution as obtained by the analysis of the light distribution on the PMT array, is considerably smaller than the pixel size of the array. Figure 1 shows a schematic view of the proposed detector design. The first experimental results from this device are expected for summer 2011.

Light readout devices and electronics

The envisaged performance can only be achieved with the right light readout device. It also requires sophisticated, fast readout electronics, capable of handling high data rates and performing complex position calculation algorithms.

A set of three identical small-size prototype detectors were built at the FRM II and distributed to the partners at STFC and FZJ. In a series of complementary studies, using PMTs with UV window and red extended photo sensitivity increased the detected photoelectrons. The position resolution was also improved, as expected. A parallel bus based electronic readout system for a GSPC was set up at the FZJ. It possesses 32 input channels, each consisting of a shaping amplifier and an 80MHz sampling analog-to-digital-converter (ADC). Events are detected by an on-board programmable electronic (FPGA) and a crate controller subsquently sends the time-stamped data via a 1 GBit optical link to a host PC, which determines the position through a maximum likelihood method.

A different, interesting approach is being followed by the STFC team. By applying commercially available FPGA-based 'Terasic Altera DE3' evaluation boards, capable of reading six 150MHz sampling ADCs, the team studied the performance of an on-board implementation of the position recognition software, using a neural network type algorithm. Figure 2 shows the comparison between the results for the position recognition achieved with a standard Centre-of-Gravity (CoG) algorithm and the neural network based algorithm. For this purpose, the small size prototype GSPC detector was covered with a Cd-mask with a regular pattern of 2 mm holes and was homogenously illuminated with neutrons. While the CoG-method shows its typical nonlinearity effect (Fig. 2left), the neural network algorithm (Fig 2right) performs much better and is only slightly worse than a sophisticated maximum likelihood method.

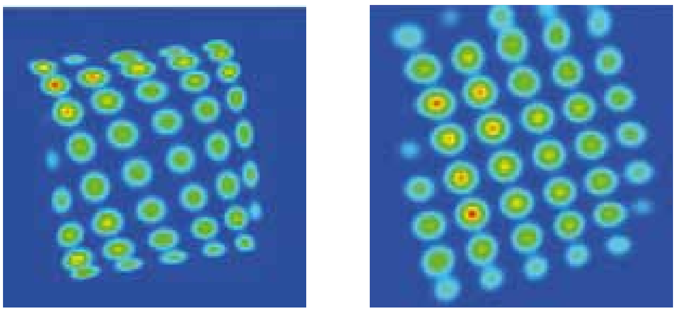

Figure.2 Image of an array of 2 mm diameter holes on a 5 mm pitch in a cadmium mask with position determined by left) Centre-of-Gravity algorithm and right) neural network algorithm

Dr. Karl Zeitelhack is head of the detector laboratory at FRM II in Garching, Germany. He is the coordinator of NMI3´s Detectors JRA.

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Highlights from our Access Programme

NMI3 funds neutron and muon scientists so that they can access the best instruments at 11 facilities across Europe. Here are some highlights of recent research carried out through our Access programme.

Using muons to measure spin polarisation in organic spin-based devices

By A. Drew

Spintronic devices, electronic devices that utilise the spin degree of freedom of electrons, hold unique prospects for future technology. Recent research by Dr A. Drew and colleagues shows that it may be possible to use spintronics to develop faster, smaller computer chips combining processing power and memory. The research was carried out at the Low Energy Muon Spin Rotation spectrometer of the Paul Scherrer Institute in Switzerland, thanks to funding by NMI3.

The main current application of spintronic devices lies in non-volatile memory. Future spintronic devices could deliver low-power logic, possibly at the quantum level, and when combined with both data communication and memory elements of a computer's architecture, this functionality could help to gain significant energy efficiency and computational speed.

Measuring spin

The most common method for using the spin in devices is based on the alignment of the electron spin (up or down) relative to either a reference magnetic field or the magnetisation orientation of a magnetic layer. Device operation normally proceeds with measuring a quantity, such as the electrical current, that depends on how the degree of spin alignment is transferred across the device. The electrical resistance of the device then depends on the reference magnetic field, or magnetisation orientation, a phenomenon known as magnetoresistance. The so-called spin valve, shown in Figure 1, is a prominent example of such a spin-enabled device that has already revolutionised hard drive read heads and magnetic memory. The reduction in spin polarisation in the yellow spacer layer is governed by the 'spin penetration length', which is related to intrinsic spin relaxation mechanisms in the spacer layer.

Understanding spin polarisation in organic spintronics

Understanding the transfer of spin polarisation in real device structures remains one of the most difficult challenges in spintronics, since it depends not only on the properties of the individual materials that comprise the device, but also on the structural and electronic properties of the interface between the different materials.

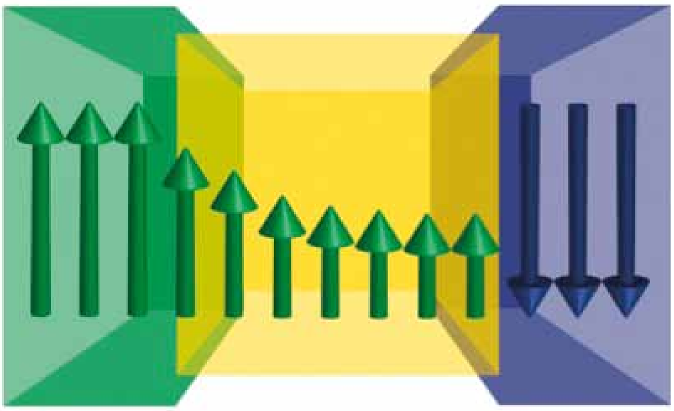

Figure 1. An archetypical spintronic device: the spin valve. A spin polarised current (arrows) is injected from a magnetic layer (green) into a non-magnetic spacer layer (yellow), where the spin polarisation is reduced (as indicated by the reducing arrow height) as the current flows further from the interface until it finally reaches a second magnetic layer (blue).

It is important to understand these properties, especially for the relatively new field of organic spintronics. However, many of the standard techniques used to measure spin polarisation in conventional semiconductors cannot be applied. There is a need for direct and spatially-resolved measurements of how spin propagates through organic spin-based devices. Measurements of spin penetration could offer clues to the relevant spin relaxation mechanisms of organic semiconductors.

Measurements on LE-muSR

For this research, we used the world's only Low Energy Muon Spin Rotation (LEmuSR) spectrometer to perform a depth-resolved measurement of the spin polarisation of current-injected charge carriers in an organic spin valve [1]. Crucially, the measurements were carried out below buried interfaces of a fully functional technologically realistic device (Figure 2). This enabled the correlation of the device magnetoresistance and the measurements of spin penetration on the nanoscopic lengthscale (Figure 3). These results suggest that the spin diffusion length is a key parameter of spin transport in organic materials.

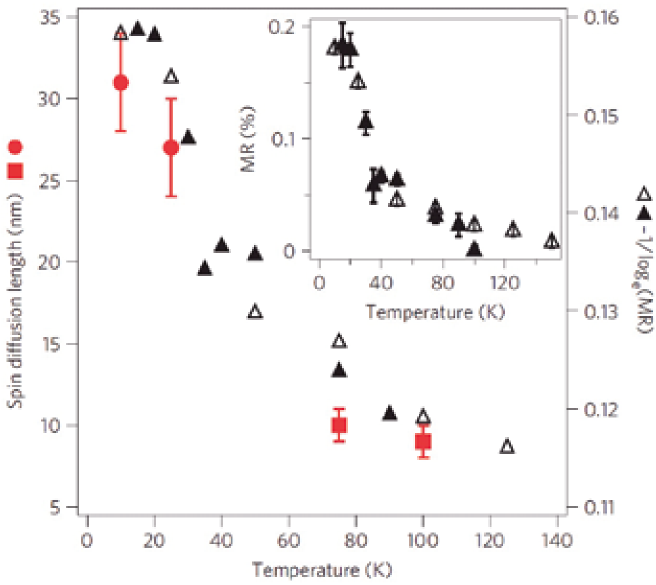

Figure 3. Correlation between spin diffusion length from muon measurements (red symbols) and macroscopic magnetoresistance measurements (black symbols) showing qualitative agreement.

