Inside nmi3

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SEVENTH FRAMEWORK PROGRAMME

www.nmi3.eu

Editorial

The end of the year, and the time to be merry, is approaching. We have good news for you. NMI3 has just been entitled 13.35 Million Euros for its activities over a period of four years, from February 2012 to 2016. For this period, the consortium will benefit from more funding for Transnational Access Activity but also from significant co-financing of Joint Research Activities.

The remainder of the budget has been allocated to networking and coordination activities, such as a collaboration on data analysis standards and the possible development of an integrated user access for the neutron and muon community.

NMI3 will also continue to support the training and education of neutron and muon scientists through an umbrella of selected European schools. As of 2012, there will be no more calls for schools proposals. In addition, an e-learning platform will be developed on our brand new website (www.nmi3.eu), to support all those seeking information.

With these funds, the consortium will be able to start a new project in February 2012, with a kick-off meeting on the 12th-13th of March 2012, at ILL in Grenoble.

Managing NMI3 is as challenging as it is interesting. As project manager, I am in contact with the best and brightest minds in neutron and muon research, as excellence is key to European project funding. This is not without its problems, for me, as the best are also the busiest.

Cultural differences can also sometimes take you by surprise. Europe is still a construct of many different cultures and languages. Luckily the neutron and muon community is good at intercultural exchange, as most neutron and muon scientists have experienced living in another country at some stage of their research career. Our very own coordination team is made up of a German coordinator and German project manager both living in France and a French information manager located in Germany.

For the new year, and the new project, I wish NMI3 to remain such a close-knit, diverse and integrated community, as this will enable us to better react to the changing European environment.

Merry Christmas and a good start to the new year.

Miriam Förster

Miriam Förster (forster@ill.fr) is the NMI3 Project Manager.

Activities

Focus on Joint Research Activities

NMI3´s Joint Research Activities (JRAs) bring together experts from facilities across Europe to develop new techniques and instrumentation for neutron and muon research. In this issue of *Inside NMI3* Stephen Cotrell updates us on the JRA dedicated to new instrumentation for muon research.

The Muon JRA – new technology for the future of muon research

By Stephen Cottrell

Europe is fortunate in having two muon sources that are complementary and together offer researchers access to the full range of μSR spectroscopic

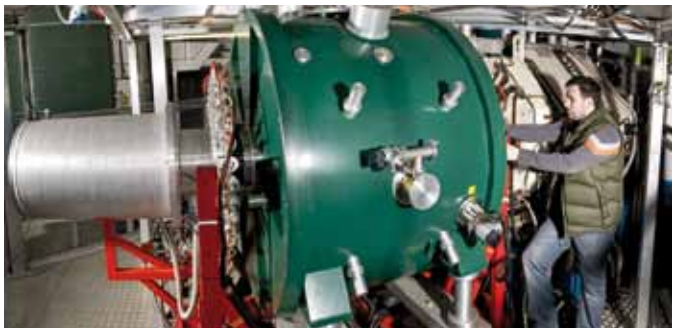


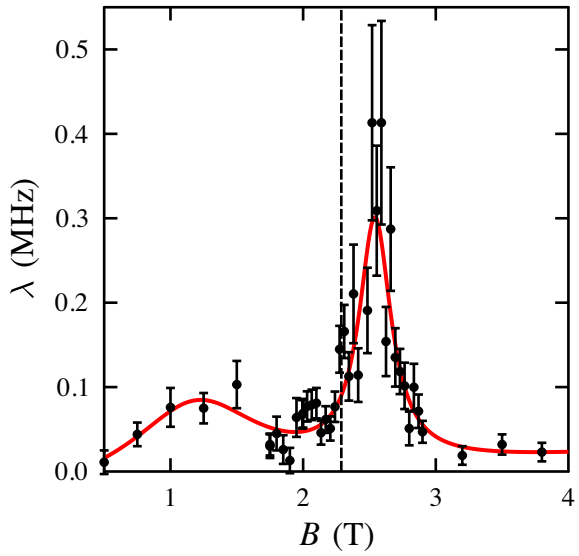
Figure 1: ISIS high field muon spectrometer. Photo: Stephen Kill (RAL), 2nd Prize winner of the 1st Illustrating NMI3 competition.

methods. The μSR technique is remarkably versatile, encompassing studies of magnetism, superconductivity and spin and charge transport, while providing a highly sensitive hydrogen analogue to probe semiconductors and proton conductors. The technique has an important role beyond condensed matter physics, and offers chemists a valuable method for investigating the fundaments of reaction kinetics. It is also a great tool for the study of organic radical structure and dynamics in solids, liquids and gases.

Figure 2: SμS high field spectrometer.

The beam structure of the SμS, located at the Paul Scherrer Institute in Switzerland, makes it ideally suited for applications where high timing resolution is essential, to follow fast muon precession or rapid spin depolarisation, for example.

Figure 3: the first example of an energy level crossing in a molecular nanomagnet detected with muons (Lancaster et al, J. Phys.: Condens. Matter 2011 23 242201).



In contrast, the pulsed nature of the ISIS beam, operated by the Science and Technology Facilities Council in the UK, allows low background time differential data to be captured at high data rates, while enabling the effect of beam synchronous stimuli (such as Radio Frequen-

cy or laser radiation) to be easily investigated. In both facilities, the work of the JRA has stimulated the development of a broad range of technologies that are now making a significant impact on European muon research.

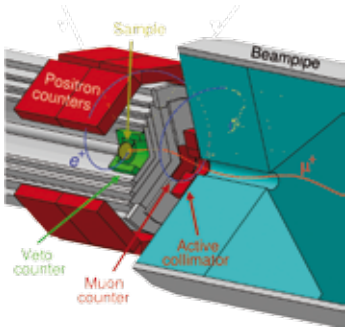


Figure 4: A study of the detector geometry and positron trajectories for the SμS high transverse field spectrometer.

Developing μSR in high magnetic fields

The development of new instruments for high magnetic field spectroscopy was essential to provide the user community with the tools necessary for future research. However, μSR in high magnetic fields is uniquely challenging. Both the implanted muons and detected decay positrons are charged and their trajectories are modified by the applied field. The detector systems need to be field insensitive yet capable of providing fast-timing. A significant aim of the Joint Research Activities in Muons under both Framework Programmes 6 and 7 has been to develop the technologies required for high field μSR spectroscopy. The importance and success of this work is evidenced by recent grant awards to both facilities to develop high field instruments.

The ISIS instrument (Figure 1) provides a 5T field parallel to the muon spin polarisation and offers a sample environment covering temperatures between 25mK and 1200K (Lord *et al*, Rev. Sci. Inst. 2011 82 073904). The instrument is now fully integrated into the ISIS user programme and has already been used for a broad range of studies, with journal publications in frustrated magnetism (Baker *et al.* J. Phys.: Condens. Matter 2011 23 306001), molecular nanomagnetism (Lancaster *et al*, J. Phys.: Condens. Matter 2011 23 242201) and molecular radicals (Cox *et al*, J. Phys.: Condens. Matter 2011 23 315801). In contrast, the spectrometer at the SμS (Figure 2) is optimised for measurements where the 9.5T field is perpendicular to the spin polarisation, and sample temperatures as low as 25mK are also available. The instrument is currently being commissioned. Test experiments have confirmed an excellent performance, through the measurement of full amplitude spin precession signals at approximately 1.29GHz in the 9.5T field. The first user experiments on this instrument are planned for 2012.

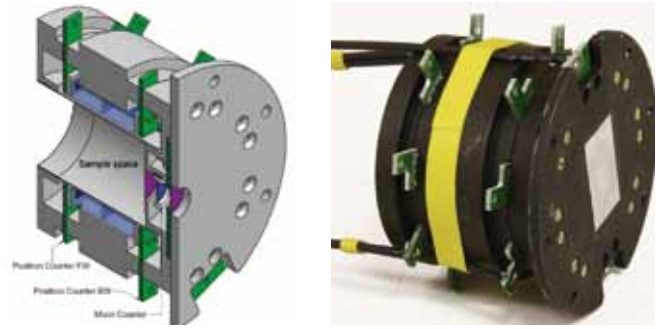


Figure 5: A prototype detector module based on avalanche photodiodes developed at the SμS with schematic view shown on the left.

Simulating beam profiles

A comprehensive suite of simulation codes has been developed to model both the profile of the muon beam through the instrument and the positron track to the detector (Lancaster *et al*, Physica B, 2006 374 480; Sedlak *et al*, Physica B, 2009 404 970). The program musrSIM, based on the popular Geant4 toolkit, enables the instrument geometry, materials and field profile to be defined. It also allows us to study the response to muons and decay positrons. Input can be taken from beam simulation programs to accurately model the incident muon beam, while the response can be analysed and tested for various acquisition parameters using the associated application musrSimAna (Sedlak *et al*, submitted to Physics Procedia). The codes have played a crucial role in the development of the detector arrays for both the ISIS and PSI instruments. As an example, Figure 4 shows a study of the detector geometry used for the SμS spectrometer, and illustrates the need to consider positron spiralling when locating the positron counters.

We checked our early simulation results during ex-

perimental work at the SμS, making use of a novel position-sensitive scintillating fibre detector developed within the JRA for profiling muon beams in high magnetic fields (Stoykov *et al*, Nucl. Instr. Meth. A, 2005, 550 212). Thanks to a grid of 20 fibres covering an area of 10x10cm^2, we could obtain detailed beam profiles. With avalanche microchannel photodiodes for the readout, we could achieve a compact design and assure insensitivity to magnetic fields.

The development of the ISIS high field instrument required new technologies for direct imaging of muons stopped at the sample position, as we needed a detailed understanding of how the muon spot evolved in position and shape in the applied field. We achieved this by developing a field-insensitive beam camera, using a high sensitivity cooled CCD to image the light from a scintillating screen mounted on the sample stage of the cryostat. The device proved crucial to the commissioning of the spectrometer. It enabled the muon spot to be monitored as automatic systems were developed to control and stabilise the beam position with the magnetic field.

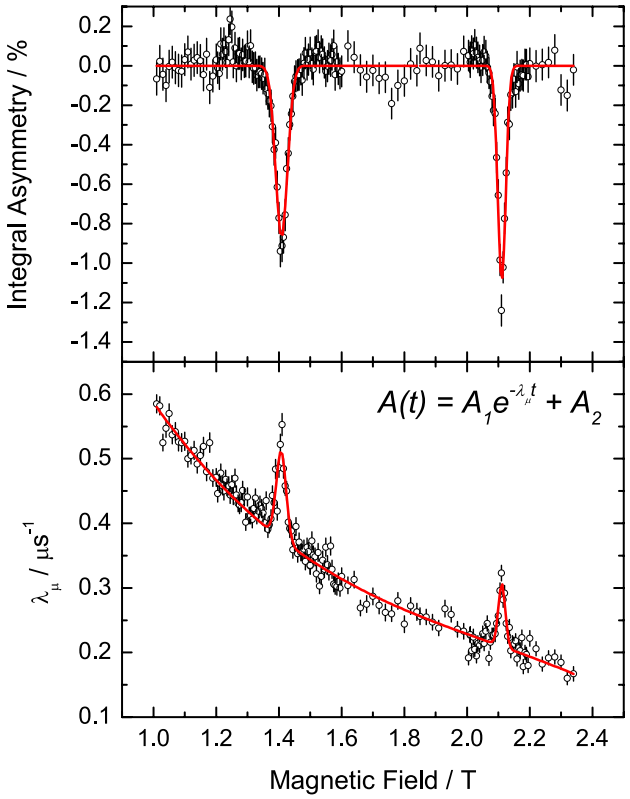
Detector optimisation

Significant work was carried out to optimise the detector arrays for high magnetic field measurements. For the ISIS instrument, although the scintillation detectors were, by necessity, positioned close to the sample, we successfully used extended light guides to move the field-sensitive photomultiplier tubes to a low field region. In contrast, the geometry of the SμS spectrometer required a particularly compact detector array, while extended guides would compromise the fast-timing resolution. We therefore had to develop a novel detector array based on Geiger-mode avalanche photodiodes for this instrument (Stoykov *et al*, Nucl. Instr. and Meth. A 2009 610 274; Stoykov *et al*, submitted to Physics Procedia). We tested a prototype detector module (shown in Figure 5) to 9.5T at the SμS and obtained excellent results. The measured time resolution was better than 80ps and, most importantly, was shown to be insensitive to magnetic fields.

Novel experimental techniques

An important area of work supported by the JRA is the development of novel sample environment equipment and experimental methods. The development of technologies for μSR at high pressures is a particular focus of this work. Problems unique to the μSR method must be overcome to provide enhanced pressure capabilities both in the gas phase and for condensed matter. In work led by Babes-Boylai University, we are developing solid sample cells with a working pressure in excess of 2.5GPa and an improved signal background. The provision of gas target pressure cells for the high field spectrometer is the focus of the work at ISIS, and we have recently explored the spectroscopy of small gas molecules during commissioning experiments at the facility (Figure 6). The application of NMR-style pulsed Radio-Frequency techniques, including muon-nuclear double resonance, is being investigated by East Anglia University and ISIS, with

Figure 6: Gas target pressure cell designed for the ISIS high field spectrometer (left) and an avoided level crossing measurement of the Mu-ethyl radical formed by implanting muons in ethene gas at 300K.



new equipment being developed to enable these experiments to run efficiently within the facility user programme. A team from the University of Parma is developing novel simulation codes to support data analysis (De Renzi *et al*, submitted to Physics Procedia). This work aims to provide a toolbox of routines for the identification of the muon site, often an important step to understand the experimental data.

Stephen Cottrell is an Instrument Scientist at ISIS (UK). He is the coordinator of the muons JRA.

Activities

Highlights from our Access Programme

NMI3 supports access to 8 neutron and muon facilities across Europe. From cultural heritage to energy research, neutrons and muons are contributing to the advancement of science in many different areas.

Neutrons reveal a zone of water increase in soil around plant roots

By Ahmad Moradi and Eberhard Lehmann

Background

Water is the main element of the soil-plant-atmosphere system and plants cannot survive without it. In the soil, it is the main vehicle for the nutrients that are essential to plants. Water is taken up by plant roots at the root-soil interface and is then transported to the leaves. There, it delivers minerals and departs the plant system to go into the atmosphere. How roots take up water from the soil is still not well known.

Better understanding of the water uptake mechanism requires new techniques capable of measuring soil water content near the roots with high spatial resolutions.

Models of water and nutrient uptake by roots have been developed based on the concept of water flow from soil to roots down a negative gradient in soil water potential. As the leaves lose water to the atmosphere, a negative water potential develops in the leaves and then propagates into the stem and roots. In extremely dry conditions, the soil loses almost all its water and its water potential drops below the limit that can be tolerated by roots. However, most of the time the soil holds enough water so that the water potential in it is considered to be higher than in the roots. This creates a water gradient across the soil-root interface, the rhizosphere. Water flows into the roots following this gradient. The water taken up from the rhizosphere is then replaced by water flowing from more distant soil. In other words, water moves from wetter and more distant soil to the relatively drier rhizosphere.

Figure 1: A three-dimensional representation of the roots of a chickpea plant. The image was obtained from segmenting the roots in the reconstructed neutron tomography data.

