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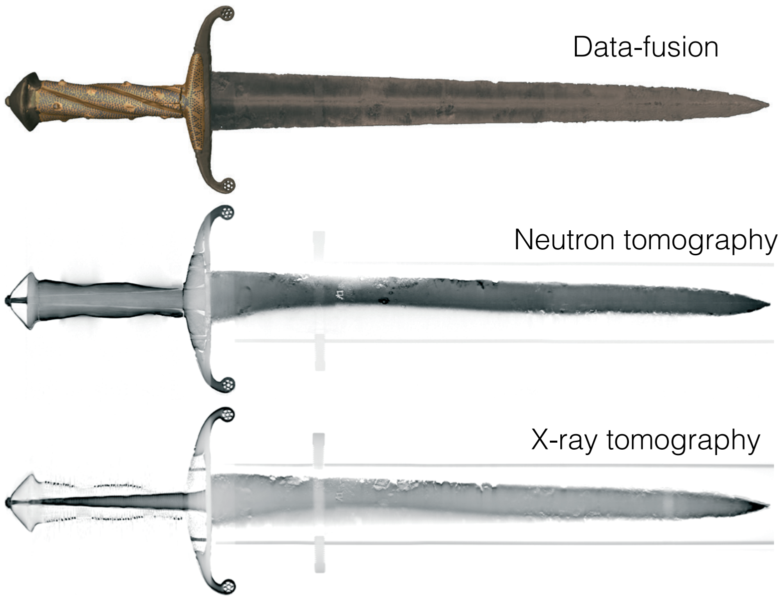

Schweizerische Gesellschaft für Neutronenstreuung
Société Suisse pour la Diffusion des Neutrons
Swiss Neutron Scattering Society

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ON THE COVER:

Tomography images of the "Sword from Zug", see the related article on Modern Trends in Neutron Imaging by E. Lehmann et al.

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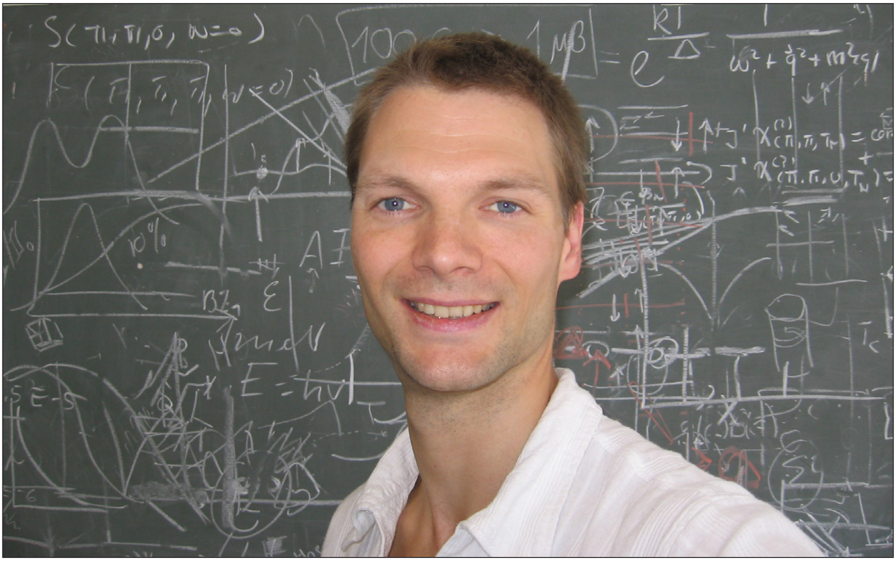

DEAR COLLEAGUES

Welcome to this issue of Swiss Neutron News. The period since last issue had several exciting events. The focus session on Frontier Experiments with Neutron Scattering at the Swiss Physical Society Meeting in Fribourg was a great success, and I thank all who contributed and participated. At this meeting we also announced the inaugural Young Scientist

Prize of the Swiss Neutron Scattering Society. The first recipients were Dr. Simon Gerber and Dr. Qianli Chen. I proudly congratulate both of them and wish them the very best success in their future careers.

I likewise take the opportunity to thank SwissNeutronics, who generously have sponsored the prize. Next year the prize will be awarded during the European Neutron Scattering Conference in Zaragoza (http://ecns2015.unizar.es).