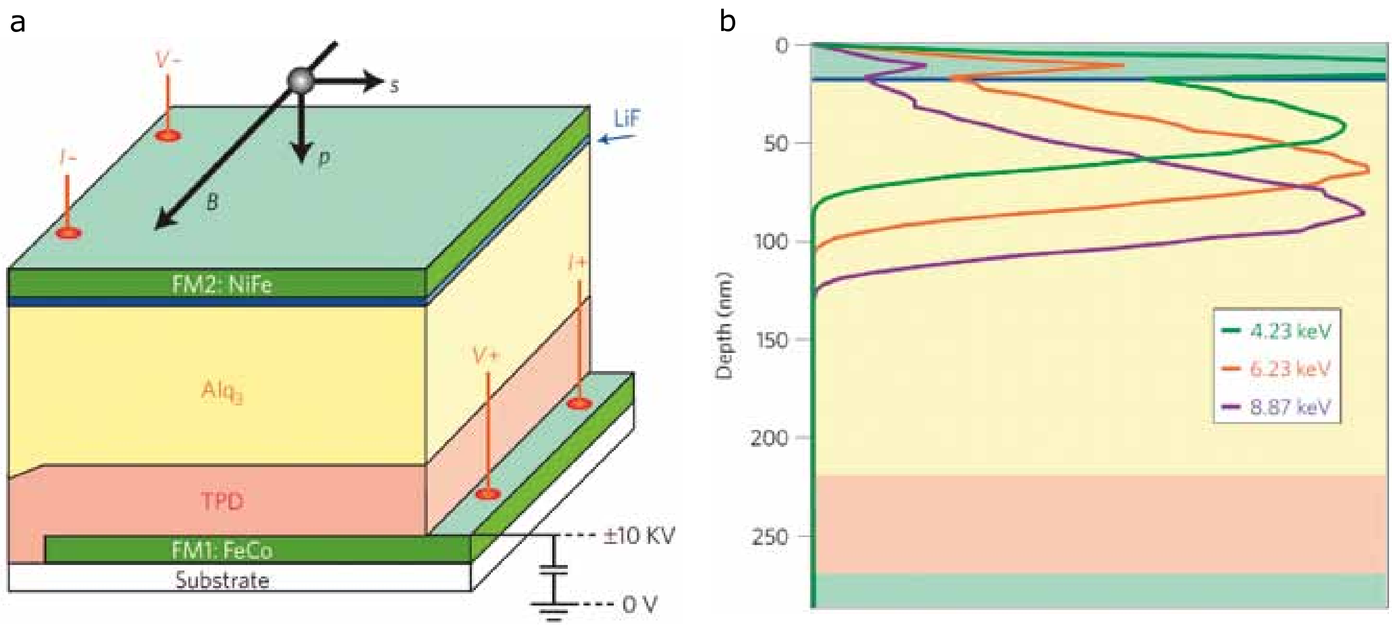

Figure 2. Schematic diagram of the experimental setup (a) and muon depth profile after implantation (b). FM1 and FM2: ferromagnetic layers 1 and 2.

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LiF reverses spin polarisation

In an extension to this work on spin penetration in the spacer layers, our group investigated how it is possible to engineer the magnetic, semiconducting interface to reverse the spin polarisation of the charge carriers in the device [3]. They did this by including a very thin (1nm) layer of Lithium Fluoride between the ferro-magnet and organic semiconductor. Figure 4 shows the magneto-resistance and the spin polarisation in the organic spacer close to the top electrode. Figures 4(e) and 4(f) are schematic diagrams showing the different states for the two devices. We can see that the inclusion of the Lithium Fluoride layer at the interface, which has an intrinsic electric dipole moment, reverses the spin polarisation of the charge carriers at that interface and therefore changes the sign of the magneto-resistance. This opens up the possibility of an electrically controllable spin valve, by the inclusion for example of a ferroelectric material at the interface.

LEmuSR reveals degree of spin polarisation

This work is a clear demonstration that Low Energy Muon Spin Rotation measurements can provide unique information about the degree of spin polarisation of the injected charge carriers, as well as their sign, within a buried active layer of a functional organic spin-valve device. The results highlight the unique potential of the technique to reveal the role of the various mechanisms that limit the spin coherence, especially in systems involving organic materials. More specifically, phenomena occurring in the organic semiconductor and those occurring at the interface can be differentiated.

References:
[1] A. J. Drew et al., Nature Materials 8, 109 - 114 (2009)
[2] L. Schulz et al., at press.
[3] L. Schulz et al., Nature Materials 10, 39–44 (2011)

Dr. A. Drew is a lecturer in the Condensed Matter Physics Group at the School of Physics of Queen Mary, University of London, and leads the spin spectroscopy sub-group.

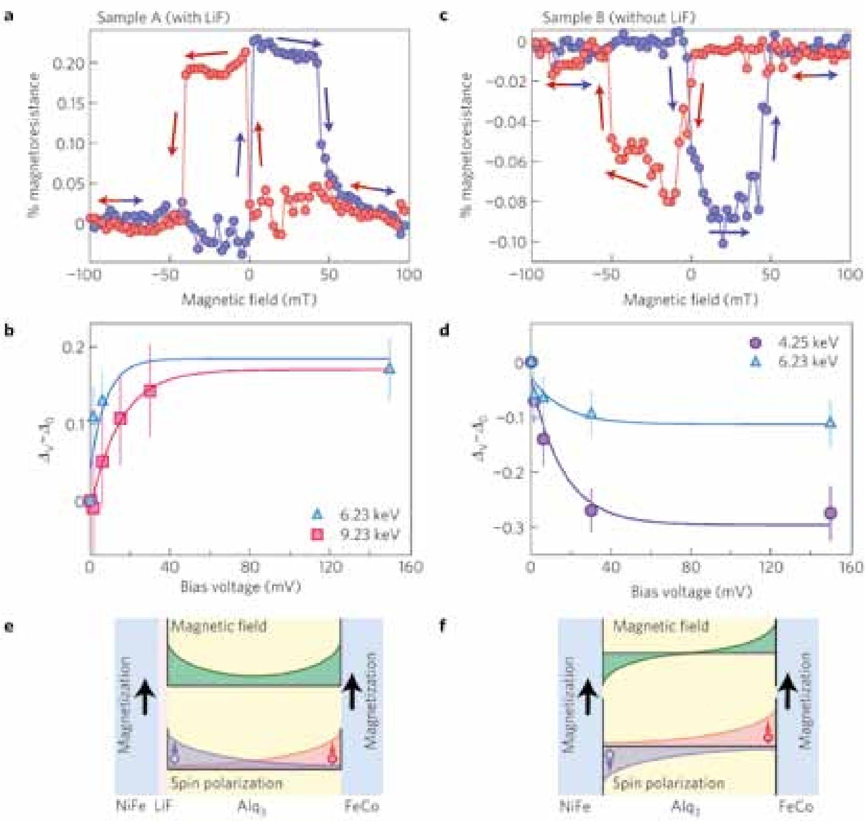

Figure 4. (a):The magnetoresistance and (b) a measure of the spin polarisation with the LiF layer. (c): The magnetoresistance and (d): a measure of the spin polarisation, without the LiF layer. (e): There is an increase in magnetisation close to the interface, (f): There is a decrease in magnetisation close to the interface

Control of electron flow and magnetism in atomically thin metaloxides

By A. Boris and B. Keimer

In modern microelectronic devices, electrons flow in channels that are beginning to approach atomic dimensions. Because the heat they generate degrades the delicate atomic structures and hampers device operation, the current semiconductor-based technology is approaching fundamental limitations. Researchers are therefore looking beyond semiconductors and are beginning to explore more complex materials as potential device platforms. A particular focus has been on metal-oxide compounds, which show a much greater variety of properties than semiconductors and thus promise entirely new functionalities. Electrons in some metal oxides form a superconducting state in which they conduct electricity without generating any heat at all. In others, they form magnetically ordered states that are useful for information storage. Current research on metal oxides aims to predict and manipulate the formation of these states in a controlled and reliable fashion.

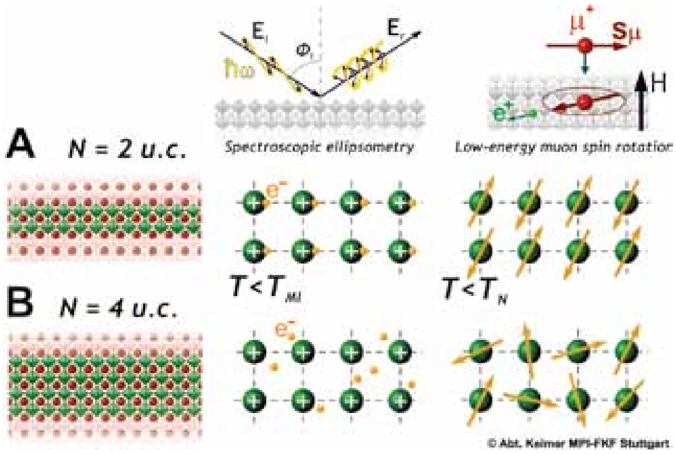

Figure 1. Schematic representation of the main experimental results: A. superlattices with thin LaNiO3 layers undergo a sequence of collective metal-insulator and antiferromagnetic transitions upon cooling, whereas B. superlattices with thicker LaNiO3 layers remain metallic and paramagnetic at all temperatures.

Investigating metal-oxide layers

Together with an international team of researchers, we have now taken an important step in this direction. The team built devices out of thin layers of two different metal oxides, which are metallic and insulating in bulk form (Figure 1). When the layers are more than three atomic monolayers thick, the electrons behave in a manner closely similar to the one in the bulk. In devices where the conduction electrons are confined to two atomic monolayers separated by insulating layers, their behaviour changes completely. Upon cooling the device, optical reflection experiments with synchrotron radiation (Figure 2A) revealed that they first form an insulating state in which every electron is attached to a particular atomic site, such that current flow is inhibited. Upon further cooling, the magnetic moments of these localised electrons then arrange in a regular pattern with neighboring moments antiparallel. As opposed to ferromagnetism, where all moments point in the same direction, this form of magnetic order is termed ‚antiferromagnetism‛. The collective behaviour of the electron system in these metal-oxide devices can thus be accurately controlled by adding a single atomic monolayer.