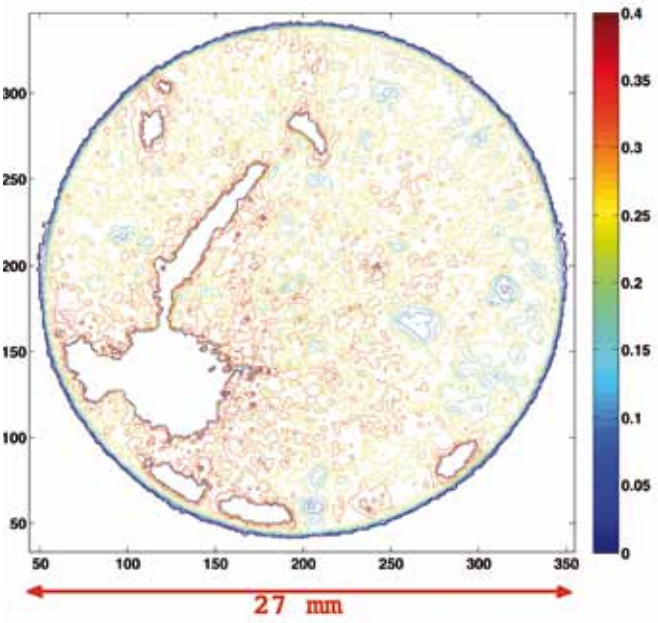


Figure 2: The micro-scale water distribution around the roots of a plant. The illustration shows a horizontal cross-section through the roots and the surrounding soil. The large, white zones represent the roots, while the regions in various colours show how much water is present in the soil – red means a large amount of water.

It has been so far challenging to measure the water content of the rhizosphere around the roots of living plants, mainly due to the difficulty in measuring soil water content at distances of less than a mm around the roots without interfering with their function. Due to their high sensitivity to water-containing materials, neutron tomography and radiography make it possible to study the distribution of water in the soil and roots, withouth having to remove the plant from the soil.

Neutron tomography setup

The measurements were performed at the NEUTRA beam line, SINQ, Paul Scherrer Institute (PSI). We grew different plant species in aluminum cylinders (height: 100 mm, Diameter: 27 mm) filled with a sandy soil. Using neutron tomography, we analysed the samples over the course of 4 days and monitored the changes in soil water contents around the roots as the plant roots took up water and dried the soil. This was done to image the temporal and spatial dynamics of water depletion around the roots over a range of soil water contents.

Results

Contrary to previous models of root water uptake, which predict a drier soil close to the roots, we consistently observed higher soil water contents close to the roots than far away from the roots. Since roots take up water from the soil and water can only move down a gradient, from wetter soil to drier soil, the only explanation is that the soil in the immediate vicinity of the roots has different hydraulic properties than the rest of the soil. We conclude that the roots modify the soil in their immediate vicinity to create a small water reserve with the same water potential as the bulk soil. This means that the soil water potential could decrease approaching the root surface but not necessarily the soil water content.

Our results agree with the findings of microbiologists on the difference in the hydraulic properties of the materials exuded by bacteria into their environment. Bacteria are surrounded by substances that act as a protecting layer to prevent them from drying out and getting wet too fast. Plant biologists also have reported the presence of similar materials around the roots of plants, commonly referred to as mucilage. We hypothesise that the release of mucilage by roots into their surrounding soil alters the hydraulic properties of the rhizosphere towards holding higher water contents.

Implication of the results

Current models of root water uptake do not account for such distinct hydraulic properties of the rhizosphere. The higher water holding capacity of the rhizosphere helps the roots to remain hydraulically connected to the bulk soil, ensuring water availability to plants in dry conditions.

These findings could help to develop plants with high tolerance to drought and to optimise irrigation schedules to improve the efficiency of water use.

This study was carried out with A. Carminati, from the Univ. Göttingen, H. J. Vogel from the Helmholtz Center for Environmental Research – UFZ, Germany, and S. Oswald, from Univ. Potsdam, Germany.

Ahmad Moradi is a Postdoctoral Soil Scientist at the Department of Land, Air, and Water Resources, University of California Davis, USA. Eberhard Lehmann is the leader of Neutron Imaging Group (NIAG) at SINQ, Paul Scherrer Institute, Villigen, Switzerland

Nanostructure and cleaning mechanism of innovative media for polymer removal from artworks: a SANS study.

By Piero Baglioni

Remediation tools for conservation

In the past, synthetic polymers have been improperly applied as protective coatings to painted surfaces. Instead of preserving the paintings, these substances promoted a series of complex degradation mechanisms, which can ultimately lead to the destruction of the artwork, as shown in figure 1. The removal of these polymer films is therefore one of the main priorities in conservation science.

Figure 1: The picture shows a Maya wall painting coated in 1999 with a film of Mowilith DM5 (vinyl acetate/n-butyl acrylate 65:35 copolymer). In less than ten years severe loss of pictorial layer occurred. The right box shows the powdering of the mortar promoted by the action of salts, which are forced to crystallize behind the surface due to the presence of the polymer coating.

Micelles (see figure 2.A) and microemulsions (see figure 2.B) are among the most effective systems available for the optimal intervention in these cases, and represent an advanced methodology for polymer removal from porous materials such as mural supports, largely preferable to the use of organic solvent mixtures. Aqueous-based systems avoid the re-deposition of polymers inside the porous matrix of the artifact, and also reduce the toxicity of the application, offering at the same time better and more controlled results than neat organic solvents.

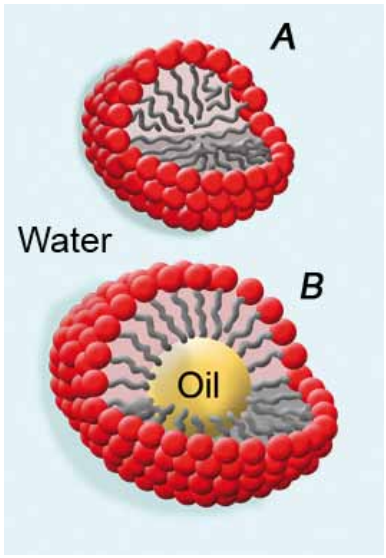


Figure 2: Schematic representation of micelles (A), and oil-in-water microemulsions (B). These nanostructured systems are the most effective cleaning tools available to remove polymer coatings from artifacts.

Nanostructure of cleaning systems

To design efficient nanofluids, prior knowledge of their ability to remove given polymer films is required. It is therefore essential to determine both their structure and dynamics. Complex nanofluids can be characterised by Small Angle Neutron Scattering (SANS). SANS is particularly suited for multicomponent systems where different regions of the nanofluid can be labeled by isotopic substitution. Using contrast variation, it is possible to characterise different components and/or regions of the aggregates, without changing the chemical composition and properties of the system.

Here we report on the structural characterisation of two nanofluids, EAPC and XYL [1-5]. Both are nanostructured systems based on sodium dodecylsulphate (SDS)/1-pentanol (PeOH). EAPC also contains Ethyl acetate (EA) and propylene carbonate (PC), both partially water-soluble solvents (EA ~8.3 % w/w; PC ~20 % w/w). XYL contains p-xylene that is almost immiscible with water. Knowing the different properties of these compounds is essential to define the nano-structure of the aggregates. The interaction of these two nanofluids with Paraloid B72 (ethyl methacrylate/methyl acrylate 70:30) was studied through the structural determination of both nanofluids before, during and after the cleaning process.

Small-angle neutron scattering measurements were performed on the PAXE instrument of the Laboratoire Léon Brillouin, LLB, (Saclay, Gif-Sur-Yvette, France). Micelles were modeled as charged prolate ellipsoidal particles interacting with each other according to a screened Coulomb potential described by the classic NAR-MMSA model.

Structure and kinetics for effectiveness

We found that the EAPC system contains elongated aggregates, dispersed in a mixture of water, PC, EA and PeOH, which cannot be considered simple 'microemulsion droplets', since both PeOH and PC have a co-surfactant action, while ethyl acetate is

interposed between apolar tails and in the core of SDS. On the other hand, the XYL system is a classically defined microemulsion composed of a surfactant, a co-surfactant, and oil (i.e. xylene) contained in the core of the aggregate and separated from the aqueous continuous phase by a surfactant/co-surfactant layer.

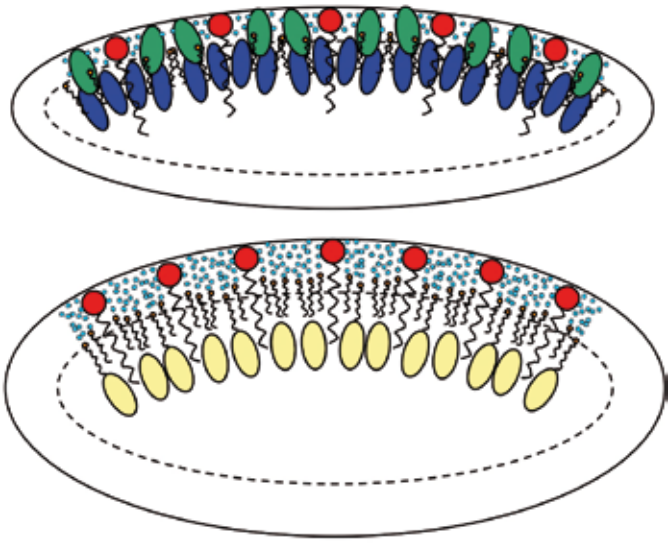


Figure 3: Schematic representation of the structure of EAPC and XYL aggregates. The dotted line indicates the position of the core/shell limit individuated through the fitting. In this cartoon the ratio between the single components amount, location of the components in the aggregate, shape and size of the micelles are represented according to the fitting results.

We performed many experiments and measurements to study the interaction mechanisms of EAPC and XYL with Paraloid B72 and get a complete, satisfactory picture of the phenomenon. We observed that the removal process is the same for both systems at the macro-scale, while there are significant differences in the kinetics of the process itself. In particular, EAPC is faster than XYL in interacting with polymer coatings. This behaviour can be explained by focusing on the interaction mechanism of the two systems. According to the results obtained from SANS we suggest that EAPC interacts with the polymer according to this model (see also figure 3):

1. Solvents dissolved in the continuous aqueous phase quickly interact with the polymer coating.
2. A series of exchanges occurs, where solvents migrate from the aqueous phase to the polymer, from the nanodroplets to the aqueous phase and from the nanodroplets to the polymer.
3. The polymer detaches from the substrate, which now is clean, while the nanodroplets get smaller and re-organise their structure due to the outflow of the solvents.

We proposed a similar mechanism for the XYL system, with one main difference, as the first step of the process is missing. In this process, solvents only migrate from the nanodroplets to the polymer to reach the equilibrium. The polymer then detaches from the substrate, while the nanodroplets get smaller and regain their structure.

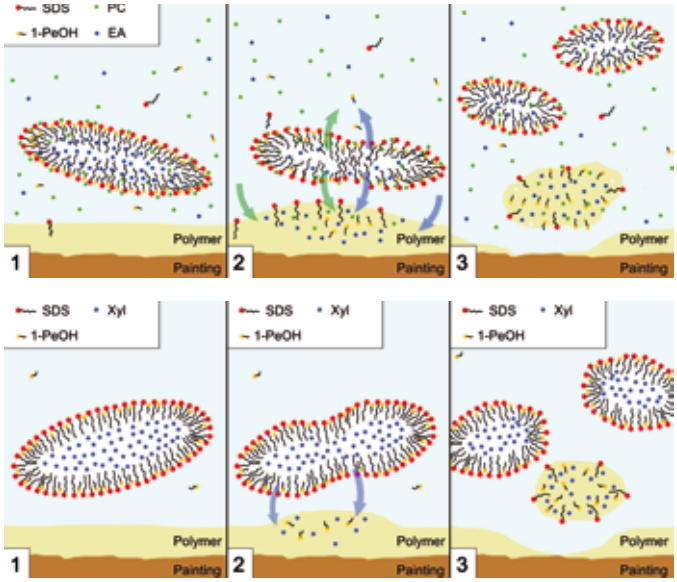


Figure 4: Cartoon showing the interaction mechanism between the detergent nanostructured systems (top: EAPC; bottom: XYL) and the polymer coating.

Therefore, we conclude that the final steps of both mechanisms are identical. The differences in the first steps, which are due to the different composition and consequent nano-structure of the systems, account for the different reaction speed that we observed. The speed of reaction indeed plays an important role in the effectiveness of these nanofluids in polymer removal from wall paintings, during real applications. We observed that, for an equal duration of application, EAPC is more effective than XYL in removing acrylic coatings.

We believe that a deeper understanding of the na-

no-structure and the mechanism that lies behind the cleaning process is key to a more conscious approach to new conservation challenges.
This work was carried out together with Michele Baglioni and Debora Berti from the University of Florence, Italy.

Piero Baglioni is a Full Professor of Physical Chemistry at the Department of Chemistry and CSGI of the University of Florence.

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SEMSANS – Spin-echo induced spatial beam modulation resolves scattering in the very small angle regime

By Markus Strobl and W.G. Bouwman

Small- angle neutron scattering (SANS) is one of the most powerful and popular techniques in the field of neutron scattering and probes length scales ranging from less than one up to several 100 nm. Due to the growing need to understand more complex structures and their hierarchical organisation, which can range up to several micrometers, a number of approaches have been developed to extend the range of sizes analysed by SANS. These, however, are still quite limited either in range or by the available flux of the particular neutron beam. Spin-echo SANS (SESANS) is a relatively new, alternative technique that doesn't rely on further beam collimation, but uses a divergent beam and hence can profit from a rather high neutron flux [1-3]. With SESANS, the small-angle scattering signal is encoded by the polarisation of a beam through sophisticated spin manipulations. This allows structural features of the sample to be measured in real space. A drawback of this technique is the effort required to keep control of the neutron spin. The neutron spin hinders measurements done with magnetic samples and/or sophisticated sample environment, which are important for many studies.

However, SESANS and spin-echo resolved grazing incidence scattering (SERGIS) [4] have proven to be powerful tools to resolve neutron scattering to very- and ultra-small angles and are applied routinely in dedicated instruments (SESANS at RID TU Delft, OffSpec at ISIS) and add-on set-ups (N-Rex at FRM II, SPEARs at LANCSE). During the PNCMI school in Berlin in 2006, R. Gähler proposed a novel approach to small-angle neutron scattering in this regime [5, 6]. In accordance with Gähler´s work, W.G. Bouwman *et al*. changed the precession region of the SESANS instrument of RID (TU Delft). This resulted in a spatial beam modulation, which could be detected behind the analyser - as long as the magnetic fields and the distances of magnet to detector were tuned to achieve the focussing of the spin states at the detector [7,8]. The polarisation in the detector plane for such configuration depends solely on the spatial position perpendicular to the beam and displays a cosine behaviour with respect to the analyser orientation. Any scattering of a sample placed in the beam will obviously reduce the amplitude of the cosine response function and can thereby be detected.