Another exciting development was the announcement early July that funding has been secured for the European Spallation Source, and the project thereby received approval to start construction (http://europeanspallationsource.se/ess-gets-green-light). With Switzerland contributing to several of the proposed instruments at ESS as well as multiple technical aspects and components, the ESS project is set to keep us busy and excited for several years to come.

Henrik M. Ronnow

POLDI: a Time-of-Flight Diffractometer for Materials Science and Engineering

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INTRODUCTION

The influence of processing procedures on the developing microstructures and thus the final material properties (e.g. hardness, yield strength, fatigue live time, residual stresses) are of fundamental interest to industry and a prerequisite for the development of new materials with improved microstructures and for advancing processing techniques (e.g. 3D printing with metals). Neutron diffraction is an important non-destructive tool to study the microstructure and its evolution during processing of typical engineering materials. A big

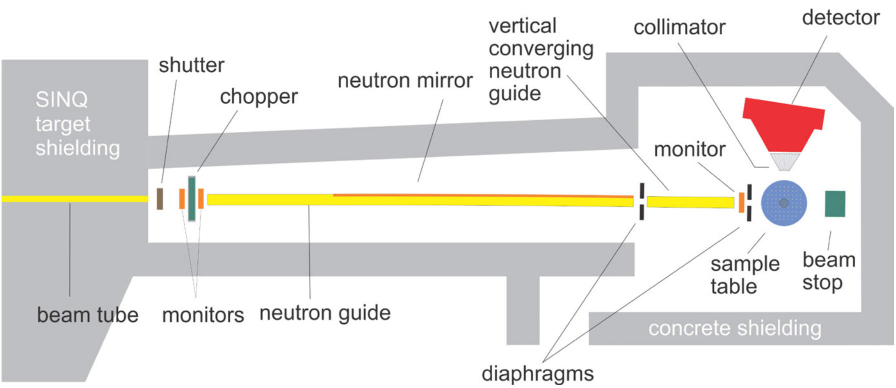

Figure 1: Scheme of the POLDI beamline in the SINQ hall at PSI.

advantage of neutron diffraction compared with X-rays is the long penetration depth allowing the investigation of big samples (like railway wheels) in one piece without any pre-experimental sample preparation. Therefore one gets access to the material properties under the natural working conditions of the investigated structural component.

SET UP

The **P**ulse **O**verlap **D**iffraction **I**nstrument (POLDI) is a time-of-flight (TOF) neutron diffractometer located in the SINQ hall at PSI. A scheme of the beamline is shown in figure 1.

POLDI makes use of the continuous neutron spectrum from the D_2O moderator, which is divided in several short pulses by a 32 slit chopper disk. The resulting neutron pulses are guided by an elliptical neutron guide to the sample 11.8 m downstream from the chopper. The diffracted neutrons are detected by a 1D ^3He detector located in a distance of 2m almost perpendicular to the incident beam. The TOF technique allows a simultaneous measurement of several powder diffraction peaks from the sample with a high accuracy.

A detailed description of POLDI can be found in Ref [1].

WHY TIME-OF-FLIGHT?

TOF strain scanners have several advantages compared to their monochromatic equivalents. The most important ones are:

(i) A full diffraction pattern is obtained without any sample and/or detector movement, which is particularly advantageous when the sample is embedded in a complex sample environment.

(ii) The average diffraction angle 2θ can be set to 90°, resulting in a cuboidal shaped gauge volume. This allows determining the strain within the same volume element along different perpendicular directions, a prerequisite for a proper calculation of the

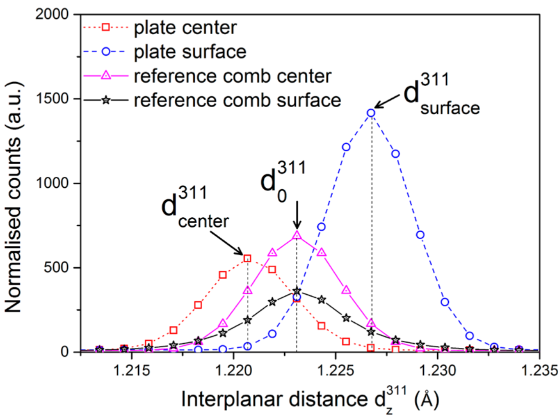

Figure 2: Neutron diffraction peak of the (311) diffracting planes measured at the mid thickness and the surface of the aluminum plate and the corresponding stress free peaks from the reference specimen.

stress tensor [2]. Also, the diffraction vectors related to the various diffraction peaks are all parallel to each other.