Using muons to detect magnetic order

To detect antiferromagnetic order in the atomically thin layers we required a novel, highly sensitive experimental method. Unlike ferromagnets, where the microscopic magnetic moments of the electrons add up to a macroscopically detectable magnetization, the electronic moments in antiferromagnets cancel out and are therefore invisible to ordinary experimental probes. We applied a method in which microscopic magnetic field sensors are implanted into the device. Since the sensors should not disturb the atomic structures they are intended to explore, they must be smaller than atoms – a requirement that can only be satisfied by elementary particles. Muons, which are in many ways similar to electrons but carry a much smaller magnetic moment, are ideal for this purpose. The muons are produced in particle accelerators and have to be slowed down such that they come to rest in the thin atomic device rather than blasting through it – a feat that we accomplished recently at the Low Energy Muon beamline of the Paul Scherrer Institute in Villigen, Switzerland,

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thanks to support by NMI3 (Figure 2B). Muons are unstable and decay only two microseconds after they are implanted into the device. The decay products, positrons, are stable particles that are propelled out of the device, where they can be picked up in a detector. The direction of the positron beam then contains incisive information about the alignment of electron magnetic moments close to the parent muons in the device.

Insight into electron behaviour in metal-oxide devices

The combination of modern device fabrication methods and experimental probes has thus allowed us to gain novel insights into the electric and magnetic behaviour of electrons in atomic-scale metal-oxide devices, and it has enabled an unprecedented level of control over this behaviour. We now hope that these methods may allow us to manipulate the superconducting state found in some bulk metal oxides in a similar manner. Success in this fundamental research effort would open up an entirely new era in electronic device engineering.

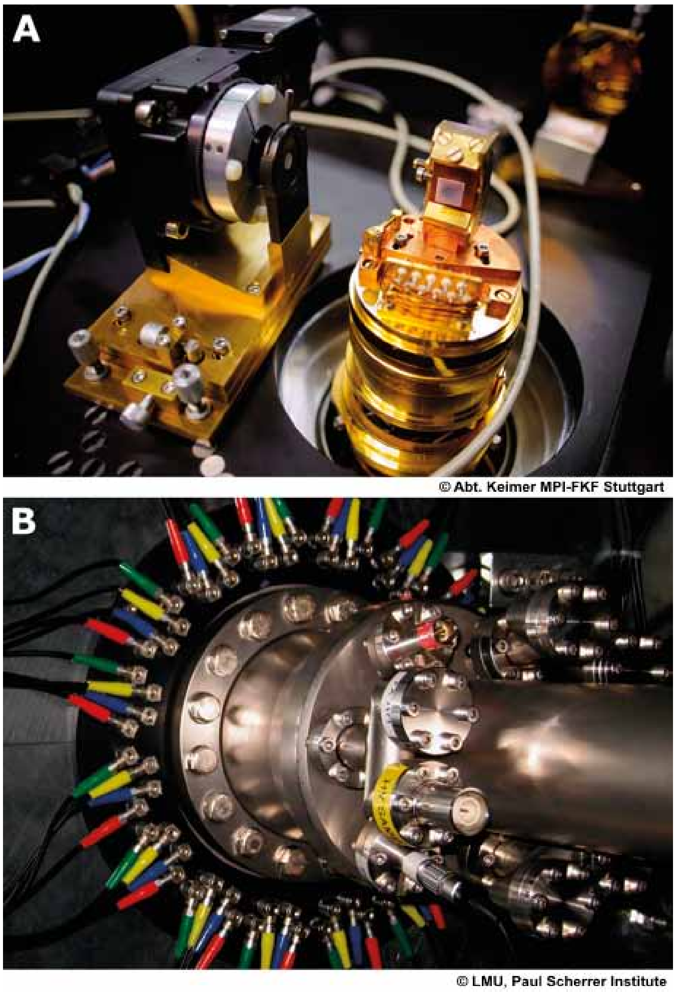


Figure 2. A. One of the samples mounted and aligned in the infrared ellipsometer located at the IR1 beamline of the synchrotron facility ANKA at the Karlsruhe Institute of Technology. B. Main mounting panel of the cryostat surrounded by positron detectors at the at the Low Energy Muon beamline of the Swiss Muon Source, Paul Scherrer Institute, Switzerland.
Reference: A. V. Boris *et. al, Dimensionality Control of Electronic Phase Transitions in Nickel-Oxide Superlattices*, Science 332, 937 (2011).

Dr. Alexander Boris is senior scientist and Professor Bernhard Keimer is director at the Max-Planck Institut für Festkörperforschung in Stuttgart, Germany.

Neutron scattering in characterisation of magnetic fluids for anticancer treatment

By M. Avdeev & V. Haramus

Cancer remains one of the most widespread diseases and leading cause of death worldwide, despite a certain progress in diagnosis and treatment methods in recent years. Over the past decade researchers have been investigating the use of colloidal nanoparticles that could act as delivery systems for targeted cancer drugs. The nanoparticles, with radii between 1 and 10 nm, can be coated with chemically active substances capable of interacting with specific types of cancer cells. Magnetic nanoparticles, in particular, have properties that make them good candidates for applications in biomedicine. The transport and concentration of these particles can be controlled by the application of a magnetic field, thus increasing the efficiency of the treatment, and avoiding the spread of the nanoparticles in healthy tissues in the organism.

Searching for biocompatible coatings

However, there are a number of problems associated with the use of nanoparticles for drug delivery. The particles must be designed so that they do not aggregate inside the body, as this could reduce their therapeutic efficiency. Aggregation can also cause blood clots, or hinder the removal of the nanoparticles from the body. Another potential complication is the premature reaction of the immune system, which can eliminate nanoparticles and thus impair their action on cancer cells. To avoid these problems, the particles must be coated with special biocompatible coatings.

The group of Prof. Peter Kopcansky, from the Institute of Experimental Physics of the Slovak Academy of Sciences, is looking for the ideal compounds and conditions to obtain aqueous suspensions of magnetic nanoparticles, so that they can be coated with drugs and biocompatible components but remain in a stable, non-aggregated state. Small-angle neutron scattering (SANS) is sensitive to aggregates in such 'magnetic fluids' and allows to determine the structure of such aggregates. Kopcansky *et al*. carried out small-angle neutron scattering (SANS) experiments at the Helmholtz Zentrum Gesthaacht, thanks to funding by NMI3, to study the coating of magnetite nanoparticles with polyethyleneglycol (PEG), one of the most promising biocompatible polymers. An important feature of PEG is that its presence in the particle structure delays the response of the reticuloendothelial system, which is a part of the immune system, and increases the lifetime of magnetic

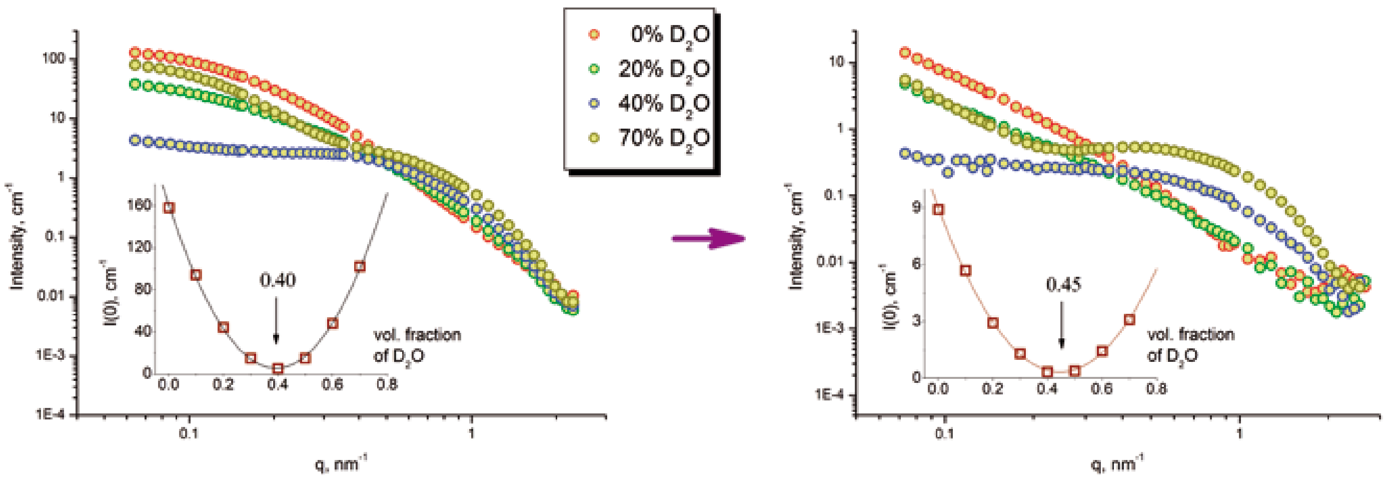
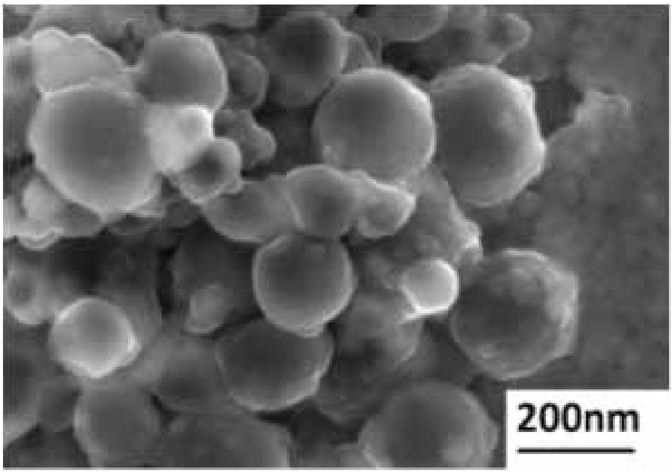


Figure 1. Change in SANS curves for various content of heavy water (D2O) in solvent after the PEG/magnetite mass ratio is increased from 1/1 (left graph) to 2.5/1 (right graph) in magnetic fluid. The volume fractions of magnetite in the studied systems are 1.7 and 0.54 %, respectively.

nanoparticles in the bloodstream from minutes to hours or even days. In addition, the polymer readily adsorbs some of the main anticancer drugs. However, the introduction of PEG into the structure of a magnetic fluid can drastically affect its stability.