W.G. Bouwman *et al*. [8] suggested making measurements simultaneously with SESANS and conventional SANS, in order to significantly increase the resolvable range of the corresponding SANS measurement. An important advantage of such Spin-echo modulation SANS (SEMSANS) compared to SESANS is the fact that the sample can be placed in a field-free region even downstream of the analyser, where no spin manipulation is required anymore. Hence, magnetic samples and samples requiring complex sample environment can be probed easily. In order to characterise structures in the sample with sizes from nm to µm, the detection of short modulation periods ranging from mm to µm corresponding to long spin-echo lengths are required. To prove the feasibility and potential of this principle, two experiments were carried out, one at the monochromatic SESANS and one at the WESP time-of-flight (TOF) instrument at RID (TU Delft). State-of-the-art detectors were used, including in TOF mode, in view of future applications at nuclear reactors and pulsed neutron sources.

Monochromatic SEMSANS

A powerful scintillator-CCD imaging detector, with a spatial resolution of approximately 130 µm and a pixel size of 65 µm, was set up at the SESANS instrument of the RID (TU Delft). The detector system, which came from the cold neutron radiography and tomography beamline CONRAD at HZB [9], was installed right behind the analyser.

Using flipping foils we could measure modulation periods of about 5 mm to 0.5 mm (Figure 1). In this set-up, we used the specific field coils of the SESANS beamline. Different samples were probed successfully using spin-echo length from 80 to 800 nm.

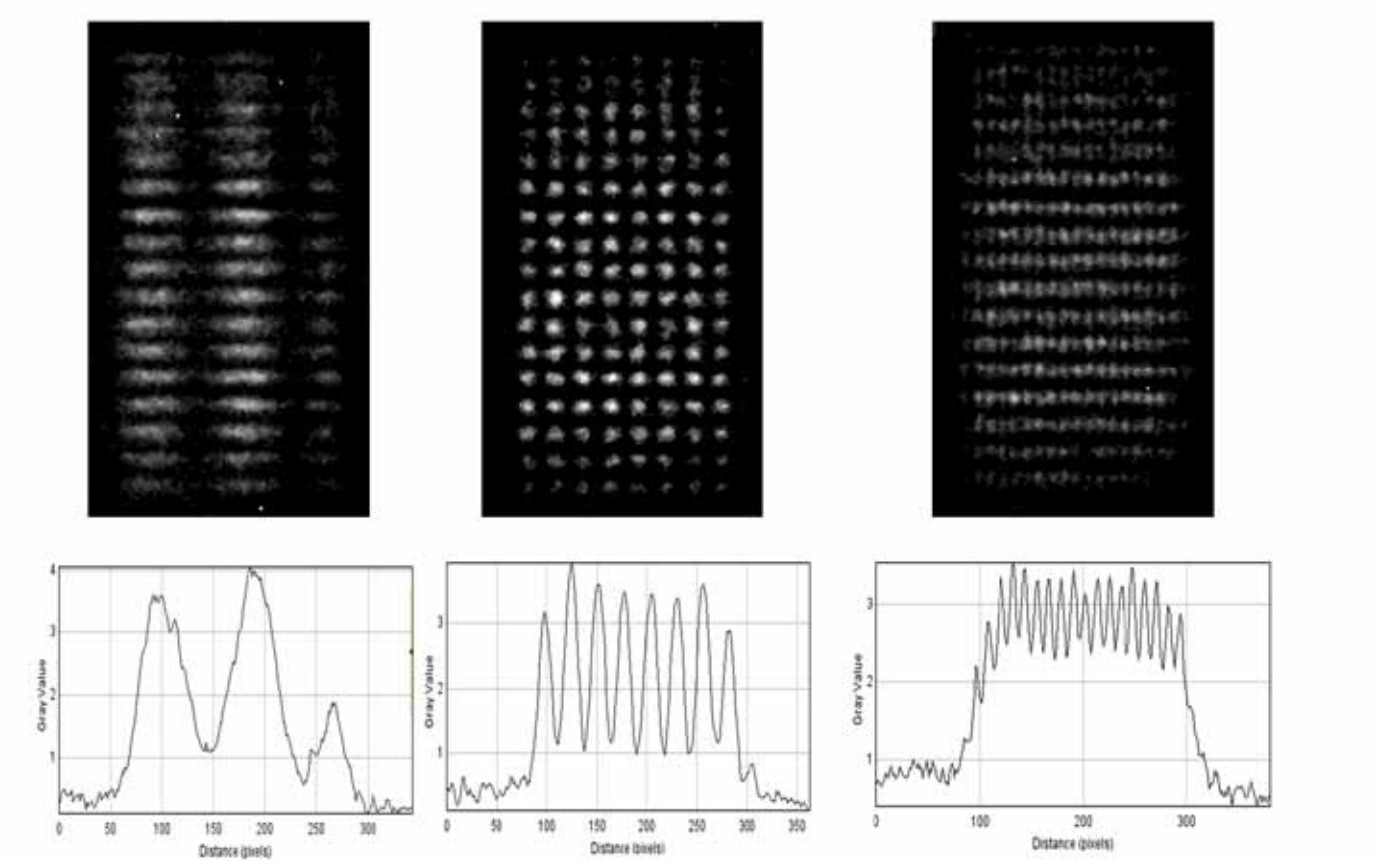

Figure 1: Modulation patterns measured at the monochromatic SESANS instrument at RID with an imaging detector system from the beamline CONRAD at HZB [9] for different magnetic field settings. Note that the horizontal stripes only display the structure of the used polarisation analyser.

Time-of-flight SEMSANS

In the TOF instrument WESP, a wavelength-dependent modulation was induced by two triangular precession regions consisting of current sheets placed under an angle of 20° to the beam (Figure 2). In order to resolve the time-dependent spatial beam modulation with sufficient spatial resolution, we used a micro-channel-plate (MCP) based neutron detector. This detector was developed by A.S. Tremsin *et al*. [10, 11] at UC Berkeley in cooperation with NovaScientific and enabled fast readout allowing for up to 14 µm spatial and sub-microsecond time resolution. The wavelength dependence of the Spin-echo length was sufficient to probe the main features of a reference sample of polystyrene spheres with diameters of 136 nm (12.4 wt%, 4 mm sample thickness) in D_2O (Figure 3). The spheres were probed in a single run and sufficient counts could be acquired for wavelengths between 1.5 and 5.3Å.

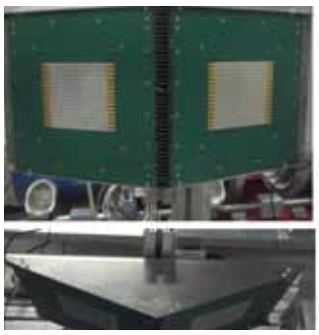

Figure 2: Triangular magnetic field regions for the TOF SEMSANS experiment at WESP at RID

These highly successful and promising proof-of-principle measurements and applications of SEMSANS on reference samples clearly demonstrate the potential of SEMSANS investigations, also with state-of-the-art detectors [9, 10, 11]. A wide range of applications in SANS, neutron reflectometry as well as for dark-field neutron imaging [12] can therefore be envisaged for this novel real-space neutron scattering method.

The experiments were performed with Frank Wieder from the Helmholtz Zentrum Berlin, Anton Tremsin from the University of California Berkeley and Jeroen Plomp and Chris Duif from the Delft University of Technology.

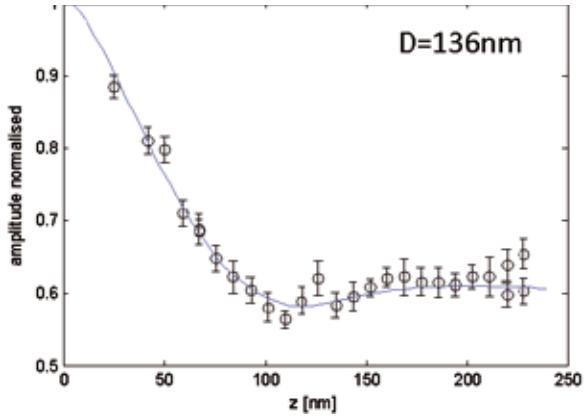

Figure 3. SEMSANS curve measured on polystyrene spheres with a diameter of 136nm and a concentration of 12.4 wt% in D^2O. The result is in good agreement with theoretical expectations for the corresponding sample (solid line).

Markus Strobl is instrument scientist at ESS-AB Lund and W.G. Bouwman is associate professor at the Delft University of Technology, The Netherlands.

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In situ neutron imaging of hydrogen storage systems

By Łukasz Gondek and Nikolay Kardjilov

Hydrogen storage

Hydrogen offers excellent prospects as potential energy carrier and a lot of effort is being put into the development of technologies allowing to introduce it into common usage [1]. The production and storage of hydrogen, as well as the recovery of the energy, are currently being investigated across the world.

However, it seems that the development of hydrogen storage systems is still one step behind the technologies for producing and converting hydrogen into energy. Hydrogen can be stored in several ways, including in high-pressure vessels, liquid hydrogen tanks, metal-organic frameworks (MOF) based on cryogenic bottles, or metal-hydrides systems. For technological, economical and safety reasons, metal-hydrides are the preferred candidates and are being extensively investigated. But their weight capacity remains unsatisfactory, and way below the 10 wt.% (weight percent) of the storage system (achieved under reasonable thermodynamic conditions) considered the threshold for mobile applications such as portable electronics and cars.

The performance of metal-hydride storage systems depends on the selection of an appropriate active material with high capacity, reversibility, and good thermal conductivity. However, the internal structure of the storage tank must be optimised in order to keep hydrogenation/dehydrogenation kinetics as high as possible. This means that the heat released upon introducing hydrogen into the metallic bed should be dissipated as the rise of the active material's temperature leads to the hampering of the hydrogenation reaction.

Although metallic hydride-based storage systems are commonly used and commercially available, the processes occurring inside such devices have been deduced from external parameters, such as changes of H^2 pressure or the container's temperature, characterising the whole container, rather than directly studied from the container's interior.

Thanks to the help of our colleagues from the neutron imaging group at HZB, Germany, we carried out in situ imaging of $LaNi_{4.8}Al_{0.2}$- based hydrogen storage container, using the cold neutron high resolution tomography and radiography facility CONRAD at BER II. For further information about experimental technique, please visit the instrument's webpage.

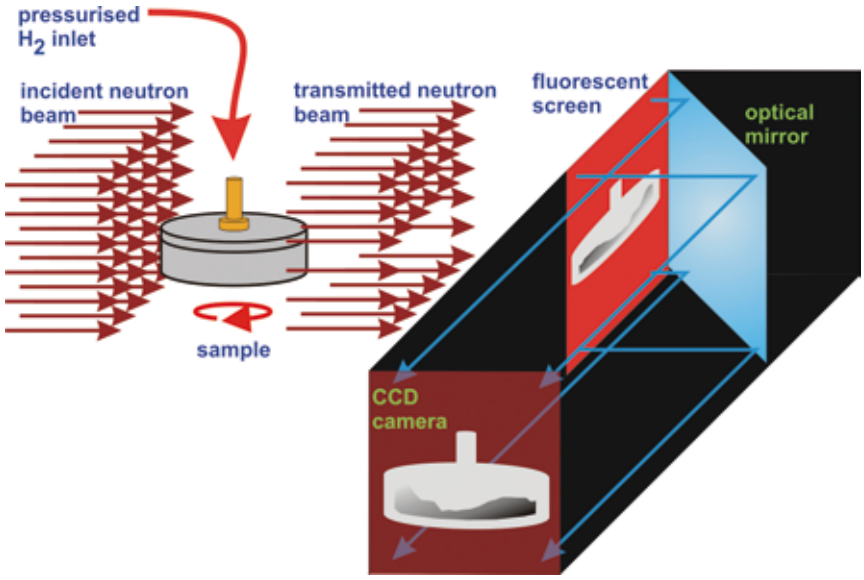

Figure 1: Experimental set-up. Schematic drawing presenting the configuration used for neutron imaging studies.

What do neutrons see?

When one thinks of radiography or tomography, X-ray medical imaging is usually the first thing that comes to mind. Although this technique is excellent for imaging the soft-tissues of a human body, it is useless for dense metallic objects a few centimeters thick, due to the attenuation of X-rays, which rises with the atomic number of the attenuator. In contrast to X-rays, neutrons have properties that make them perfectly suited for the investigation of processes inside hydrogen storage tanks. We performed radiography and tomography experiments on the operating hydrogen-storage tank using CONRAD (see Figure 1 for experimental set-up).

Our results show that neutron imaging allows the qualitative as well as quantitative analysis of hydrogen absorption/desorption kinetics, with a spatial resolution of 70 µm (0.07mm). A radiographic image of our container with details of its construction is presented in Figure 2.

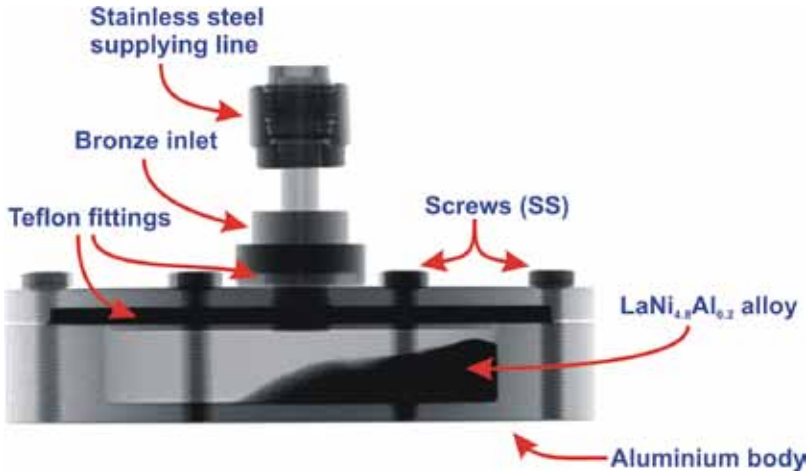

Figure 2: Radiographic image of the investigated container. All details of the construction are excellently visible.

Compared to other elements, such as simple metals, hydrogen has a very high attenuation coefficient. It is therefore possible to track even small quantities of hydrogen within the filling alloy. Thus, we were able to quantitatively visualise, in 3D, the hydrogen distribution upon operation of the container (see Figure 3). We were able to confirm that the hydrogen uptake in the bed ($LaNi_{4.8}Al_{0.2}$) is enhanced along the aluminium body of the container where heat can be easily transferred. This hints at a crucial role of heat dissipation during the exothermic reaction of hydrogen loading into the bed. Apart from the above, other factors, such as compression of the $LaNi_{4.8}Al_{0.2}$ powder under the hydrogen pressure applied, were noticed.

To conclude, we obtained first-hand information about the complex phenomena taking place inside of the hydrogen storage systems upon operation. It seems that neutron imaging has been under-exploited for the characterisation of metal-hydride containers [2]. Complementary imaging using both radiography and tomography may be crucial for the development of more efficient hydrogen storage devices.