(iii) In a measurement where strain components along certain directions are determined the sample can obviously not be rotated, in contrast to a regular powder diffraction measurement. In that case monochromatic instruments with a narrow bandwidth may sample only a relative small fraction of the grains. This can be pernicious for the case of samples with large grain size, as the resulting diffraction pattern may not be representative for the bulk. This problem is less critical in the case of a TOF diffractometer as the neutron beam has a relatively large bandwidth.

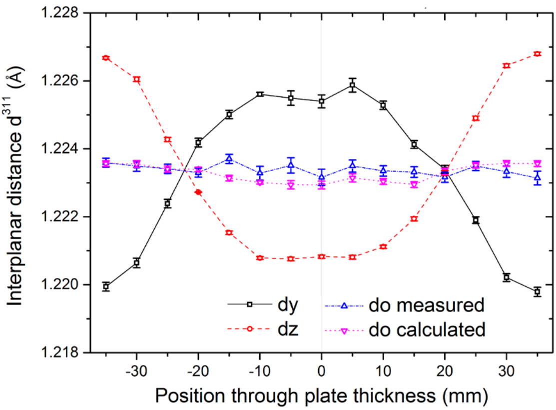

Figure 3: Thickness depending interplanar distances measured in the in plane (d_y) and out-of-plane (d_z) direction (with respect to the sample surface).

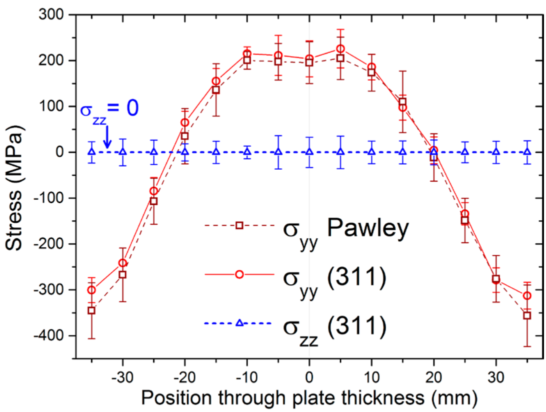

Figure 4: Residual stress profile through the 75mm thick aluminum plate calculated from single peak analysis (311-planes) and from a Pawley Refinement.

WHAT CAN WE LEARN?

POLDI was originally designed as a neutron strain scanner. From the position of the diffraction peaks the lattice spacing d_{hkl} for the various grain families can be determined. The elastic lattice strain can be derived as the relative difference of d_{hkl} with that of a stress-free reference sample. By moving the sample in the neutron beam position-sensitive strain profiles can be measured. When strain is determined along three principle directions the stress can be determined by using Hook's law. In example I this is demonstrated in the case of a thick Al plate.

In 2007 POLDI was equipped with a uniaxial tensile rig and in 2013 with a biaxial tensile rig to perform in-situ mechanical testing. Here diffraction patterns are accumulated while the specimen is under load. By following the evolution of the peak positions and peak profiles information on the micro-structural evolution can be obtained. In examples 2 and 3 it is shown what can be derived from uniaxial and biaxial tensile tests, respectively.

RESIDUAL STRESS IN A THICK ALUMINUM ALLOY PLATE

In the current trend towards thicker aluminum plates, a major concern is the generation of high internal stresses during quenching due to different cooling rates over the plate thickness. These internal stresses can cause distortions during machining and pose serious safety concerns. Also the ageing behavior of the material is affected by the quenching procedure and of major interest for industry.

In what follows we present the results for a 75mm thick as-quenched aluminum plate. Diffraction patterns along three prinicple directions were recorded at various positions across the thickness of the Al plate. Figure 2 displays the (311) diffraction peak at the center and surface of the as-quenched plate, together with corresponding peaks of a stress-free plate. The resulting evolution of the interplanar distance is shown in figure 3. These measurements allow to derive the residual stress profile through the thickness of the plate, as is shown in figure 4.