SANS experiments on magnetic fluids

PEG was incorporated into the stabilising shell of magnetite (Fe_3O_4) nanoparticles in a water-based magnetic fluid. To perform SANS contrast variation the solution was diluted with different mixtures of heavy and light water. Based on the different scattering properties of hydrogen and deuterium, our SANS experiments allowed us to see that the structure of the modified fluid depends on the concentration of PEG. The addition of large amounts of PEG with a molar mass of Mw = 1000 g/mol results in the development of branched aggregates (fractal dimension of about 2.5) with a final size above 100 nm (see Figure 1). It is accompanied by a significant decrease in the volume fraction of dispersed magnetite in the system. A small change in the effective match point, where the scattering intensity reaches its minimum as a function of the content of deuterated component in the solvent, indicates that PEG is adsorbed in its plain configuration on the magnetite surface. This slightly affects the thickness of the stabilising shell.



As Prof. Kopcansky explains:"*Neutron scattering is a unique tool, which allows us to follow in detail the structural changes at the nanolevel after the polymer is incorporated in the system and finally helps to choose those optimal compositions and conditions, when the aggregation instability is minimal*".

In addition, interdisciplinary SANS experiments on this and similar magnetic fluids have been carried out in collaboration with chemists, physicists and biologists from Slovakia, Germany, Hungary, Switzerland, Ukraine and Russia. Among recent achievements of this group is the synthesis of the magnetic fluid with polyethyleneglycol coating containing the drug Taxol® (see Figure 2). The new fluid was successfully probed in in-vitro tests. The next step, the introduction in living organisms with cancer tumors, is in progress.

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Dr. Vasyl Haramus is responsible for SANS-1 instrument, WPS, at Zentrum für Material – und Kuestenforschung GmbH at the Helmholtz-Zentrum Geesthacht, in Germany.

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[3] Závišová et al. J. Magn. Magn. Mater. 323 (2011) 1408-1412.

Figure 2. Magnetic nanoparticles with polyethyleneglycol and the drug Taxol, encapsulated in biodegradable polymer, as seen in scanning electron microscopy.

Vacant crystal sites provide valuable clues on the fast hydrogen transport in Mg-Ti-H films

By S. Eijt

Over the last decade, there has been growing interest in the development of lightweight metal hydrogen compounds, or hydrides, capable of reversible hydrogen storage at low and medium temperatures, for use in the zero-emission hydrogen cars of the future. Exploiting the high volumetric hydrogen capacity of metal hydrides could help to overcome the technological limitations of high-pressure hydrogen storage tanks, on the road to economically-viable hydrogen storage systems.

Mg-Ti films for hydrogen storage

Magnesium-Titanium (Mg-Ti) alloys are promising materials for applications such as hydrogen storage media and metal hydride rechargeable batteries. Hydrogenation of Mg-Ti films with sufficiently high Titanium concentrations leads to the formation of a cubic (fluorite) $Mg_{1-y}Ti_yH_x$ phase with substantially faster hydrogen transport capacities than the common tetragonal (rutile) MgH_2 phase [1]. Such Hydrogenated Mg-Ti films can show high hydrogen storage capacity, close to the targets set for application in the zero emission hydrogen cars of the future. Furthermore, upon hydrogenation, the optical properties of Mg-Ti thin films change markedly from the metallic to the insulating metal hydride state, making these films very attractive for use in fast hydrogen sensors and hydrogen switchable mirrors (figure 1) [2].To study this phenomenon, we carried out positron lifetime studies on the pulsed low energy positron beam system (PLEPS) of the Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) in Garching, Germany, thanks to NMI3 funding. Our research revealed the presence of defects in the crystal lattice resulting from the removal of two adjacent atoms, also called divacancies, both in the as-prepared and the hydrogenated Mg-Ti metal films. We deduced the presence of relatively large local lattice relaxations around the divacancies in cubic MgH_2, pointing to a major role played by these divacancies in the mechanism leading to the fast hydrogen transport in this cubic MgH_2 phase.

PALS experiments on the PLEPS spectrometer

The transport of hydrogen in materials is of central importance, as it determines the rate of hydrogen loading and unloading. Vacancies are empty atomic positions in the crystal lattice where a metal or hydrogen atom has been removed. These vacancies strongly affect the mobility of hydrogen and metal ions, in the metal as well as in metal hydrides and, consequently affect hydrogen sorption kinetics. We exploited the high sensitivity of positron annihilation lifetime spectroscopy (PALS) to determine for the first time the presence and type of vacancies in Mg-Ti and Mg-Ti-H thin films [3,4]. Thin film positron annihilation lifetime spectroscopy was performed using PLEPS. The positron lifetime is a direct measure of the local electron density at the positron annihilation site, and can therefore be used to extract in a unique manner the size of vacancy-related defects.

Figure 1. (Left) A mirror consisting of a $Mg_{0.7}Ti_{0.3}$ thin film. (Right) After applying a hydrogen containing gas, the mirror changes into a light absorbing $Mg_{0.7}Ti_{0.3}H_x$ film.

Positron affinity for Mg reveals divacancies

Positron Doppler broadening studies revealed chemical segregation of the coherent Mg-Ti films into Mg and Ti domains at the nanoscale [3,4]. As a consequence of the large difference in positron affinity for Mg and Ti, positrons have the remarkable capability of monitoring the Mg domains exclusively (figure 2) [3]. The PALS studies showed that saturation trapping of positrons in vacancy-related defects occurs inside the Mg areas of the Mg-Ti(-H) films. This shows that defect concentrations are at least of the order of 10^{-4}, but that higher values are quite likely.

Figure 3 presents the extracted positron lifetimes for the Mg layer and for the Mg-Ti layers in the metallic and in the metal hydride states. The measured positron lifetime of 312 ± 4 ps (1 picosecond equals 10^{-12} seconds) for the Mg film is close to the value of 316 ps for the divacancy in Mg obtained in recent ab-initio calculations.

The Mg-Ti lattice contracts proportionally to the Ti-fraction and reduces the size of the divacancy, leading to a larger electron density at the positron trapping site and correspondingly higher positron annihilation rates. Remarkably, the positron lifetime for the fluorite phase $Mg_{0.7}Ti_{0.3}H_x$ is almost equal to the positron lifetime for the rutile phase $Mg_{0.9}Ti_{0.1}H_x$, despite the significantly smaller volume per formula unit, by 16 %, for the fluorite phase. This indicates that the divacancy in the fluorite MgH_2 structure occupies a relatively large open space leading to a low electron density. This requires local lattice relaxations of nearby hydrogen and Mg atoms (figure 3). We deduce that the presence of divacancies combined with relatively large local lattice relaxations may effectively lower the migration barriers for hydrogen diffusion in the fluorite MgH_2 phase, leading to fast hydrogen transport.

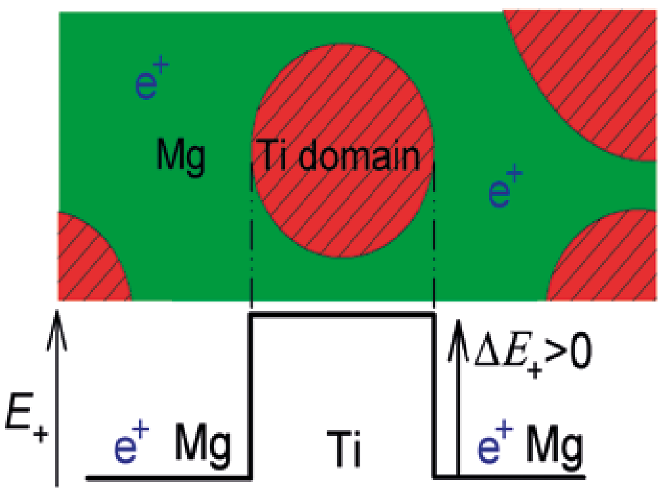


Figure 2. Schematic representation of the nano-scale chemically segregated Mg-Ti domain structure. The schematic drawing for the positron potential energy E+ shows that a Ti domain embedded in Mg acts as a positronic potential barrier with height ΔE+=2.1 eV.