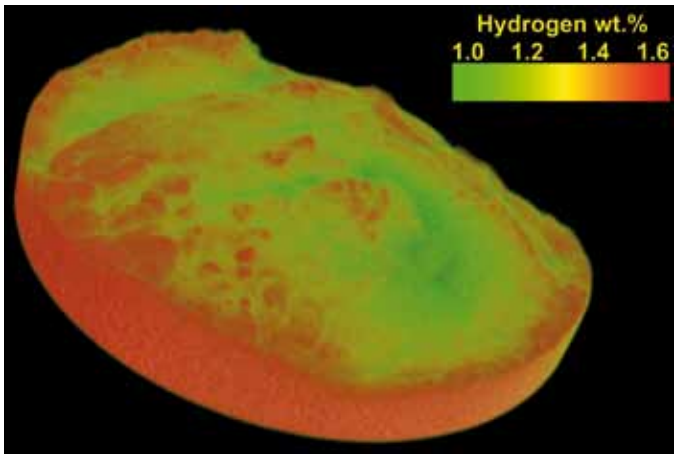

Figure 3: The interior of the hydrogen storage container, only the bed without details of the container is displayed. Different colours represent the hydrogen concentration in the bed: green means low hydrogen concentration, orange – high. As apparent, the concentration is enhanced around walls.

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Łukasz Gondek is a researcher at the AGH University of Science and Technology in Krakow, Poland and Nikolay Kardjilov is the V7 instrument scientist at the Helmholtz Center Berlin for Materials and Energy in Berlin, Germany.

Local atomic order in Tellurium-rich infrared optical glasses

By Jóvári Pál and Ivan Kaban

An important aim of research on telluride glasses is the design of single-mode fibers capable of guiding infrared light with wavelengths up to 20 μm. Due to their excellent glass forming ability, selenium based glasses are used to guide light in the mid-infrared region, up to about 14 μm. The cut-off can be shifted to longer wavelengths by replacing selenium with tellurium. Unfortunately, tellurides are usually poor glass-formers [1]. By searching for alloys with the appropriate combination of optical properties, glass forming ability and stability, it was found that the ternary compositions $Te_{78}Ge_{11}Ga_{11}$, $Te_{70}Ge_{20}Se_{10}$ and $Te_{73}Ge_{20}I_7$ (denoted with TGG, TGS and TGI, respectively) satisfy the above requirements rather well [2-4]. These alloys can be relatively simply

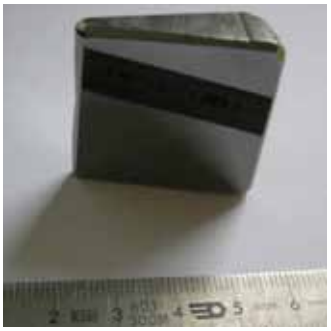

Figure 1: A prism made of TGG ($Te_{78}Ge_{11}Ga_{11}$) glass.

shaped, which makes it possible to produce long fibers, lenses or prisms as demonstrated in Figure 1. At present, the $Te_{77}Ge_{20}Se_3$ composition appears to be the best compromise between the glass thermal stability and optical transparency [4]. The goal of our study was to gain insight into the structure of $Te_{78}Ge_{11}Ga_{11}$, $Te_{70}Ge_{20}Se_{10}$ and $Te_{73}Ge_{20}I_7$ bulk glasses and understand how the third component (Ga, Se, I) builds in the host network and promotes the glass forming ability.

Neutrons and X-rays reveal local atomic order

We have performed neutron and X-ray diffraction measurements as well as extended X-ray absorption spectroscopy experiments at Ga, Ge, Se, Te and I K-absorption edges. The experimental datasets were fitted by the reverse Monte-Carlo (RMC) simulation technique [5,6]. This method allowed us to generate large scale atomic models compatible with experimental information. Bond lengths and coordination numbers of Te were obtained for the TGG, TGS and TGI glasses. The average coordination number N_{Te} is close to 2 in TGI, TGS as well as in the binary glass, while it is significantly higher in TGG. The sum of N_{TeGe} and N_{TeTe}, which is very close to 2 in TGG, suggests that Ga participates in the 'third bond' of Te atoms. Thus, unlike Se or I, Ga does not build into the Ge-Te covalent network. Instead, it forms a covalent bond with the non-bonding p-electrons of Te, which results in an increase of the average Te coordination number. This is consistent with the expected role of Ga in the initial composition: catching the Te lone electron pairs to prevent tellurium from crystallizing. Figure 2 shows a schematic model of TGG glass based upon the above results.

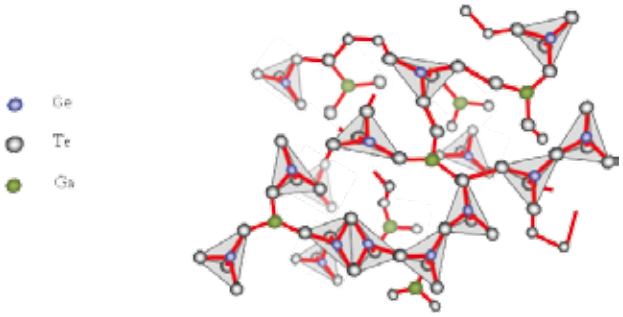

Figure 2: A model structure of TGG ($Te_{78}Ge_{11}Ga_{11}$) with threefold coordinated Te atoms (Ge: blue, Ga: green, Te: gray).

Our results clearly show that the third component has a strong influence on the average Te-Te distance. While the Ge-Te distance is essentially the same in all alloys investigated (2.60±0.02 Å), the Te-Te bond is significantly longer in TGG (2.80±0.02 Å) than either in TGS (2.73±0.02 Å) or in TGI (2.70±0.02 Å). The Te-Te distance in $Te_{85}Ge_{15}$ (2.75±0.02 Å) is just half way between the corresponding values of TGI and TGG. Hence, the strength of $GeTe_4$ (respectively $GeTe_3I$, $GeTe_3Se$) 'units' is very similar in $Te_{85}Ge_{15}$, TGG, TGI and TGS glasses, but the connection between these units is different. Shorter Te-Te distances in TGS and TGI suggest that Te-Te bonding is stronger in these alloys than in TGG.

Ga, Se, I and glass formation

By combining different experimental techniques it was possible to determine short-range order of Te-Ge-based glasses. We showed that the increase of glass forming ability is achieved by entirely different strategies. While I and Se build in the covalent network making Te-Te bonding stronger, Ga increases

the average coordination number of Te (and also network connectivity) but decreases Te-Te bond strength.

This research was carried out together with B. Bruneau from the Laboratoire Sciences Chimiques de Rennes UMR-CNRS, France, A. Wilhelm and P. Lucas from the Dept of Material Science and Engineering, University of Arizona, Tucson, USA, B. Beuneu from the Laboratoire Léon Brillouin, Saclay, France and D.A. Zajac, from HASYLAB at DESY, Hamburg, Germany.

P. Jóvári is a scientist at the Neutron Physics group, Research Inst. for Solid State Physics and Optics, Budapest, Hungary and I. Kaban is research scientist at the Inst. for Complex Materials, at the Leibniz Inst. for Solid State and Materials Res. Dresden

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Alcohols, anesthesia and neutron scattering

By Mária Klacsová, Daniela Uhríková and Pavol Balgavý

1 - alcohols (CnOH) with a number of carbon atoms (n) lower than 14 are general anesthetics [1]. Lipid theories of anesthesia suggest that the bilayer of biomembranes is the primary target of anesthetics. Bilayer structural perturbations induced by anesthetics affect membrane protein conformations and result in functional changes in the proteins. In the bilayer, the OH group of CnOH is located at the level of phospholipid polar groups and the CnOH alkyl chain extends into the bilayer´s hydrophobic interior. At a constant alcohol concentration in the bilayer, the mismatch between shorter alcohol and longer lipid hydrocarbon chains should result in a decrease in the bilayer thickness; this decrease should diminish with the alcohol chain length increase up to the lipid length. The aim of our investigations was therefore to study bilayer thickness as a function of CnOH chain length n. The bilayer thickness can be obtained from small-angle neutron scattering (SANS) on unilamellar phospholipid vesicles (ULV) [2, 3]. We performed this experiment on PAXE at the Laboratoire Léon Brillouin (LLB) in Saclay, France.

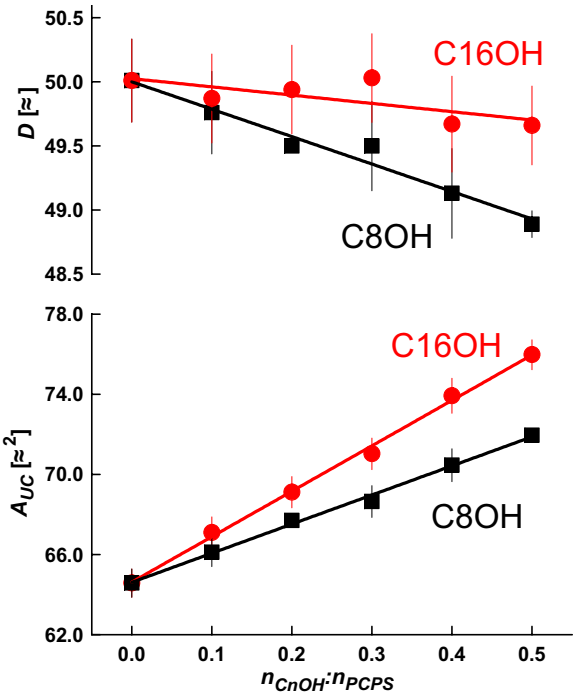

Figure 1: Dependence of bilayer thickness D and the lateral area of unit cell A_{UC} on alcohol:lipid molar ratio n_{CnOH}:n_{PCPS}.

SANS experiment on PAXE

We prepared ULVs from dioleoylphosphatidylcholine (DOPC) with a small amount (4 wt. %) of dioleoylphosphatidylserine (DOPS). We dispersed solid DOPC+DOPS+CnOH mixtures in D_2O + H_2O mixtures (outer contrasts) and extruded these dispersions through 50 nm pores in 2 stacked carbohydrate filters. We measured SANS spectra on PAXE (sample to detector distance 1.3 m and 5.05 m, λ=0.6 nm) at 25°C.

The extruded ULVs are polydisperse hollow spheres with a single bilayer separating the inside and outside aqueous compartments. We divided the bilayer into three strips corresponding to two polar headgroup regions and the bilayer center spanning

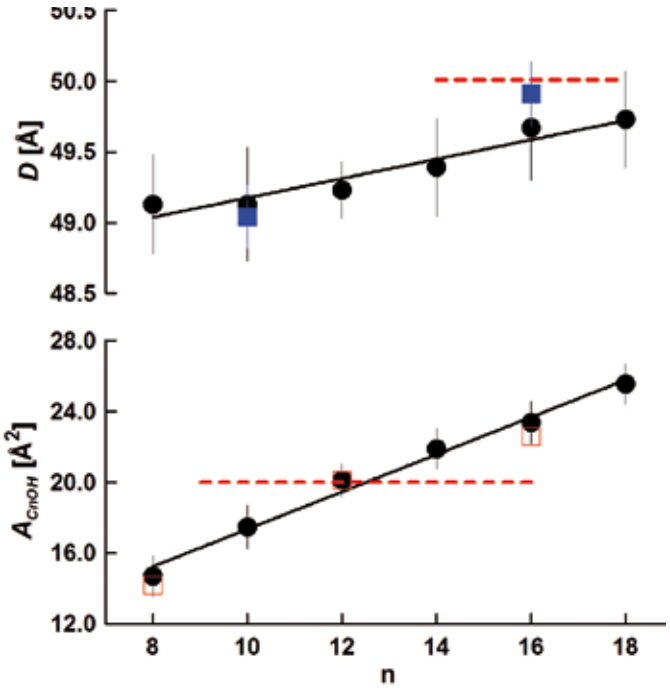

Figure 2: Dependence of bilayer thickness D and the CnOH interface area A_{CnOH} as a function of CnOH chain length n at molar ratio n_{CnOH}:n_{PCPS} = 0.4.

hydrocarbon region. The scattering length densities of polar and hydrophobic regions were calculated using the known scattering lengths and component volumes of DOPC, DOPS and CnOH were measured by densitometry.

From SANS data, we evaluated the bilayer thickness, D, as well as the lateral area of the unit cell, which consists of a phospholipid molecule and a particular fraction of the alcohol at the bilayer–aqueous phase interface, AUC (see [2, 3]). For illustration, selected D results as a function of CnOH:lipid molar ratio (Figure 1) and as a function of CnOH chain length n at fixed CnOH:lipid=0.4 molar ratio (Figure 2) are shown and compared with control value of D (dashed line) obtained at CnOH:lipid=0:1 molar ratio. As predicted, the thickness D decreases due to CnOH and lipid chain length mistmatch. This effect is larger at higher CnOH concentrations and diminishes with the CnOH chain length n. The interface area AUC increases due to CnOH intercalation between lipid molecules. From the data, we have also calculated the interface area of CnOH, ACnOH, in bilayers (Figure 2). Anomalously small values of ACnOH were obtained for n<12, which were smaller than the chain cross-section area ~20 Å2 (dashed line) in solid rotator phases of n alkanes. We suppose that this anomaly is caused by the lipid headgroup whose interface area is larger or equal comparing to the sum of hydrocarbon chains cross section areas, so that a small OH group is located underneath at the lipid glycerol fragment. Simulations of DOPC+CnOH bilayers carried out with the GROMACS molecular dynamics package, using the MARTINI coarse-grained force field, reproduced our experimental results [3]. Dr. M. Bulacu and Professor S.J. Marrink from the University of Groningen performed these simulations.

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M. Klacsová was a PhD student of biophysics (2006-2010) and P. Balgavý her supervisor at the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, D. Uhríková is the Head of Department of Physical Chemistry of Drugs, Faculty of Pharmacy, Comenius University in Bratislava and P. Balgavý and M. Klacsová are staff members of this Department.

German-Hungarian collaboration in Prompt Gamma Activation Analysis

By Zsolt Révay and Petra Kudejova

Prompt Gamma Activation Analysis (PGAA) is a nuclear analytical technique performed at several neutron beam facilities all over the world. It is based on the radiative capture of neutrons, whereby binding energy is released in the form of prompt gamma radiation when an atomic nucleus absorbs a neutron. If the nucleus is radioactive after de-excitation, it then decays with a delayed emission of a beta particle and gamma photons. Both types of gamma radiations are characteristic for each element: their energy identifies the emitter nuclide, while their intensity is proportional to its amount. In other words, the detection of these radiations enables the determination of the constituents of the sample analysed. The first process is used in prompt gamma activation analysis, while the radioactive decay in neutron activation analysis (NAA).

In principle, all isotopes of all chemical elements can be analysed using PGAA, though with extremely different sensitivities. The great advantage of the method is that it is suitable for the analysis of light elements, where many instrumental analytical techniques fail. It is useful for the determination of the major and minor components of a sample, as well as for the analysis of certain trace elements like boron, cadmium, rare-earths, or hafnium. PGAA also provides a unique tool for hydrogen or water analysis, as it is the only method allowing to investigate water solutions and trace amounts of hydrogen (or water) in materials. Since both neutrons and gamma photons penetrate deep into materials, the acquired gamma spectra contain analytical information about the whole irradiated sample. This is why PGAA makes it possible to study samples in any form, even samples inside containers with a wall thickness of several millimeters. With the right collimation of the neutron beam and of the out-coming gamma radiation, even internal parts of complex objects can be abalysed.