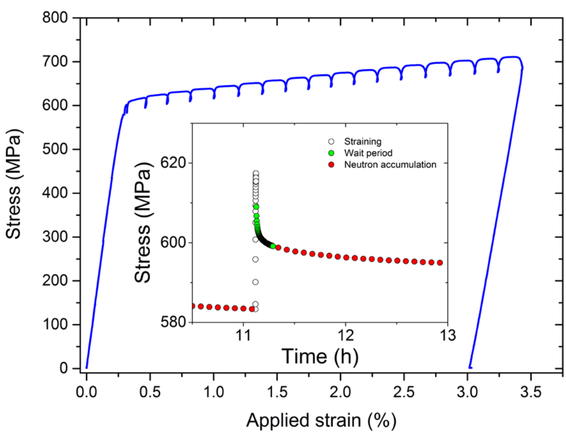

Figure 5: Stress-strain curve recorded during in situ tensile deformation. During the measurement the displacement was kept constant in the plastic regime resulting in some stress relaxation, as shown in the inset.

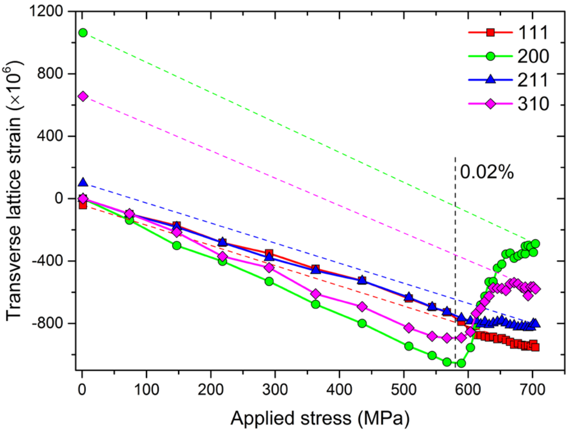

Figure 6: Lattice strain with applied true stress for the (111), (200), (211) and (310) grain families perpendicular to the applied load.

Also shown is the stress profile derived from a multi-peak analysis (Pawley refinement). As expected, the plate exhibits strong compressive stresses at the surface, balanced by tensile stresses at the center of the plate. This experimental result can be used to verify numerical simulations for a better understanding of the production process.

The full experiment description and data analysis of this investigation can be found in [3].

INTERGRANULAR AND INTERPHASE STRAINS IN STEEL

Mid-carbons steels with a tempered bainitic microstructure are commonly used for creep resistant applications in power plants. The mechanical properties are governed by the complex microstructure comprising fine ferrite platelets with cementite particles and finely dispersed vanadium carbides.

Uniaxial in situ load experiments with neutrons give direct access to the microstructure of the ferrite phase during simulated natural working conditions of possible power plant structures. The lattice strain development during the applied load (shown in Figure 5) is recorded by taking several diffraction patterns over the loading process. Figure 6 shows the development of the transverse lattice strain vs. the applied true stress for 4 different lattice plane families. All of them show a compressive behavior during the elastic load up to the yield point of 580 MPa. From the slope of the elastic part of the curves the elastic modulus E can be extracted as an important material parameter.

Beyond the yield point the curves are no longer linear; the (200) and (310) grain families exhibit a tensile shift, whereas the (111) and (211) are more or less unaffected. This is an indication for a significant load transfer between the plastifying ferrite matrix and the cementite particles that remain elastic. This results in strong residual interphase and intergranular stresses after removing the load.

The full experiment description and data analysis of this investigation can be found in [4].

MULTIAXIAL IN-SITU STRESS EXPERIMENTS

Nowadays uniaxial deformation rigs are available at most engineering neutron diffractometers worldwide. It is however well known that a material response to mechanical work may strongly depend on the chosen load path. For instance, during forming metals often experience complex load states and/or undergo strain path changes. The mechanical response that occurs during such processes has been studied in great detail for many years. However, little is known about the microstructural evolution and its link to the macroscopic variables.