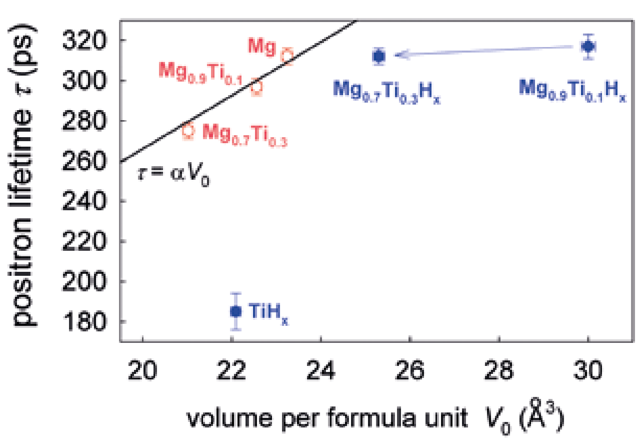
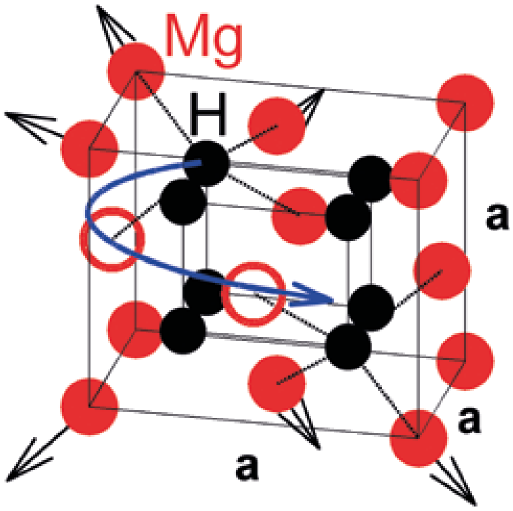


Figure 3. (Left) Positron lifetime of metallic and hydrogenated $Mg_{1-y}Ti_y$ films as a function of volume per formula unit. The fitted solid line indicates the expected effect of increased volume on the experimental positron lifetimes for the divacancies in the metallic films. (Right) Artistic impression of the relaxed geometry of the divacancy and facilitated hydrogen mobility in fluorite phase MgH_2.

Potential applications, nanocomposites for hydrogen storage

By exploiting the unique capabilities offered by positron lifetime spectroscopy using PLEPS, we were able to show the presence of divacancies in the metal sublattice of both the rutile and fluorite MgH_2 phases. The positron lifetimes of these vacancies are comparable, though their size must differ considerably. Hence, we deduce the existence of local lattice relaxations in the fluorite phase, which may play a crucial role in the enhanced hydrogen transport in fluorite MgH_2.

Our research is now focusing on stabilising the promising fluorite phase into MgH_2 nanopowders enabling bulk synthesis. We are doing this by an innovative process, involving the synthesis of Mg-Ti nanoparticles through spark discharge generation [5]. We are also investigating different vacancy concentrations in this interesting metal hydride phase, by adding suitable catalysts, in order to produce better nanocomposites for hydrogen storage applications.



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Dr. Stephan Eijt is Assistant Professor at the Technische Universiteit Delft in The Netherlands.

PLEPS/ NEPOMUC at FRM II. Picture: W. Schürmann

Activities

Inelastic neutron scattering reveals interaction between cobalt ions

By R. Mole

Small magnets the size of a molecule could be the memory chips of the future. Low dimensional molecular magnets are being studied as potential memory elements for information storage or quantum information processing, or as components for molecular machines. This is due to a phenomenon called single molecule magnetism [1], that is, the observation of a hysteresis at the molecular level, in the absence of any long range order. The origin of this effect is strongly dependent upon the anisotropy of the molecular spin. Component ions with a first order orbital angular momentum are therefore particularly interesting , due to the large anisotropy associated with them. In particular, octahedral cobalt (II) has been shown previously [2] to display an array of interesting physical properties, including some reports of unusual slow relaxation of magnetisation.

Picture: FRM II/TUM

Inelastic neutron scattering used to define energy levels

In a recent study [3] with researchers from the University of Manchester and scientists from the FRM II, along with theoretical work performed at the University of Leuven, we have gone back to basics to study cobalt dimers – pairs of cobalt ions, surrounded by coordinated organic molecules. Dimers are the smallest possible exchange-coupled cluster and have the simplest possible exchange Hamiltonian, thus making them easy to study theoretically.

The work relied heavily on the use of inelastic neutron scattering (INS), as this technique can directly probe the energy level associated with an exchange-coupled dimer. As opposed to other techniques, such as electron paramagnetic resonance (EPR), the selection rules allow the observation of more transitions and the data can be collected without applying a magnetic field. The inelastic neutron scattering experiments were performed using the cold neutron time of flight spectrometer TOFTOF (photo) at the FRM II; the measurements utilised several configurations, including high resolution data up to 20 μeV (Figure 1).

Well-resolved spectra reveal zero field exchange interactions

The use of these high resolution configurations resulted in well-resolved spectra for both samples studied, complemented by the equally well-resolved EPR spectra. The availability of such high quality data was key to the success of the work. This allowed the zero field exchange interactions to be determined unambiguously. Funding from NMI3 allowed researchers from the University of Manchester to spend time at the FRM II, which ensured that the data was of the highest quality and complemented the comprehensive set of multi frequency EPR and magnetometry data that had already been obtained Subsequent analysis of the inelastic neutron scattering data, coupled with the use of ab initio methods, allowed significant progress to be made with analysing the more complex EPR spectra. In particular, we could fix varying parameters enabling the full characterisation of the exchange and g matrices. As this was possible for two different clusters with closely related structures, it is now possible to make some observations about the relationship between the structure of a cluster and the magnetic properties observed. This suggests that the relationship between the local crystal field around the cobalt centers and the superexchange pathway, is controlling the magnetic interaction. Others have noted the importance of the orientation of gi in interpreting magnetic data of polymetallic CoII complexes [4]. In a sense, this is analogous to magnetostructural correlations for spin only ions such as copper (II), where the crystal field directions are easily established by inspection.

For cobalt (II), the local crystal field can vary subtly with minor changes in ligand sphere, and this could explain the diverse magnetism displayed by polymetallic cobalt clusters and extended networks.

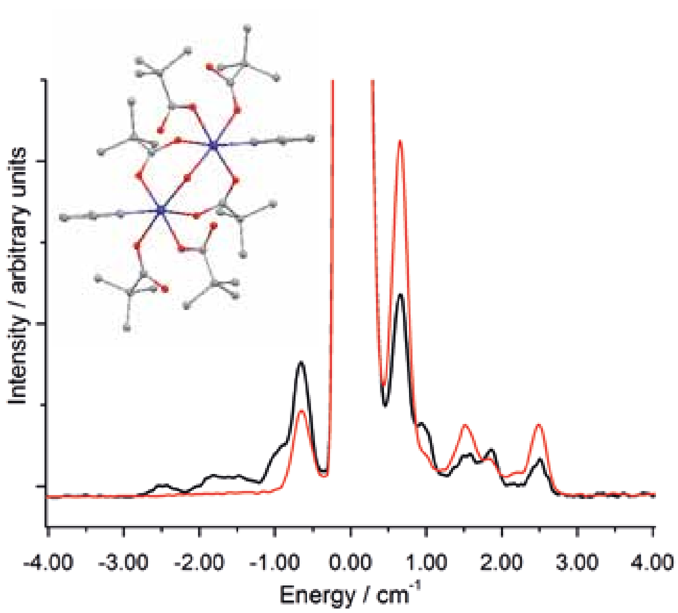

Figure 1. Variable temperature INS of $[C_{o2}(H_2O)(O_2C^tB_u)_4(HO_2C_tB_u)_2(py)_2]$ obtained at 3.5 K (black) and 0.7 K (red). Inset crystal structure of $[C_{o2}(H_2O)(O_2C^tB_u)_4(HO_2C^tB_u)_2(py)_2]$

Dr Richard Mole is instrument scientist at the Bragg Institute, at the Australian Nuclear Science and Technology Organisation.

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Activities

Schools & Workshops

A total of 16 schools and workshops have been supported by NMI3 in 2010 and so far in 2011. Until now, a total of 97,500 euros have been awarded to European Schools and Workshops under the 7th Framework Programme (FP7).

Looking back at 2010

Schools	Dates	Location
Tutorial on Neutron Scattering	11-19 March 2010	Berlin, Germany
Central European Training School	31 May - 4 June 2010	Budapest, Hungary
School on neutron diffraction data treatment using the Fullproof suite	2 - 7 May 2010,	Grenoble, France
ISIS Muon Spectroscopy Training School	23-28 May 2010	Didcot UK
McStas / VITESS user training workshop 2010	17 -21 May 2010	Ven, Sweden
European Summer School on Scattering Methods Applied to Soft Condensed Matter	12 - 19 June 2010	Bombannes, France
Polarised Neutron School (PNCMI)	28 June - 2 July 2010.	Delft, the Netherlands
The power of neutron scattering techniques in the nano and bio sciences	12 - 16 July 2010	Jaca (Huesca), Spain
PSI Summer School on Condensed Matter Research	7 -16 August 2010	Villigen, Switzerland
Laboratory Course on Neutron Scattering	6-17 September 2010.	Garching , Germany
Francesco Paolo Ricci School	25 September - 4 October 2010.	Villa Mondragone Monte Porzio Catone, Rome, Italy
School on neutron diffraction data treatment using the Fullproof suite	26 -30 January 2011	Grenoble, France
Les FAN de LLB/Orphee	6-9 December 2010	Gif Sur Yvette, France
HERCULES	27 February to 30 March 2011	Grenoble, France
First International Spring School on McPhase	10 - 13 May 2011	Gijón , Spain
Neutron Instrument Design School	7 - 17 June 2011	Lund and Vik, Sweden

Forthcoming schools

Here is a list and short description of forthcoming schools supported by NMI3.

12th Oxford Summer School on Neutron Scattering

5th to 16th September 2011
St Anne's College, Oxford,
United Kingdom

The international Oxford Summer School provides an intensive series of lectures, exercise classes and tutorials in the area of neutron scattering. The students are accommodated in St. Anne's college with the lectures held in the Department of Physics, Oxford University. The course lecturers are all acknowledged international experts in their field. The school offers students a comprehensive exposure to neutron scattering from the theoretical background, through to sources and instrumentation and the application of these techniques to a diverse range of disciplines. An exhaustive list of topics can be found on the school website. The topics are backed up by tutorial sessions in small groups with the course lecturers. This represents a unique opportunity to discuss the course material with the lecturers, to work through examples drawn from the course material and to share research experiences.