PGAA at BNC

The PGAA facility in Budapest started operating in 1995. The Budapest Research Reactor is a 10-MW water-cooled, water-moderated, tank-type reactor equipped with a cold neutron source. The PGAA facility is located 35 m away from the reactor at the end of a super-mirror-coated, curved neutron guide. The thermal flux at the sample position is 1.5×10^{8} cm^{-2} s^{-1}. One of the major projects of the group has been the establishment of spectroscopic library of capture gamma data and the development of the analytical procedures from detector calibration through spectrum evaluation to the determination of the composition of the sample. For the past 15 years, the major fields of application have been

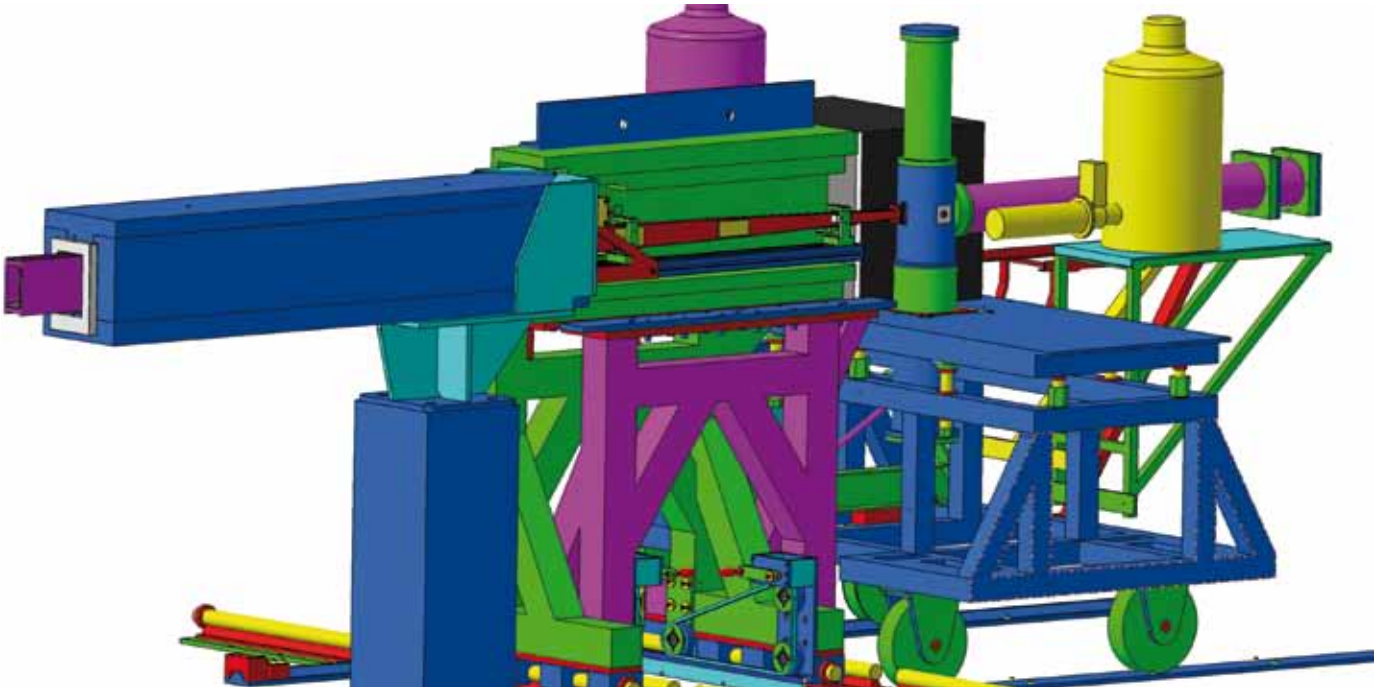


Figure 1: Design of the PGAA set-up at FRM II 2006 – 2010

archaeology, geology and the investigation of nuclear materials. Measurements at this facility, similarly to other instruments at Budapest Neutron Center (BNC), are supported by NMI3.

PGAA at FRM II

The PGAA instrument at FRM II was originally developed at PSI, Switzerland, where it was in operation from 1998 to 2001. The Nuclear Physics Institute of Cologne University, headed by Prof. Jan Jolie, then took over the responsibility for the instrument. Considerable work was first carried out in Cologne to re-design and upgrade the instrument. Then, in partneship with FRM II, the new PGAA facility was installed at the end of a 51-m long, curved cold-neutron beam guide NL4b (2006-2007). The instrument was tested in 2007 and opened to users in 2008. The thermal neutron flux can reach 6.1×10^{10} cm^{-2} s^{-1} - the highest cold flux ever reported. While keeping a good signal-to-noise ratio, the high neutron flux allows to investigate very small samples (mg or below) or materials with extremely low neutron capture cross-section. Similarly to the Budapest PGAA, the type of measured samples and applications is broad and includes archaeology, geology, environmental science, medicine, material science and irradiations.

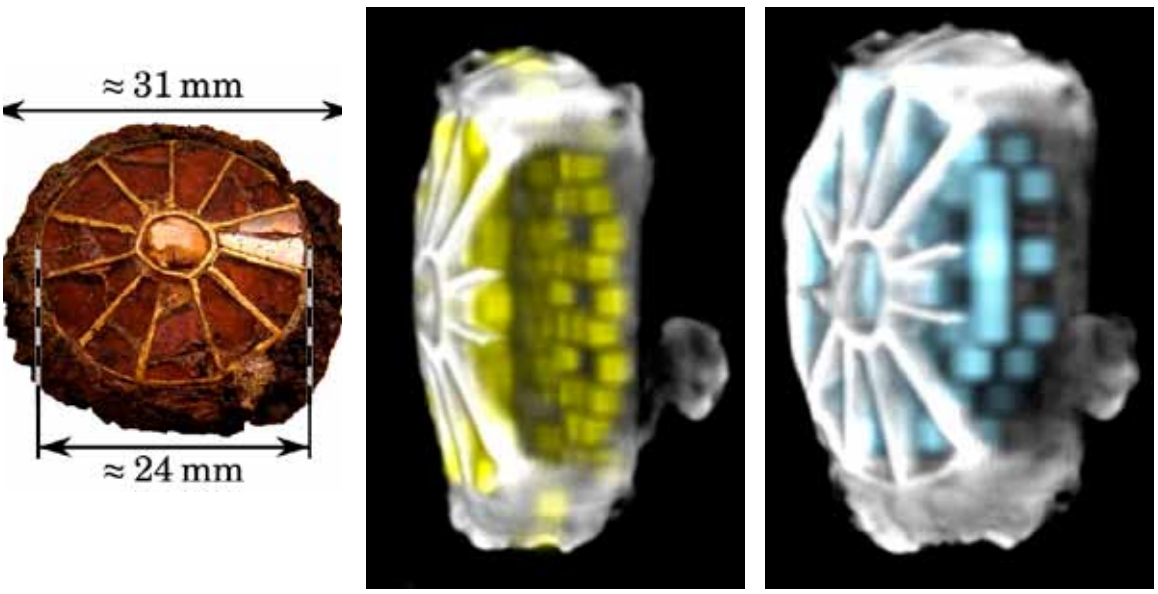


Figure 2: Disc fibula from the 6th century, 3D elemental maps for gold and silver

Fruitful collaboration

Contact between the two PGAA groups was established at the 11th Capture Gamma Symposium in Pruhonice, Czech Republic, in 2002. Both groups agreed to cooperate and the Budapest group offered their help and know-how to rebuild the PGAA instrument at FRM II, and for the measurements and analyses. A number of visits and exchanges have taken place since the beginning of the project.

A joint research project was established in the frame of the ANCIENT CHARM project (EU NMI3/FP6) from 2006-2009. The two groups collaborated on the development of a new technique, Prompt Gamma Activation Imaging, driven by Neutron Tomography (PGAI-NT) for the investigation of precious cultural heritage objects. One of these objects was a fibula from the 6th century found in western Hungary (see figure 2), which was investigated at both laboratories using the PGAI-NT technique. Without disassembling the precious jewel, its internal structure and composition could be studied in detail. Its origin, most probably a German workshop, could also be determined using this technique.

The collaboration continues, with the measurements of low-cross-section nuclides at FRM II, in order to further improve the spectroscopy database. Z. Revay from Budapest is currently working as PGAA instrument scientist, at FRM II. In the frame of this active collaboration, the instrument will be significantly rebuilt and upgraded.

Zsolt Revay and Petra Kudejova are PGAA instrument responsibles at FRM II in Garching, Germany.

News from the facilities

New management team at ILL

The Institut Laue-Langevin (ILL) has appointed a new management team. Andrew Harrison, formerly Science Director is now Director General, with Helmut Schober, the current NMI3 coordinator, taking the role of Science Director. Jose-Luis Martinez will be continuing as Director of Projects and Techniques.

ILL is coordinator of the NMI3 consortium, and one of eight European intergovernmental scientific research organisations. It is therefore not directly involved in the Transnational Access programme supported by the European Commission, a programme aiming to facilitate access to nationally-funded facilities for European researchers.

Located in Grenoble, France, ILL is the biggest neutron facility in Europe and more than 2000 researchers come to Grenoble every year to use its high neutron flux and state of the art instruments. NMI3 coordinator and new Science Director Helmut Schober believes that this number can grow further "ILL and NMI3 work hand in hand to make neutrons available to as many European scientists as possible."

ILL launched its modernisation programme, the ´Millennium Programme´, in 2000, through the design of new neutron infrastructure and the introduction of new instruments. A second phase of development began in 2008 to build five new instruments and upgrade four others.

According to Andrew Harrison, now Director General, "We have been given a huge boost over the past decade through our instrument renewal plan, and we have many of the world's best neutron scientists and engineers. However, we will make the most progress in developing new techniques and instrumentation by working with other neutron institutes on the challenges that face us all."

ILL is also involved in many of NMI3´s Joint Research Activities (JRAs). The Deuteration JRA is coordinated by Trevor Forsyth, currently based at ILL. ILL´s involvement in the Sample Environment JRA is coordinated by Eddy Lelièvre- Berna, and Bruno Guerard is coordinating its participation in the Detectors JRA. Pierre Courtois has taken over from Ken Andersen, now at ESS, as coordinator of ILL´s contribution to the Neutron Optics JRA.

ILL was founded by France and Germany in 1967 with the United Kingdom becoming the third major partner in 1973. Twelve more countries have since become members, including one non-European partner: India.

The new ILL Management team (from left to right): José Luis Martinez, Helmut Schober and Andrew Harrison.
Picture: ILL

NEUTRONS FOR SCIENCE

A second set of instruments for the ISIS Second Target Station

By Philip King and Martyn Bull, ISIS

Alongside the seven instruments that are up and running on TS-2, construction has started on four new 'Phase 2' instruments following the announcement of funding by David Willetts MP, UK Minister for Universities and Science, in March. Chipir, Larmor, Zoom and Imat will all be built over the next few years.

The ISIS Second Target Station.

Chipir

Concrete shielding for Chipir, an instrument designed to look at the effect of cosmic radiation on microchips, has been manufactured and installed this year. This shielding stops stray neutrons from the instrument entering the experimental hall, and creates a platform on which Chipir will be placed.
Chipir will be one of only a handful of facilities outside of the US capable of looking at the response of silicon microchips to cosmic radiation. Cosmic radiation has the power to cause the failure of critical electronic systems such as those found in aircraft and road vehicles. The new neutron beam line will replicate the cosmic radiation that can affect microchips. The findings will help manufacturers build more reliable electronic systems for use in cars, planes and other devices.

Left: Beginning of the construction of the Chipir beamline.
Right: Design drawing of Chipir.

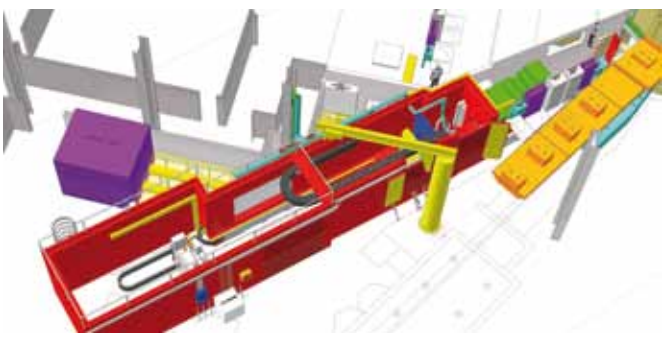
Larmor

Larmor will extend both the spatial and temporal ranges accessible to the neutron technique and is particularly applicable to soft matter and biomolecular science. It will exploit the Larmor precession of the neutron spin to deliver a suite of techniques extending those presently available at ISIS. Larmor will initially be used for small-angle neutron scattering (SANS) with polarisation analysis, spin-echo SANS and Larmor diffraction, but additional operational modes will be made available as the instrument develops. Detailed instrument design is now underway, and component procurement has started.

Design drawing of the new Larmor instrument.

Zoom

Zoom will be a flexible, high count rate small-angle scattering instrument ideally suited for kinetic and dynamic experiments. Additionally, it will allow for grazing incidence techniques to study surface structures and will be able to polarise neutrons for studies of magnetic materials. It will be the first ISIS instrument to use focusing, which, when coupled with a high resolution, two dimensional detector, will enable us to reach very small Q, ~ 0.0003 $Å^{-1}$ (~ 2 μm) with a wide simultaneous Q range out to at

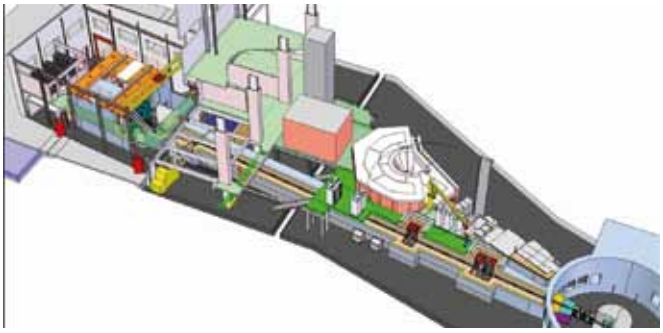


Design drawing of Zoom.

least ~ 0.15 $Å^{-1}$. Stage 1 of the design, a highly flexible small angle instrument, is presently underway.

Imat

Imat is a neutron imaging and diffraction instrument for materials science. The instrument will offer a combination of possibilities such as neutron radiography, neutron tomography, energy-selective imaging, neutron strain scanning and texture analysis. The combination of these analytical techniques on the same instrument is unique and will allow new types of experiments to be carried out. For example, residual stresses inside engineering-sized samples can be more effectively analysed if the diffraction scans are guided by radiographic data. Conversely, diffraction analysis may be indispensable for a quantitative analysis and physical interpretation of the attenuation features observed in radiography data. Imat will have a straight neutron guide to transport the neutrons to an aperture selector giving a maximum field-of-view of 20x20 cm^2 at a sample position at 56 meters from the moderator.



The new Imat instrument.

FRM II is back in operation

By Jürgen Neuhaus, FRM II

The neutron source Heinz Maier-Leibnitz (FRM II) in Garching, Germany is back in operation and available for external users after a long maintenance break, which lasted 373 days in total.

For the FRM II, this was the first long shut down with exchange of beam tubes. The inclined beam tube SR11 hosting the positron source was changed due to the burn-up of the Cadmium inside-layer. In addition, a thimble in the moderator tank had to be exchanged for the future 99Mo irradiation facility. Unfortunately, minor technical problems discovered during the inspection of the heavy water circuit delayed the restart by 6 months. The coinciding natural disaster in Japan had placed an additional burden on our reactor department in order to restate the secure operation of the reactor.