A visit to the ISIS spallation neutron source and the second target station is also included. Two school related evening lectures will be provided. An informative and popular session on science communication is also included.

The international school is limited in size to 50 residential places. Registration is officially closed (1st May 2011) but the school does have a waiting list. To be added to this list please email us at osns@stfc.ac.uk

Further information on the school can be found at:

http://www.oxfordneutronschool.org/

Topics covered during the school include:

- The properties and sources of neutrons
- Neutron Instrumentation
- Theoretical description of neutron scattering
- Elastic scattering and spectroscopy
- Polarised techniques
- Hard and Soft condensed matter, biology and engineering research using neutrons

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Science & Technology Facilities Council ISIS

Activities

Jülich Centre for Neutron Science Laboratory Course Neutron Scattering

5th to 16th September 2011
Forschungszentrum Jülich and FRM II, Garching, Germany

The JCNS Laboratory Course Neutron Scattering is organised annually since 1997 by Forschungszentrum Jülich.The aim of the course is to give a realistic insight into the experimental techniques of neutron scattering and its scientific power. The laboratory course consists of one week of lectures held at Forschungszentrum Jülich followed by one week of neutron scattering experiments at the new research reactor FRM II in Garching close to Munich. The lectures encompass an introduction to neutron sources, scattering theory and instrumentation. Furthermore, selected topics of condensed matter science are presented. There are two hours of exercise work related to the lectures each day. In the second week, for five days 10–12 neutron scattering instruments are made available free of cost. The participating students work in groups of five. Each group performs one neutron scattering experiment per day, so that each student gets experience on five different instruments.

In summary, the scientific programme of the laboratory course comprises 20 hours of lectures, 20 hours of exercises (half of the time in tutored groups), and 40 hours of experiments (including preparation and reporting). The number of students admitted is typically 50 to 60. The feedback collected from the students is consistently positive and the fact that many of the former participants are now scientists in neutron scattering-related workgroups shows that the course has a lasting success in education.

The whole course including local accommodation and meals is made available for free to the selected students. For non-German EU students the travel expenses are also reimbursed.

Further information on the JCNS Laboratory Course Neutron Scattering can be found at the website **www.neutronlab.de**
The course will be held under identical conditions in September 2012.

Picture: W. Schürmann

FRM II
Forschungs-Neutronenquelle
Heinz Maier-Leibnitz

Jülich Centre for Neutron Science

Summer School on Application of Neutrons and Synchrotron Radiation in Engineering Materials Science

12th to 16th September 2011

Lauenburg, Germany

The summer school is the continuation of two very successful autumn schools with the same title in 2005 and 2007. Organisers are HZG, DESY, HZB, TU Berlin and TU Leoben.

The school is designed to provide a systematic overview of the use of neutrons and photons in the field of engineering materials science to students from all over Europe. The program of the first part of the school, the theoretical course, will touch all state-of-the-art scattering and imaging techniques using the two probes in a focused three day course. It will include about 25 talks given by internationally renowned experts with topics in the following fields: materials and processes, sources, methods (scattering, imaging) and applications. The last part, new developments, will contain a view into current research and neighbouring fields. The school will be complemented by a two days practical at the neutron outstation of HZG (FRM II) and/or at the synchrotron source of DESY doing practicals at the relevant instruments (e. g. strain scanners, texture diffractometers and tomography stations). Thus, all in all the school will take five days. To our knowledge the focus of this school on the application of neutrons and photons in engineering materials science is unique in Europe.

The anticipated number of students is 50, the registration deadline will be the 18th of July. Students and postdocs from other EU countries can apply for financial support. The language of the school will be English. The participation fee includes accommodation and food for the duration of the school as well as the book *Neutrons and Synchrotron Radiation in Engineering Materials Science* which has resulted from the previous autumn schools. You can register for the school using the online registration provided on the website of the summer school.

For more information visit the website:
http://www.hzg.de/summerschool

Picture: HZG

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Activities

10th PSI Summer School on Condensed Matter Research

13th to 22nd August 2011
Institut Montana Zugerberg, Zug & Paul Scherrer Institut, Villigen, Switzerland

Theme for 2011: Probing Phase Transitions using Photons, Muons and Neutrons

It is the very first time that the PSI Summer School will be held in Zug - on the premises of the Institut Montana Zugerberg (international boarding school), Zug, Switzerland.

For the 3rd consecutive year, the PSI Summer School offers a twofold educational program with the school in Zug for ca. 120 students (August 13 - 19) followed by hands on training at the PSI Facilities in Villigen. The practical training will be available for approximately 20 students. The transfer from Zug to Villigen will take place on Friday 19th August 2011. The training will end on Monday 22nd August.

Scope

Phase transitions are not only a well known fact of everyday life, but also an important field of current research and of technological applications. Water turns to ice, ferroelectricty and magnetism coexist in multiferroics, data is stored in magnetic bits: these are all but manifestations of phase transitions.

Paul Scherrer Institut (PSI) operates facilities producing photons, neutrons, and muons. These are ideally suited for studying phase transitions because they provide information about the position of atoms, the state of electrons and the arrangement of spins. In this summer school, more than 20 world-class experts will introduce the different aspects of phase transitions from an experimental and theoretical point of view. Following the school, a practical training is offered at PSI. It will allow a limited number of participants to get hands-on experience with state-of-the-art instrumentation using photons, neutrons, and muons.

At the end of the school students will not only understand why water turns into ice; they will know how to apply modern methods to the problem of phase transitions and will have established contacts to the speakers and participants allowing them to use the knowledge gained for your own research.

For more information visit the website

http://www.psi.ch/summer_school_11
or contact **zug2011@psi.ch.**

PAUL SCHERRER INSTITUT PSI

Neutrons in Biology 2011 School

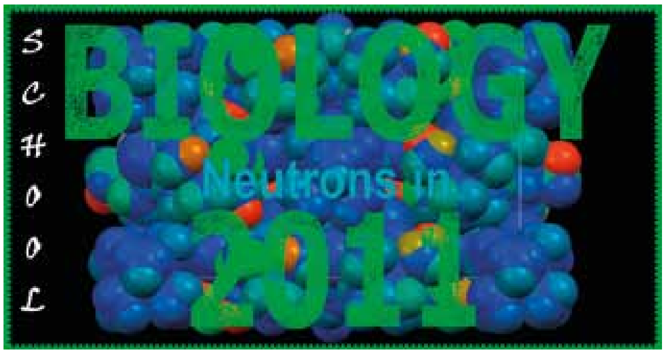
21st to 23rd October 2011
EPN Campus, Grenoble, France

Neutron scattering techniques have a significant role to play in answering important questions in structural biology. During the course of the Neutrons in Biology intensive 2011 school participants will be tutored in the neutron scattering techniques that are most applicable to structural biology – Macromolecular Crystallography, Small Angle Scattering and Reflectometry – with an emphasis on their complementary nature. The main goal of the school is to teach participants what is required to perform a successful biological neutron experiment, giving a clear indication of what information the different techniques can provide, the sample requirements and what complementary measurements should be performed to maximise the information gained. The students will be given hands-on training in the use of state-of-the-art data analysis and modelling software appropriate to each technique, as well as visits to beamlines at the European Photon and Neutron Science Campus (EPN Campus).

The school, run as a satellite to the 2011 Neutrons in Biology and Biotechnology meeting, is open to non-national participation and the language will be English: it is intended both for students new to the field of neutron scattering and more advanced neutron users who work on challenging biological systems. Lectures and tutorials will be given by international experts during 3 days with introductory morning sessions followed by afternoon practical sessions, to enable participants to gain experience and individually discuss data analysis with the tutors. Students will gain a grasp in modern software that allows for data from other X-ray, microscopy or spectroscopy techniques to be directly integrated into a neutron study for improved fitting and cross-validation.

Applications for the School are now accepted and can be sent until the 15th August (please see the School website for more details: **http://www.ill.eu/news-events/events/nib2011/satellite-school-21-23rd-oct/**).

A maximum of 20 participants will be selected. Limited funding will be available to support travel and living expenses of students and Post-docs.



Activities

European Neutron School - Fan de LLB-Orphée

5th to 8th December 2011
Saclay, France

Fan de LLB-Orphée is an annual 3.5 days school, delivered in French, that gives young French speaking researchers a first simple contact to real experimental neutron scattering. Students and post-docs working in all scientific areas where neutrons can provide valuable insights will be welcome; those having not yet had any contact with neutrons scattering will be selected in priority. After a 4-hour introduction to neutron sources and neutron scattering, 10 different subjects, based on various scientific problems that can be addressed by neutron scattering, will be proposed to students. Within each subject studied by group of 5, students will discover 2 different neutrons scattering techniques. The main specific feature of our school is that usually, most of the students come with their own samples which are tested during the training among our demonstration samples. This ensures a strong and efficient participation of all to the courses.

The usual number of participants is 35. The deadline for registration is 1st October 2011.

For more information:
http://www-llb.cea.fr/fan

Picture: LLB

5th FullProf School on Neutron Diffraction Data Treatment using FULLPROF SUITE

23rd to 27th January 2012
Institut Laue Langevin, Grenoble, France

Precise crystallography has significantly contributed to the success and recent developments in materials science, solid-state physics and chemistry. Among the available programs for diffraction data analysis, the FullProf Suite is one of the most widely used packages by the scientific community working in these fields.

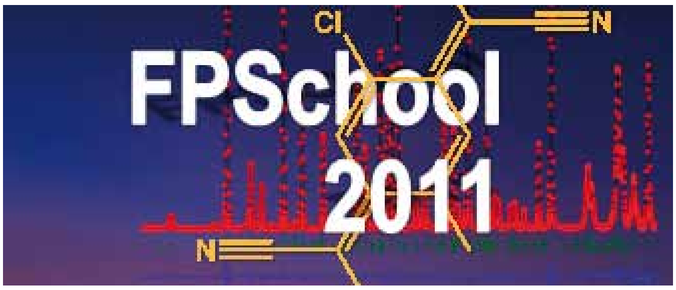
The aim of our annual school on the FullProf Suite (FPSchool) is to contribute directly to the training of the upcoming generation of scientists with intensive hands-on schools focused on the analysis of diffraction data using the FullProf Suite.

Theoretical introductory lectures (max. 1 hour/lecture) will be followed by hands-on practical computing sessions. The afternoons will mostly be dedicated to practical sessions. In order to favour intensive scientific exchanges, the number of students is limited to 30.

For more information visit the website:
http://www.ill.eu/news-events/events/fpschool-2012/

Important dates:

- 28 Oct 2011: Opening applications
- 18 Nov 2011: Deadline for applications
- 28 Nov 2011: Decisionabout accepted applications
- 18 Dec 2011: Deadline for registration
- 18 Jan 2012: Deadline for payment



NEUTRONS
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Activities

Foresight studies

In 2010, NMI3 organised two workshops as part of its Foresight Studies series. The aim of these workshops was to discuss the future of neutron and muon research, focusing on the application of neutron science to areas of particular importance in the 21st century: Energy and Food.

Neutrons and Energy

Neutrons for Global Energy Solutions, NGES 2010, was held in Bonn, Germany, from September 26th to 29th 2010. The conference gathered practitioners of neutron techniques and major actors both in the global energy market and in energy policies, in order to define and highlight the impact of research with neutrons at all levels of the energy chain.

The diversity of applications of neutron techniques for energy research was widely illustrated during NGES2010. Thanks to their properties and specific interactions with matter and materials, neutrons are a powerful tool for materials research. The areas of energy research currently benefitting from the application of neutron techniques include the visualisation of light elements such as hydrogen and lithium; tomography and scattering measurements on large devices, in situ or in operando; the resolution of structural features over a length scale range spanning the pico- to micrometer; the identification of chemical species in catalytic reactions via analysis of vibrational modes; and the characterisation of radiation damage in power plant materials.

Many scientists working with energy research are fairly new to neutron scattering. Having to use large-scale facilities with limited access due to a strong overload presents difficulties to be overcome for new user groups. Organisational issues specific to neutron facilities, such as longer preparatory and planning phases, have to be taken into account. A number of bottlenecks for the efficient application of neutron techniques to energy research were identified during the workshop. For instance, neutron facilities are asked to establish solid communication channels with the energy research community and should facilitate access to their instruments. This is especially important for the energy industry. In addition, several improvements to the instrumentation and to sample environments were suggested to better attend the energy research community. The large diversity of tools for data analysis might be seen as prohibitive by new neutron users. Having modeling and simulation groups within the neutron centers might attract more scientists from energy research. A respective list of guidelines for corrective actions was established, which is intended to help neutron facilities to better adapt to the needs of energy research.

Sustainable energy provision is probably the biggest challenge technology-oriented societies are faced with today. Research in this area should thus be considered in a societal context, and this close connection was stressed by the presence of Mr. Arnaud Mercier from the European Commission and by Mrs Vierkorn-Rudolf from the German Ministry for Education and Research. NGES 2010 was jointly organised by Forschungszentrum Jülich & the Jülich Centre for Neutron Science, the Neutron Sciences Directorate, Oak Ridge National Laboratory, and the Science& Technology Facilities Council & ISIS and was supported by the European Commission via the NMI3/FP7 project

The official report of the workshop can be found here :
https://neutron.neutron-eu.net/FILES/NGES2010_Report_final.pdf

Activities

Neutrons and Food

The application of neutron scattering to food–based systems is still in its infancy, but has significant potential to help us understand the complex relationship between food structure, processing, rheology, nutrition, food quality and security.

In late 2010, the Neutrons and Food workshop was organised by the Australian Nuclear Science and Technology Organisation (ANSTO) together with NMI3, Oak Ridge National Laboratory, and the Australian Government Department of Innovation Industry, Science and Research, to identify the future scientific needs in the application of neutron scattering to Food Science. Over 50 people attended, including 25 international experts, coming predominantly from Europe, North America and Australia.

With participants coming from both academia and industry, and working in the fields of food science or neutron scattering, the workshop aimed to help neutron facilities to better adapt their infrastructure to the requirements of the wider scientific community and to enable potential users to develop collaborations with neutron scattering researchers. A speed networking session between food material scientists and neutron scattering specialists, on the first day, was very successful. The participants agreed that the most pressing questions are always related to very complex systems; on the one hand, the structure and dynamics of food are studied on multiple lengths and timescales, but there is also a need to understand other essential aspects, such as physiology and metabolism.

The best way to understand the behaviours and processes around food are model systems, and there should be a dialogue between the researchers designing models and those using them, to ensure their viability and relevance.

The workshop also made clear that, due to the interdisciplinary nature of the subject, there is a need for more interaction between various communities, for example in order to combine different techniques. All agreed that communication and outreach to the public health and industry sectors are crucial to increase the visibility of good research. According to the attendees, the workshop paved the way for future networks and collaborations between scientists from different areas of food and neutron research.

Topics covered:

- Protein and complexes
- Digestion and metabolic processes
- Drinks and beverages
- Dairy
- Lipids and fats
- Glassy states
- Food packaging and foot safety
- Plant materials

The dicussions focused on four main areas:

- model systems
- interaction between facility, academia and industry
- collaboration and outreach
- access to large-scale facilities

For the full workshop report please consult the web page:
http://www.nbi.ansto.gov.au/neutronsandfood/

News from around the World

Bundesministerium
für Bildung
und Forschung

Forschungszentrum Jülich leads Germany´s contribution to the European Spallation Source

The German government and the Helmholtz Association announced in November 2010 that they will contribute to the Pre-construction and Design phases of the European Spallation Source (ESS), in Lund, Sweden. The German bid has been coordinated by the Forschungszentrum Jülich and a lot of the research will take place at Jülich. The Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) and the Helmholtz-Zentrum Geesthacht für Material- und Küstenforschung (HZG) will also take part, as well as the Forschungs-Neutronenquelle Heinz Maier-Leibnitz in Munich (FRM II), the Karlsruhe Institute of Technology and the Helmholtz-Zentrum Dresden-Rossendorf.

"*Germany has been a pioneer in the development of large-scale spallation neutron sources and it all started in Jülich in the 1980´s. It was quite natural that the government asked Jülich to lead the contribution to the ESS,*" says Prof. Dieter Richter, Science director at JCNS and FRM II and Coordinator of the German ESS project.

The German Ministry of Education and Research (BMBF) has vowed to inject 15 million euros into the project, and a further 6 million euros will be donated by individual participating laboratories from the German Helmholtz Association and the FRM II. This money will contribute to the Design Update, the Preparation to Build programme, and the work to deliver all licences and permits to operate.

This German contribution "*is a sign that Germany is really willing to be a partner in this large project,*" adds Prof. Richter.

"*This is only a first stage of participation, in the future we wish also to participate in the construction of ESS, in particular of the instruments*."

Like Germany, the other 15 members of the ESS will contribute to the Pre-construction and Design phase of the project.

Most of the German contribution into the research for the ESS target development will be done at Forschungszentrum Jülich, while the accelerator research will be concentrated at DESY. The development of instruments will be a joint initiative of all the German centers involved. According to Prof. Richter, the area that requires a particular effort is instrument component development and in particular research into detectors.

The coordination of the German ESS contribution wants to make sure that the work is done in concordance with the German Neutron community. "*We should involve the community, so that their interests are part of the project.*" says Prof Richter.

UK joins European Spallation Source

In Spring 2011, it was the turn of the UK to confirm its participation in the European Spallation Source project. The UK was welcomed as 17th member of the ESS project in a meeting in Bilbao on April 15th 2011. The UK will be member of the ESS steering committee but has not yet committed funding to the construction or operation phase of the ESS.

"*The UK is an important new partner in the ESS project. ESS will benefit from the established UK technical and scientific expertise developed at ISIS neutron source outside Oxford and UK scientists will get direct access to the world's premier neutron source when it will be ready in 2019*." Said Lars Börjesson, President of the ESS Steering Committee, in the official announcement published on the ESS website.

Welcome to the Helmholtz-Zentrum Geesthacht (HZG)

On November 1st 2010, the GKSS Research Centre changed name to become the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research. The new name highlights the centre´s connection with the Helmholtz Association of German Research Centres and the city of Geesthacht. It also highlights the focus of the centre´s research activities, divided into two main areas. Its Institute of Materials Research concentrates on research into high-performance materials for implants in regenerative medicine and ultra-lightweight materials for the car and aviation industry. The aim is to develop materials that can be used for environmentally-friendly technologies, for example as membranes for biogas treatment or for the storage of environmentally-friendly hydrogen. The Institute of Costal Research deals with issues concerning the status and changes of the coastal regions and develops the basis for future coastal zone management.