During this long period, much work has been carried out on the instruments. The biggest project was the complete reconstruction of the imaging facility ANTARES. The instrument had to move to another beam port, SR4b, as SR4a goes to the installation of a cold guide towards the new east guide hall.

Picture: Wenzel Schürmann / TUM

This guide will provide an intense neutron beam for particle physics. ANTARES is expected to be back in operation mid-2012.

The first sections of the neutron guides were replaced by boron-free float glass guides to minimise radiation damage. The beam ports in the shutter of SR9 had been modified to provide two independent beams for the future single crystal diffractometer using polarised hot neutrons. Last but not least, the number of detectors on TOFTOF was increased from 600 to about 1000 and the electronics were improved with regards to noise and shielding. Most groups worked hard to improve or extend the experimental possibilities.
The next deadline for proposals is January 27th 2012. User Office: http://www.frm2.tum.de/en/user-office/news-dates/index.html

Schools

Until July 2011, NMI3 contributed to neutron and muon schools through a call for proposals. The July call was the last one and NMI3 is now supporting a selected group of European schools. Below is a list of schools supported by NMI3 in the first half of 2012.

The Berlin Neutron School

8th to 16th March 2012
Berlin, Germany

The Berlin Neutron School organised by the Helmholtz Zentrum Berlin für Materialien und Energie (HZB), the first ever neutron school, was founded in 1980 by Prof Hans Dachs. The aim of the school is to provide an introduction to neutron scattering with an emphasis on hands-on, practical experience using the instruments at the BERII reactor.

Picture: courtesy of Berlin School

The scientific program of the course consists in 7 working days and the school usually accepts 30 students.

The first 2.5 days of the school consist in comprehensive lectures on the principles and techniques of neutron scattering, followed by a tour of the instruments and an introduction to sample environment. As well as the course lectures given by members of HZB, students will attend lectures given by guests invited to talk about current issues in the field of neutron research. In previous editions of the school, Prof Michael Steiner (ENSA) has talked about the future of neutron sources in Europe, Andrea Denker (HZB) has lectured on neutron auto-radiography and Toby Perring (ISIS) has talked about spallation source techniques.

After this first session, the students begin the 3.5 days of experiments. In groups of four to five, they are introduced to triple-axis spectroscopy, powder diffraction, small angle scattering, reflectometry, time-of-flight spectroscopy, tomography and spin echo, under the guidance of the instrument scientists. On the last day of the school students attend lectures on how to use neutron scattering as a tool for research in specific subject areas such as biology, chemistry, engineering and physics.

For more information please visit:
www.helmholtz-berlin.de/events/neutronschool/

HZB Helmholtz Zentrum Berlin

Muon Spectroscopy Training School at ISIS

19th to 23rd March 2012
Didcot, UK

The aim of this school is to provide a practical training course for young researchers on the spectroscopic techniques using muons as probes in condensed matter research. The ISIS Pulsed Neutron and Muon Source, at the STFC's Rutherford Appleton Laboratory (RAL), is home to intense beams of pulsed muons for condensed matter investigations. ISIS has previously run five muon spectroscopy training schools (1994, 2003, 2005, 2007 and 2010), which have provided students with first hand practical experience of running a μSR experiment, together with the background knowledge required to understand the technique's principles. The goal of the training schools was to provide researchers near the start of their careers with the skills neces-

sary to take the maximum benefit from future facility time, to provide young researchers with valuable

Picture: courtesy of ISIS

experience of working at a large, international facility and to improve knowledge in related fields such as computing and cryogenics.

Application deadline: 13th January 2012.

For more information please visit:
http://www.isis.stfc.ac.uk/groups/muons

Science & Technology Facilities Council
ISIS

22nd HERCULES

4th March to 4th April 2012
Grenoble, France

The aim of the HERCULES annual sessions is to train young European researchers (PhD students, postdoctoral scientists) to optimally use the state-of-the-art instruments at the present and future Large Installations (LI) that deliver neutrons or synchrotron radiation in Europe. Since their inception in 1991, the HERCULES annual sessions have offered basic theoretical and experimental know-how for a multidisciplinary audience composed of young biologists, chemists, physicists, geoscientists, industrial scientists.

Picture: courtesy of HERCULES

The HERCULES annual sessions are organised every year for 70-75 participants. A substantial fraction of the school duration is devoted to neutron interactions with matter, neutron production, and the various techniques involving neutron scattering (elastic, inelastic, quasielastic). The duration of the course is 4.5 weeks. To meet the training needs, 50-60 lecturers selected among the best European specialists of all the fields concerned will be involved, and about one hundred scientists of the partner LI will secure the practicals and tutorials.

The sessions include lectures, practicals and tutorials, visits to laboratories and a poster session. Emphasis is given to experimental training (by group of 4 participants), resulting in more than one week of practicals with beam in four neutron and synchrotron LI per participant.

In 2012, the practicals will take place at Swiss Light Source (SLS) at the Paul Scherrer Institute, and at synchrotron SOLEIL, for the synchrotron radiation part, and at the reactor Orphée at LLB (Leon Brillouin Laboratory) and at ILL, for the neutron part.

For more information and for registration for HERCULES 2012, please visit the website:
http://hercules-school.eu

Neutron Scattering Studies of Magnetic Materials

18th to 22nd May 2012
Seignosse, France

The school focuses on the use of the neutron scattering techniques for the study of magnetism and magnetic materials in condensed matter physics. It is supported by the French society of neutron scattering (SFN).

The coupling between magnetism and other degrees of freedom (charge, orbit, lattice) leads to a great variety of physical phenomena present in emerging fields like multiferroism, thin films and nanomagnetism, and in fields in which the neutron tool has already proven its invaluable contribution such as superconductivity, heavy fermion systems, magnetic frustration and low dimensionality systems.
The purpose of this school is to show what the different neutron scattering techniques (diffraction, inelastic scattering, small-angle scattering, use of polarised neutrons and polarisation analysis, reflectometry) and analysis tools, such as symmetry, numerical simulations, can bring in each of these fields, both for the study of the static (magnetic structures) and dynamical (magnetic excitations) properties.
The targeted participants are PhD students and post-doctoral scientists discovering these techniques, but also more experienced researchers wishing to deepen their knowledge in neutron scattering. This school may attract scientists from large facilities, and also physicists, chemists, and crystallographers working or wishing to work in the field of magnetism.

This school will be conducted in French, except for a few lectures given by non-French speakers. It includes an introduction to neutron scattering and magnetism and lectures covering the different aspects of the neutron techniques dedicated to the study of magnetic materials, as well as complementary techniques. To illustrate these lectures, examples will be presented during short seminars, tutorials or practicals that will tackle the analysis of the results obtained by neutron scattering studies. The participants of the school will also be encouraged to present posters on their work related to the theme of the school.

For more information please visitthe website:
www.sfn.asso.fr/JDN/JDN20/.

Francesco Paolo Ricci School

22nd to 29th May 2012
Taormina, Italy

The XI edition of the International School of Neutron Scattering Francesco Paolo Ricci will be dedicated to training students in neutron spectroscopy techniques applied to the investigation of the structural, dynamical and functional properties of biosystems and to their biotechnological applications.

7th Paolo Ricci School in 2008.

The school is open to 25 students of all nationalities and is aimed mainly at undergraduate and PhD students as well as post-docs in physics, biophysics, biology, chemistry, biochemistry and engineering.
The school will include lectures, tutorials, practical

and hands-on data analysis sessions, covering various aspects of neutron scattering with a particular emphasis on techniques and instrumentation oriented towards the study of biological and biophysical systems.

Central European Training School (CETS)

14th to 18th May
Budapest, Hungary

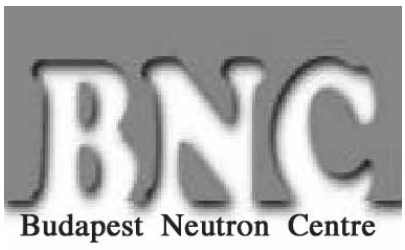
CETS includes hands-on training at the Budapest Research Reactor facilities and it is targeted at members of the European Community with special focus on the Central European region.

The aim of this course is to provide insight into neutron scattering techniques (small-angle neutron scattering, three-axis spectroscopy, neutron reflectometry, prompt gamma activation analysis, neutron diffraction, time-of-flight spectroscopy and neutron radiography) and their application for studies on structure and dynamics of condensed matter. Participants will also gain experimental skills and guidance in data evaluation/interpretation will be provided. The school is a forum for the presentation and discussion of recent research work by young scientists. We welcome graduate and PhD students as well as newcomers to neutron research from the field of structural research in physics, chemistry and biology.

The training consists of five days of tutorial lectures given by renowned lecturers from European centers like ILL, ISIS, HZB. The lectures are followed by experimental works at the instruments to introduce students to the art of utilisation of instruments at a large-scale facility. Students will get acquainted with sample preparation, experiment planning and running as well as data processing and interpretation of results. The number of participants is limited to 30-35 (due to limitations of training facilities available).

For more information please visit: http://www.kfki.hu/~cets/

Contact: rosta@szfki.hu, szekely@szfki.hu



The contribution of neutrons to the study of quasicrystals

Following the award of the Nobel prize in Chemistry to the father of quasicrystals in 2011, **Juliette Savin** *reviews neutrons´ special contribution to the study of these peculiar crystals.*

Dan Shechtman, an Israeli scientist currently working at Technion, Israel was recently awarded the 2011 Nobel Prize in Chemistry for the discovery of quasicrystals in the early 80´s. Since then, neutrons have contributed to confirm Schechtman´s findings and helped to determine the structure and dynamics of quasicrystals.

The discovery of quasicrystals: a paradigm shift

On the 8th April 1982, in an experiment that was going to revolutionalise not only chemistry but also physics and mathematics, Dan Schechtman exposed a sample of Aluminium-Manganese (Al-Mg) alloy to a beam of electrons. The electron beam diffracted off the alloy atoms and created an unusual diffraction pattern. This pattern, unlike any other, revealed a crystal that was highly ordered, infinite, yet never repeated itself and showed a ten-fold rotational symmetry.

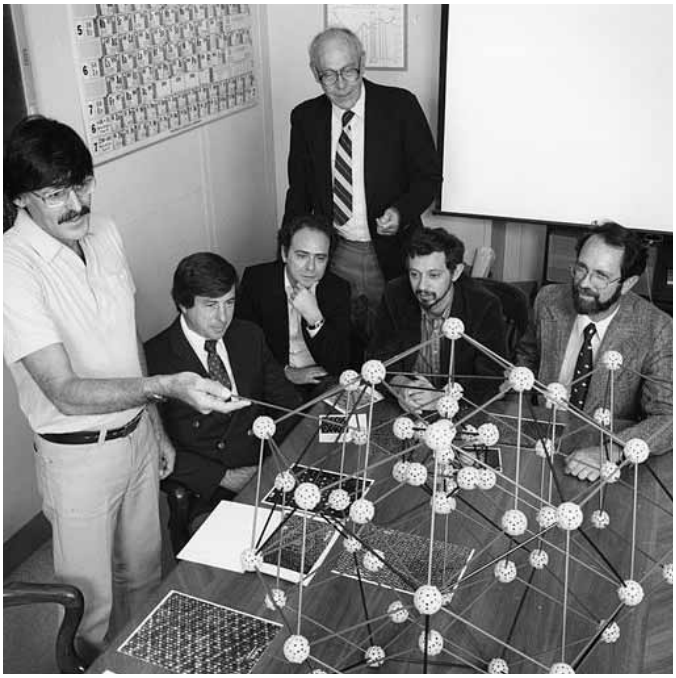


Figure 1: Dan Shechtman discusses the material's surprising atomic structure with collaborators (and co-authors Denis Gratias and John Cahn, third and fourth from the left) Picture, courtesy of Phillip Westcott, National Institute of Standards and Technology, Wikimedia Commons.

"10 fold???" wrote an incredulous Schechtmann in his notebook, following his stupefying finding. At the time, a ten-fold rotational symmetry within crystals simply wasn´t allowed.

Dan Schechtman had to face a very skeptical scientific community that believed crystals could only be periodic arrays of atoms, allowing only certain symmetries that generated this periodic pattern. After much controversy, and having to leave his lab, Dan Schechtmann published his seminal paper about quasicrystals in 1984 [1], which gradually led to a paradigm shift. Quasicrystals became a new field in science, drawing from and enriching chemistry, physics and mathematics.

"When they were discovered, quasicrystals revolutionised our understanding of crystals and long range order, and ultimately of all solid-state physics," explains Marc de Boissieu, a quasicrystal expert at SIMAP – CNRS/Grenoble-INP/UJF in Grenoble, France.

According to the classical crystallographic restriction theorem, crystals can only possess two, three, four, and six-fold rotational symmetries. The Bragg diffraction pattern of quasicrystals, however, shows sharp peaks with other symmetry orders, such as five-fold, eight-fold, ten-fold, twelve-fold or even 18-fold [2]. This can be explained by the well ordered, but aperiodic and infinite structure of quasicrystals.

Similar aperiodic patterns have been found in artefacts dating back to the middle ages, such as the Islamic mosaics of the Alhambra Palace in Spain and the Darb-i Imam Shrine in Iran, but Daniel Schechtman was the first to show that they also exist in chemical systems. "Daniel Schechtmann certainly benefitted from the fact that other scientists – the mathematician Roger Penrose and the

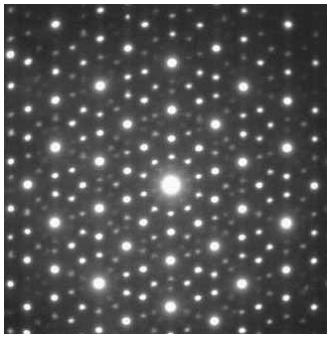


Figure 2: Electron diffraction pattern of an icosahedral Ho-Mg-Zn quasicrystal
Picture: Wikimedia commons

crystallographer Alan Mackay for instance- had already investigated the subject of aperiodic mosaics and patterns in detail," adds Marc de Boissieu.
Since then, quasicrystals have been discovered in many synthetic intermetallic systems as well as in liquid-crystals [3], polymers [4], nanoparticle assemblies [2] and micellar systems [5]. Naturally-occuring icosahedral quasicrystals, an alloy of aluminum, copper, and iron, have recently been discovered in a river bed in Russia [6].

Neutrons and quasicrystals

Neutrons have played a crucial role in confirming that what Dan Schechtman was seeing wasn´t an artifact of the diffraction pattern. In research carried out in the USA, Europe and Japan, neutrons have helped uncover the precise atomic structure of quasicrystals, as well as their peculiar dynamics and unusual properties.

Inspired and incited by French crystallographer Denis Gratias, co-author of the 1984 paper [1], French researchers at ILL and LLB started investigating the structure and dynamics of quasicrystals using neutrons very early after their discovery. "Denis Gratias spearheaded quasicrystal research in France and in Europe," explains Marc de Boissieu.