HZG takes part in the Helmholtz Association´s Research with Photons, Neutrons and Ions (PNI) programme, operates the REFSANS and participates in the running of the STRESS- SPEC and SANS-1 instruments at FRM II in Garching, Germany as well as high-energy synchrotron radiation beamlines at DESY (Hamburg, Germany).

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Picture: HZG

News from around the World

FLNP and JINR re-open the IBR-2 reactor

By A. Vinogradov and O. Culicov, FLNP/JINR

The 10-year modernisation programme of the IBR-2 pulsed reactor, in Dubna, Russia has successfully been completed: the Russian Frank Laboratory of Neutron Physics (FLNP) of the Joint Institute for Nuclear Research (JINR) loaded fuel into the IBR-2 reactor core and started testing its main technological parameters at the beginning of 2011.

The IBR-2 reactor had been shut down since December 2006. A huge amount of work on design, planning, installation and adjustment of new units and systems of the reactor complex was carried out by FLNP staff members in cooperation with a number of the JINR Divisions, in order to reopen it in 2011.

In accordance with current safety requirements and standards, the old equipment was replaced and a considerable amount of repair and construction work was carried out inside and outside the reactor facility. A new fuel-loading reactor vessel and new in- and out-of-vessel instruments were installed, as well as a movable reflector with considerably improved operational parameters. New electronic equipment and protection systems were fitted on the reactor; the emergency power system, the technological parameters control equipment and the system for permanent monitoring of the reactor were also completely replaced. The reactor is now fully equipped with modern safety systems.

Numerous characteristics of the reactor will be studied during the course of 2011, as the safety limits and conditions of operation have to be determined: the first experiments on the extracted neutron beams will be carried out and unique cryogenic moderators will be installed. The installation and testing of the cold moderator system should be completed by 2013.

The recent modernisation of the IBR-2 in Dubna should ensure the safe operation of the reactor, one of the world's highest-intensity neutron sources, until 2035. At a mean power of 2 MW, the time-average thermal neutron flux density from the moderator surface will be ~1013 n/cm^2/s and the peak density should reach — ~1016 n/cm^2/s. A 1.5-fold increase in the thermal neutron flux, as compared to that of the IBR-2 reactor before modernisation, is expected. Research experiments by scientists from more than 30 countries are already planned at IBR-2 and the user program will resume in 2012.

Picture: FLNP/JINR

News from around the World

Russian PIK is functional

The Russian high-flux research reactor PIK has been functional since the end of February 2011. The reactor core is currently partly filled with fuel assemblies and it is ready for physical start up at minimal power. PIK has been designed to reach a power of 100MW, however it will only reach it once the construction of the auxiliary buildings and alarm systems are finalised.

"*Nevertheless this fact provides inspiration for all future neutron beam users*" says Dr Valery Fedorov, Director of Neutron Research Department at the Petersburg Nuclear Physics Institute, in St Petersburg, Russia. Once fully operational, PIK aims to be the most powerful research reactor in the world.

Picture: PIK

Coordination & Management

We have a new website

A brand new NMI3 website will be launched in 2011. The website will include new functionalities such as a special area for students, with educational resources and a e-learning site. With improved navigation and clearer pages, we aim to improve communication inside and outside NMI3. We hope that you will like our new website! Feedback is highly welcome.
Please visit us at www.nim3.eu

General Assembly in Rome

The next NMI3 General Assembly will take place on November 8th and 9th in Fiumicino, near Rome, Italy. The General Assembly is the central body of NMI3. It represents all the main actors in neutron scattering and muon spectroscopy research in Europe, European and international observers from other continents, as well as user organisations. All important decisions within NMI3 rely on consensus within the General Assembly.

Last NMI3 meeting in Budapest. Picture: NMI3

New NMI3 Information Manager

As our new Information Manager, Juliette Savin will be responsible for keeping the NMI3 website as user-friendly and up-to-date as possible and communicating NMI3´s activities to the scientific community and the general public.

Juliette has studied biology and science communication. She has experience in science journalism, Public Relations and marketing and in scientific events organization. Before joining the NMI3 she has worked in Brazil, for the Federal University of Rio de Janeiro and in London for the Open Access publisher BioMed Central.

"*The NMI3 website is its window. I am here to make sure that it provides all the information that its members or the general public might need. I also want to make sure that the research that is carried out thanks to NMI3´s activities gets the visibility it deserves. Have you got exciting new results that could have important implications for society? Please get in touch; I want to know all about them!*" she says.

Juliette is successor to Ana Claver, who had been Information Manager for NMI3 since its foundation in 2002.

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Thomas Gutberlet is HZB´s new User Office Coordinator

Dr. Thomas Gutberlet is the new Head of User Coordination for Neutrons at Helmholtz-Zentrum Berlin für Materialien und Energie. From 2007 to 2011, Dr. Gutberlet was Head of the User Office of JCNS at the Forschungszentrum Jülich and at the FRM II in Garching. Before that, he was instrument scientist at SINQ at PSI in Switzerland, and assistant to neutron instrumentation at the ESS, located at the former Hahn-Meitner Institut in Berlin.

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Schools	Pictures courtesy of the school organisers

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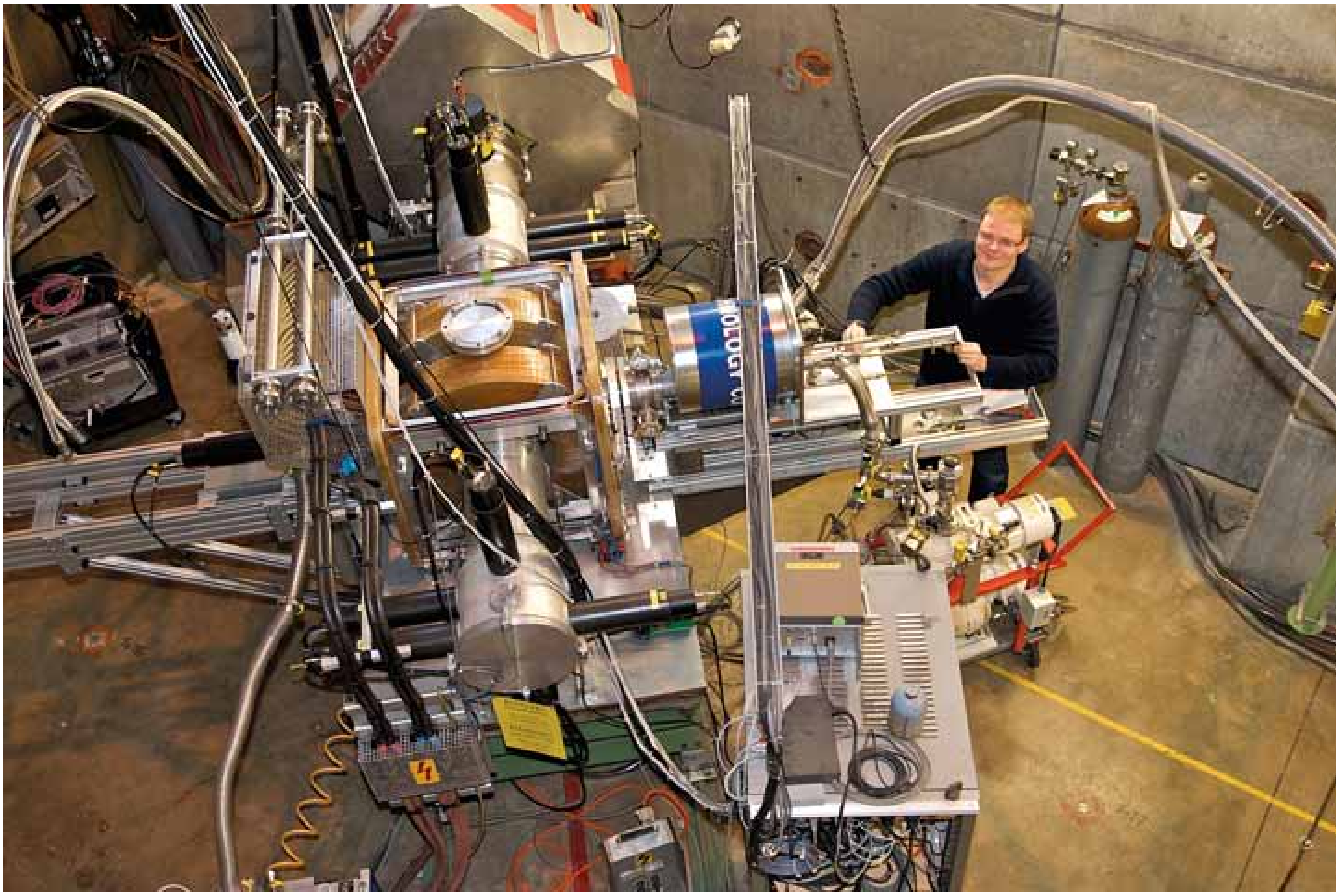

GPS at PSI, Switzerland. Picture: M.Fischer/PSI

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SEVENTH FRAMEWORK PROGRAMME

NMI3 supports European Neutron and Muon research through:

Education
Funding for European Neutron & Muon Schools organised by top European institutions

Access Programme
Access to European facilities for transnational teams of scientists

Joint Research Activities
European collaborations working towards the future of Neutron & Muon research

www.nmi3.eu