Christian Janot, Jean-Marie Dubois and Jean Pannetier were among the first to use neutrons to study quasicrystals at ILL, in 1986 [7]. They used a technique called isomorphic substitution, which gives information about specific atoms in materials containing more than one atom, like alloys. They were among the first to record a neutron diffraction pattern of Al-Mn-Si icosahedral quasicrystals and their work initiated a long-term research programme on quasicrystals at ILL.
Neutrons offer a better contrast than X-rays and electrons for a number of elements, such as Lithium, Manganese or Nickel. By combining X-rays and neutrons, researchers from France, the USA and Japan were thus able to build precise atomic models of icosahedral quasicrystals such as Al-Mn-Si, Al-Li-Cu, or Al-Pd-Mn [8-11].

Using inelastic neutron scattering on three-axis spectrometers at ILL (IN8, IN14) and LLB (2T, 4F) Marc de Boissieu *et al.*, in collaboration with European and Japanese teams, could study the lattice dynamics on a series of quasicrystals, such as i-AlPdMn, Zn-Mg-Y, decagonal Al-Ni-Co, and, more recently, the Zn-Mg-Sc icosahedral phases. Due to the long range quasiperiodic order, the atoms in quasicrystals vibrate in a characteristic way, leading in particular to low phonon heat conduction. This was shown in the first experiments and more recently by combining experimental results and atomic scale simulation in the Zn-Sc system. [10]

A small-angle neutron scattering study recently carried out on D11 at ILL showed the existence of colloidal quasicrystals for the first time. These poly-

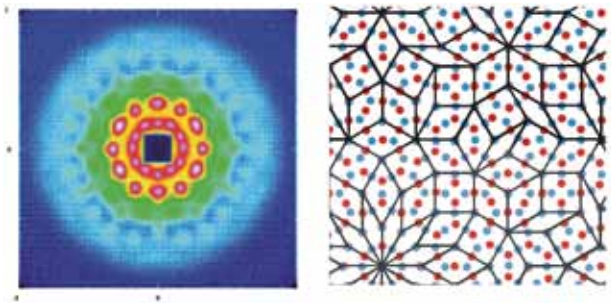


Figure 3: Discovery of colloidal quasicrystals with small-angle neutron scattering, as measured at D11-ILL: the 12-fold diffraction symmetry of a quasicrystalline micellar phase and the corresponding tiling pattern with the position of the micelles
Picture: Taken from [5] courtesy of the authors.

mers evolve through self-assembly into quasicrystalline micellar structures presenting 12- and even 18- fold rotational symmetries [5].

The neutron diffraction patterns generated by quasicrystals are usually very dense, presenting a continuum of reflections, some being much stronger than others. “This makes it difficult to work with classical single-counter detectors and really large high resolution area detectors are usually needed.” Explains Björn Pedersen, instrument scientist for RESI, a thermal single crystal diffractometer at FRM II, in Garching, Germany. “That´s why there are not that many instruments in the world where neutrons can be used to study quasicrystals,” he adds.

Diffuse neutron scattering experiments done at ILL and LLB have enabled researchers to measure what distinguishes quasicrystals from normal crystals and to identify the specific diffuse scattering signature of the quasicrystal order [12], as shown in Figure 4.

Because they possess a magnetic dipole moment, neutrons can be used to analyse the magnetic properties of materials, at the atomic scale. Some experiments have been carried out at single crystal diffractometers around the world to look for a possible magnetic order in decagonal and icosahedral

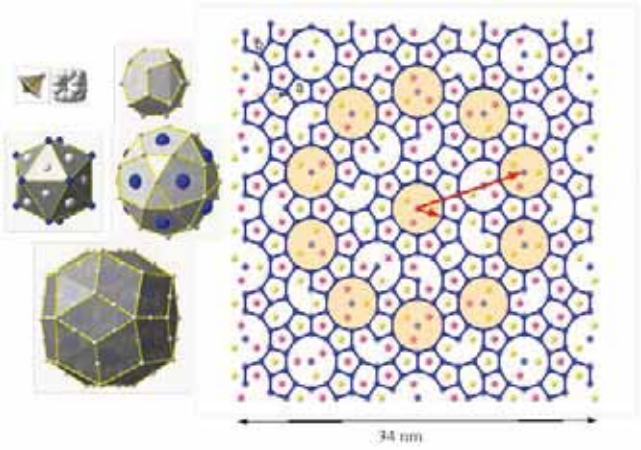


Figure 5: Structure of the CdYb icosahedral quasicrystal. Left panel: successive shells of the cluster found White and blue color stand for Cd and Yb atoms respectively. Right panel: 5 fold section showing the cluster distribution in the quasicrystal. Only the clusters centers have been represented. The hierarchical packing of the clusters is shown with the orange disks. Picture courtesy of Marc De Boissieu

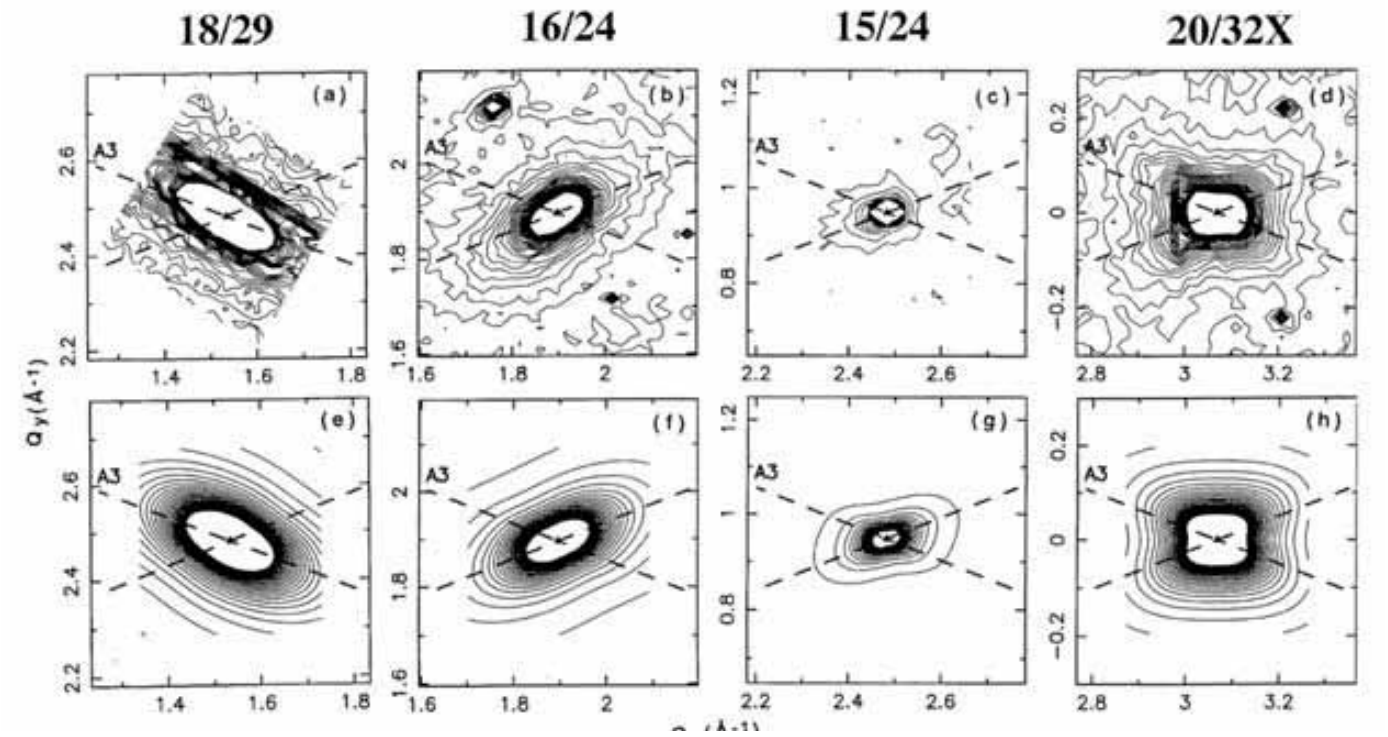


Figure 4: Top panel (a-d): isointensity contour plots measured by elastic neutron scattering around different Bragg peaks in the i-AlPdMn phase at room temperature. Bottom panel: simulation of the diffuse scattering using hydrodynamic theory. The dashed lines indicate directions parallel to 3-fold axes. Figure courtesy of Marc de Boissieu.

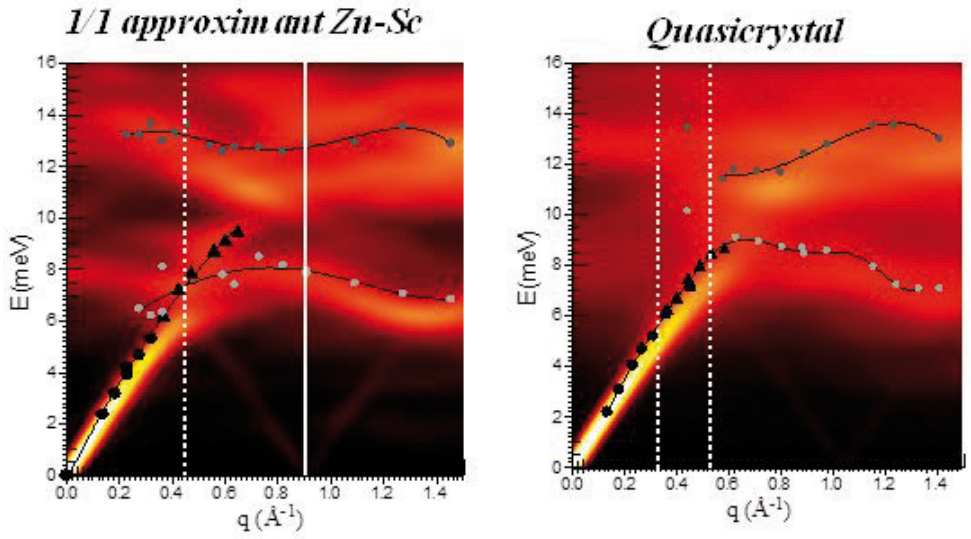


Figure 6: Dispersion relation measured by inelastic neutron scattering in the quasicrystal (right) and the periodic approximant. The color coded background correspond to the atomistic simulation. Picture taken from [10] courtesy of Marc de Boissieu

quasicrystals. Recent studies carried out at ILL and Tokai, in Japan have shown a short range magnetic order in Zn-Mg-Re icosahedral alloys [11] and have shed light on the magnetic characteristics of quasicrystals.

Applications of quasicrystals

Intermetallic quasicrystals, like all complex metallic alloys, present unusual physical properties that can be exploited for a number of niche applications. Because they are poor heat conductors they can serve as good thermal barriers, to protect metal parts from overheating, for example. They have low friction coefficients, and trials have been carried out to replace Teflon with a quasicrystallic coating on cookware, for instance. More studies are investigating this property for use in mechanical parts. Quasicrystals are hard and brittle, but they can be used for structural strengthening, to reinforce other light alloys such as Mg-based alloys. Quasicrystals are also being studied for use as catalysers, to replace noble metals like gold or palladium.

The European Union is supporting research into complex metallic alloys, including quasicrystals, via an international network –The European Integrated Center for the Development of New Metallic Alloys and Compounds (www.eucmac.eu).

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and

T. Janssen, G. Chapuis, and M. de Boissieu, Aperiodic Crystals. From modulated phases to quasicrystals (Oxford University Press, Oxford, 2007).

News from around the World

News from ESS

Enthusiastic scientists at first In-kind meeting

More than 110 enthusiastic scientists from the 17 ESS partner countries met in September to plan and discuss the in-kind contributions to the scientific instruments that will be installed in the facility. The meeting, named ESS In-kind Contributions Meeting for Neutron Science for the ESS - IKON-1, was held in Lund, Sweden, close to the ESS headquarter.

"We have set ourselves an ambitious goal," says Dimitri Argyriou, ESS Science Director.

According to Ken Andersen, Head of Instrumentation at ESS, "We will have to think out of the box to develop new instruments that will be able to draw all of the benefits from the ESS long pulse beam characteristics, while foreseeing the needs of the science community 10, 20 and even 30 years into the future."

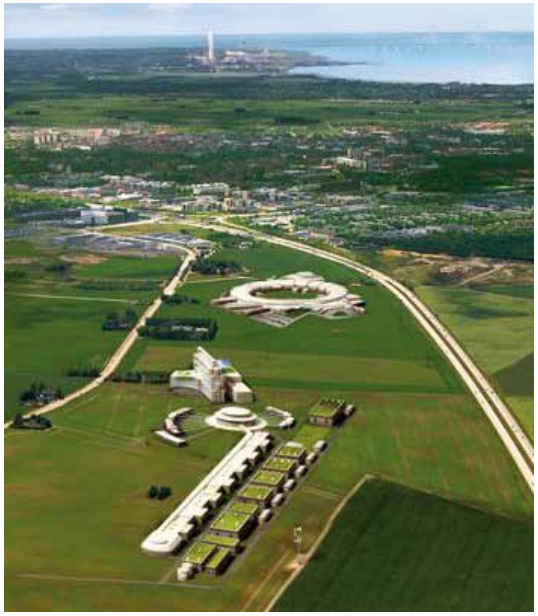
The first meeting provided information on the progress of the ESS and the current status of instrument development, as well as valuable discussions on the choice and design of the best possible instruments for ESS. There were also presentations on in-kind contributions from Germany, Denmark and Switzerland.

"The In-Kind contributions are vital", says Dimitri Argyriou. "We could not assemble a suite of instruments without the expertise of the ESS partner laboratories and research institutes."

The next IKON-meeting will be held in Malmö, Sweden on 9-10 February. The registration for IKON-2 will open soon at http://esss.se

Science and Scientists meeting in Berlin

Building on the exchange during the first S&S meeting in Prague, the next S&S meeting will take place in Berlin, Germany, on 19th and 20th April 2012. The meeting aims to bring together researchers in the various science areas and experts in neutron instrumentation to exchange ideas and progress further towards the realisation of the ESS.
For more information and registration please go to http://esss.se/ess_conferences



Picture courtesy of ESS AB

EUROPEAN SPALLATION SOURCE

Reconstruction underway at J-PARC - beams are expected for Dec 2011

The repair work at J-PARC, following the Earthquake and tsunami of March 2011, is underway and a lot of progress has been made over the past few months. The restoration of the facility is proceeding on schedule and beams are expected for mid-December.

Neutrons facilities

The Materials and Life science experimental Facility (MLF) building and its surroundings have been repaired and the facilities in MLF have almost been restored to their original condition. Repair is underway on the vacuum breaks found in aluminum neutron beam ducts of the neutron beam shutter blocks. Measures are being taken to prevent loosening of bolts for the duct flanges, for all the 17 ducts currently in use. A liquid nitrogen storage tank and a helium buffer tank for the cryogenic hydrogen system, both of which are 2.5 m in diameter and 10 m in height, were leaning due to ground subsidence. They have been restored to an upright position, as shown in Figure 1. The first operation of the system after the earthquake is scheduled for November.

Many of the beamline front shields, which are usually stacked in an upright position in each beamline, were severely displaced following the earthquake and are being restored to their original position. The subsidence of the annex buildings reached 15 cm in some places, as shown in Figure 2. The shielding and instruments were removed from the west annex building, where BL18 (SENJU), BL19 (TAKUMI) and BL20 (iMATERIA) are located, the building was elevated to the original height by concrete injection as shown in Figure 2. The shielding and instruments are currently being returned to the building and realignment and offline commissioning has started.

For the 2011B period (January to March 2012) of user operation, 50 neutron proposals have been submitted for 2 cycles in February and March. After evaluation by four referees, all the proposals will be reviewed by the neutron science proposal review committee (NSPRC) held on November 4th, and the results will be approved by the MLF advisory board on November 14th.

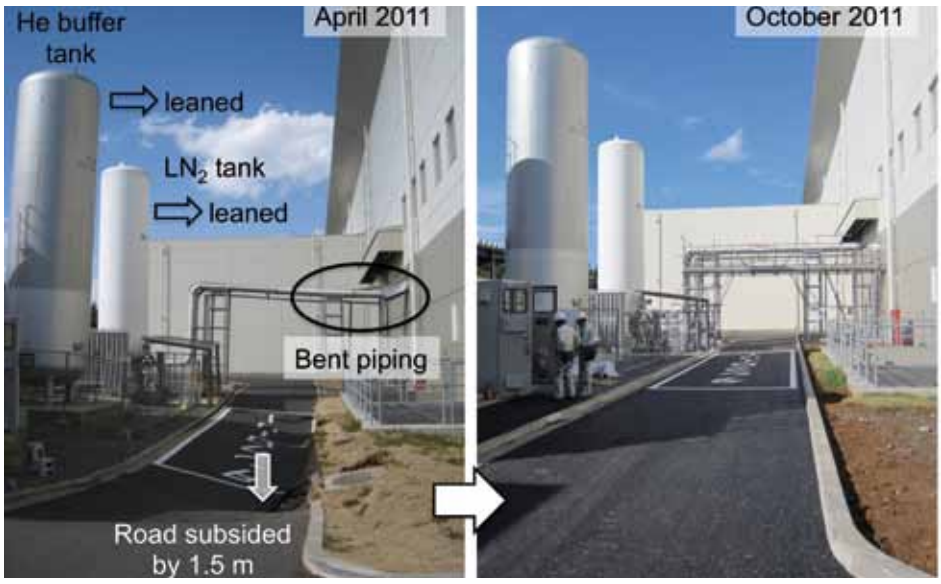


Figure 1: The liquid nitrogen storage tank and the helium buffer tank for the cryogenic hydrogen system leaned due to the ground subsidence (left), and uprighted (right). Picture courtesy of J-PARC

New Neutron instrument

A 1-dimensional elliptic mirror has been developed in combination with a supermirror (m=4) coated with ion-beam sputtering and precise elliptic surface figured with numerically-controlled local wet etching process. Neutrons in wideband wavelength were focused with a focal spot size down to 0.1 mm and peak intensity gain up to 52 without significant diffuse scattering.

Muon Science Facility (MUSE)

MUSE staff have been working hard to repair the damage caused by the earthquake. The helium ducts, control cables, power cables, compressed air piping, and support stand for the on-line

refrigerator system were damaged, due to a settlement, about 10 cm around at 1.5 m outside the MLF building. They were replaced in accordance with the high pressure gas regulations and the systems are now under inspection. The proton beam transport line from the 3-GeV Rapid Cycling Synchrotron to MLF (3NBT) was severely damaged at the expansion joint to MLF. For the repair of the wall, water ducts for the air circulation systems for the proton beam tunnels in the vicinity of the muon target were removed and are now being re-installed. Anchor bolts split out from the concrete blocks above the Decay-Surface Muon Line (D-line) ceiling were fixed. All repair work should be complete by the end of November 2011, and the beam should be back on, as planned, on 12th December 2011.

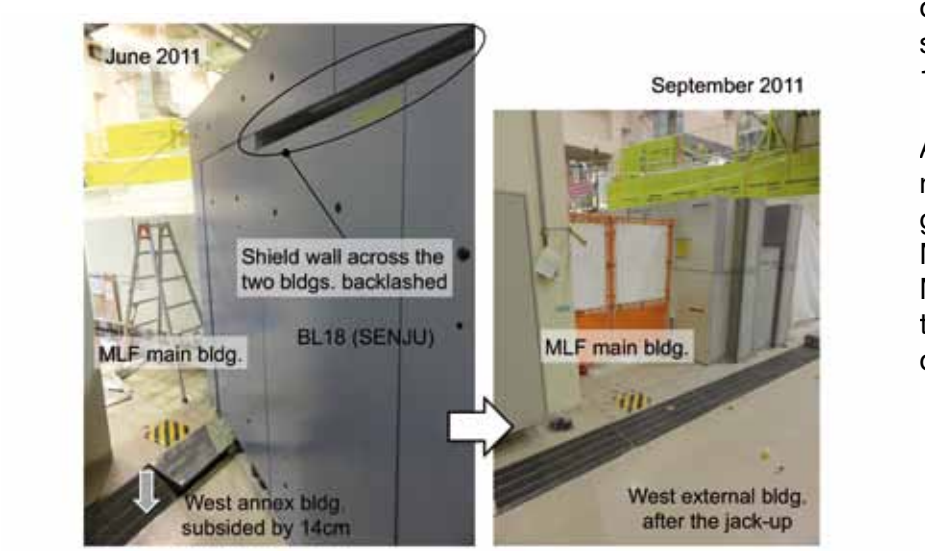


Figure 2: The subsided annex building (left) and that after the jack-up (right). Picture courtesy of J-PARC

A kicker and septum system are now being installed, to allow a single bunched muon beam up to 60 MeV/c towards Decay- Surface Muon Instruments (D1 and D2 Instruments) area in the MUSE secondary D-line.

R. McGreevy now Deputy Associate Laboratory Director for Neutron at SNS

Robert McGreevy, coordinator of NMI3 during the 6th EU Framework Programme (FP6), has recently moved to the USA to become Deputy Associate Laboratory Director for Neutron Sciences at SNS, in Oak Ridge, Tennessee. Robert McGreevy had been a proponent of the integration of European neutron facilities since the beginning of the 90´s. After a stint as coordinator of the Access Programme at Studsvik in Sweden, in FP4 and FP5, he took on the challenge to launch NMI3, in 2002.

"It was clear to me that smaller facilities like Studsvik couldn´t do it on their own and needed European support. That´s one of the reasons I accepted to take on the I3 project, NMI3." Robert McGreevy explains.

Before joining SNS, Robert McGreevy had been division head at ISIS since 2002. NMI3 wishes him all the best in his new position!

Robert McGreevy in 2003
Picture: NMI3

IBR-2 user programme resumes

Following the recent modernisation of the IBR-2 pulsed reactor in Dubna, Russia, the user programme at IBR-2 is about to resume. Users are invited to submit applications for beam time through the user website at http://www.ibr2user.ru before January, 11th, 2012. The beam time will be distributed over the reactor´s operation cycles from May to December, 2012 on the basis of the proposal evaluation results by the Expert Committees and in accordance with the FLNP JINR User Policy regulations.

Picture courtesy of IBR-2

Operated by the Frank Laboratory of Neutron Physics (FLNP), the IBR-2 reactor provides an average power of 2 MW and 1850 MW power per pulse with the peak thermal neutron flux of 5.10^{15} n/cm^2/c from the moderator surface. It is presently equipped with 11 spectrometers including 6 diffractometers, 1 small-angle scattering spectrometer, 2 reflectometers and 2 inelastic scattering spectrometers. Two more spectrometers will become operational in a few months.

A detailed description of the instruments and sample environment is available at http://flnp.jinr.ru/34/.

“We are extremely happy to welcome new users at our facility. IBR-2 is now fully operational and the users can benefit from our instruments and interaction with a highly qualified and dedicated staff consisting of scientists, engineers and technicians ready to assist throughout the experiments at each instrument. We are looking forward for new achievements in many fields of science.” Says Alexander Belushkin, FLNP Director.

The experimental hall at IBR-2. Picture courtesy of IBR-2

Coordination & Management

Our new website is online!

We would like to invite you to visit our new website and register at www.nmi3.eu. With clear navigation and content, our new website brings you up-to-date information about the consortium and its activities. "A lot of work has been put into redesigning the website. We are pleased with the result and we hope our users are too. With our newsletter, our website is our main communication platform." Says Jürgen Neuhaus, the NMI3 Networking manager.

Scientists who are not yet familiar with neutron and muon science will find dedicated pages with information about what can be investigated with neutrons and muons. These pages also present detailed descriptions of techniques as well as an interactive map with all facilities worldwide.

In our News and Media section, readers will find news about the consortium and scientific highlights from our Access programme. They will also be able to download our biannual newsletter. Our picture and video gallery and a calendar of events are also located in this section. Don´t forget to visit our History pages, for a quick overview of the history of NMI3 and important dates in neutron and muon science. Our Women in science pages celebrate diversity in neutron and muon science and the fact that more women now work in science, by presenting portraits of female colleagues.

Readers looking for information about the consortium management, our Joint Research Activities, our Access Programme and our Education activities will find all this in the About NMI3 section.

We ask our readers to register so that they can be kept up-to-date on the latest NMI3 news. Upon registration, you can opt to receive our biannual newsletter or other email correspondence.

Make sure you register before the end of 2011 to win a beautiful NMI3 T-Shirt!

We hope that you enjoy our new website and look forward to seeing you soon on www.nmi3.eu.

www.nmi3.eu

Flavio Carsughi is the new JCNS User Office Coordinator

We would like to welcome Flavio Carsughi, the new User Officer for JCNS at FRM II, Garching, Germany. Before coming to Garching, Dr. Carsughi was project manager at Forschungszentrum Jülich. Before that, from 2001 to 2004, he worked as part of the ESS Central Project Team. Flavio Carsughi studied Nuclear Engineering (material science) in Milan, Italy, and got his PhD at the RWTH in Aachen, Germany. His scientific activity includes investigations on irradiated materials and proteins in solution, and he has made broad use of neutron scattering in his career. He is author of more than 70 publications.

Picture: NMI3

Winners of the first Illustrating NMI3 picture competition

The first prize goes to Martin Kreuzer from Helmholtz Zentrum Berlin for his striking fish-eye photograph of the instrument BioRef at HZB, also displayed on the cover of this Newsletter.

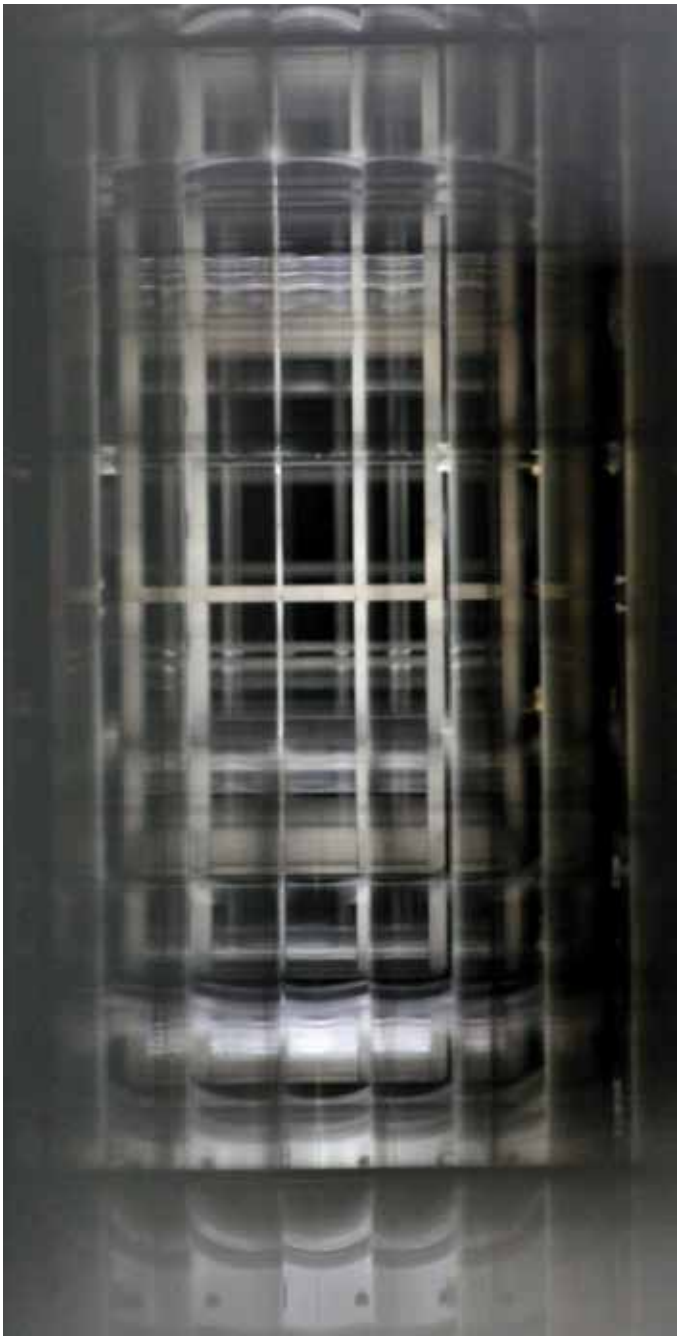
A fish-eye perspective of the new BioRef neutron reflectometer at the neutron source BERII at the Helmholtz Zentrum Berlin with the sample position in the center. The neutrons are guided through a chopper system from the right side and are detected with a position sensitive detector on the left side. As a special feature an infrared beam line is installed on the sample stage, with an infrared spectrometer on top, in order to perform combined infrared spectroscopy and neutron reflectivity measurements. The software AutoStich 2.2 was used to merge 10 individual pictures of the instrument resulting in the final perspective.

The second prizes go to S. Kill, M. Trapp and S. Klimko:

Stephen Kill from ISIS for his photograph of the new high-field muon spectrometer (HiFi) at ISIS.

The new high-field muon spectrometer (HiFi) at ISIS provides magnetic fields up to 5T for muon studies of magnetism, molecular dynamics and polymer systems. Computer simulations of muon and positron paths through the instrument were undertaken with NMI3 JRA funding to enable the instrument detector array to be designed. The instrument is working very successfully as a full part of the ISIS user programme.

Marcus Trapp from Helmholtz Zentrum Berlin for his photograph of the guide system of the time-of-flight reflectometer BioRef, at HZB.



BioRef is a newly built time-of-flight refelectometer at the Helmholzt-Zentrum Berlin dedicated to biological samples. View from the sample position of the time-of-flight reflectometer BioRef through the guide system of the instrument.

Sergey Klimko from Laboratoire Léon Brillouin also got a second prizse for his photograph of a new spin –flipper for neutron resonance spin-echo (NRSE) spectrometer MUSES at LLB, CEA-Saclay.

New spin-flipper for neutron resonance spin-echo (NRSE) spectrometer MUSES at LLB, CEA-Saclay.

Spin-echo measurements with NRSE require a set of different values of static magnetic field and corresponding radio-frequency fields in spin-flipper. The present spin-flipper can provide a wide range of magnetic fields (from 0 to 300 G) and frequency range from 50kHz to 1 MHz. The high resolution of the MUSES spectrometer results from the homogeneity of the magnetic fields in the flippers.

Calendar - upcoming meetings

NMI3/FP7-II	kick-off meeting	12th and 13th March 2012	ILL, Grenoble, France
NMI3/FP7-I	General assembly, board meeting, possible JRA meeting	5th and 6th December 2012	FRM II, Garching, Germany

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