Recently a unique multi-axial deformation rig has been installed at POLDI. It is a custom-built machine, developed in close collaboration with Zwick/Roell (Ulm, Germany). The rig has the following operation modes: (1) uniaxial tension-compression with maximum load up to 100kN, (2) in-plane biaxial tension-tension with maximum loads of 100kN and 50kN along the two axes respectively and (3) biaxial tension/torsion up to a moment of 200Nm. The applied strain in the center of the sample can be monitored with a clip-on axial

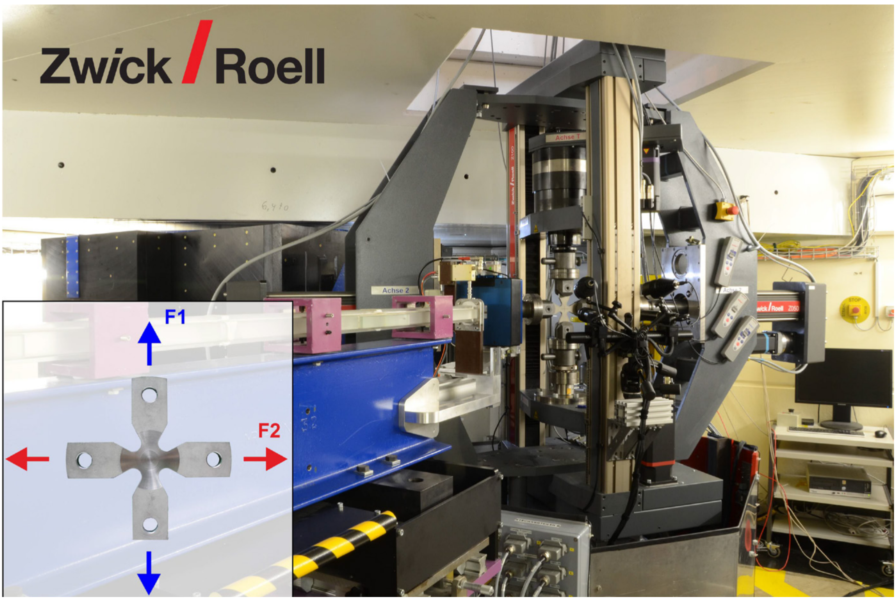

Figure 7: Multiaxial test rig mounted at POLDI and specimen geometry.

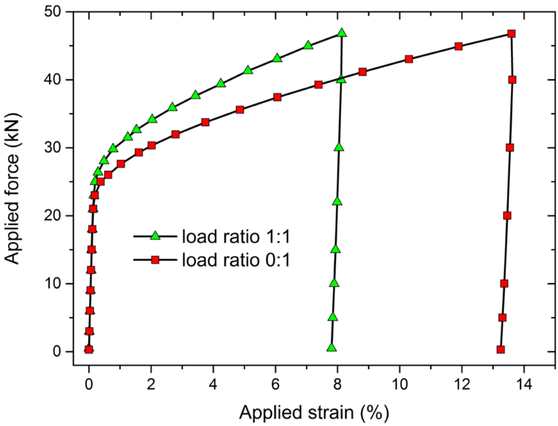

Figure 8: Mechanical data and evolution of the macroscopic strain for load ratios 1:1 and 0:1.

extensometer for the uniaxial case and a digital image correlation technique (Aramis 5M 3D System) for the in-plane biaxial measurements.

Figure 7 shows the rig mounted at the POLDI beam line and a picture of a typical cruciform-shaped specimen (inset).

In the following the results of a model experiment are shown. Cruciform shaped stainless steel samples were deformed up to 50kN with load ratios 1:1 (equibiaxial loading) and 0:1 (uniaxial loading). The corresponding mechanical data are shown in figure 8. Figure 9 displays the evolution of lattice strain of the (200) axial grain family as a function of applied load.

Some key observations:

- Under biaxial loading conditions the values of the lattice strains in the elastic regime are about half as high compared to uniaxial loading.
- The deviation from linearity occurs at similar applied force, however the nature of the deviation significantly differs between the two loading ratios.
- The nature and magnitude of the residual strain after unloading strongly depend on the loading conditions.

SUMMARY AND OUTLOOK

POLDI is a well-established neutron strain scanner equipped with several different sample environments to cover a wide range of experimental conditions.

It can be used to evaluate stress-strain behaviors of samples from industrial or scientific interest. The obtained results can be used to optimize production processes or to determine fundamental mechanical properties of new materials.

To increase the performance of the beamline a detector upgrade program is on the way. As a first milestone a second detector (based on scintillator technology) is expected for the end of 2015. It will be placed opposite the existing one.

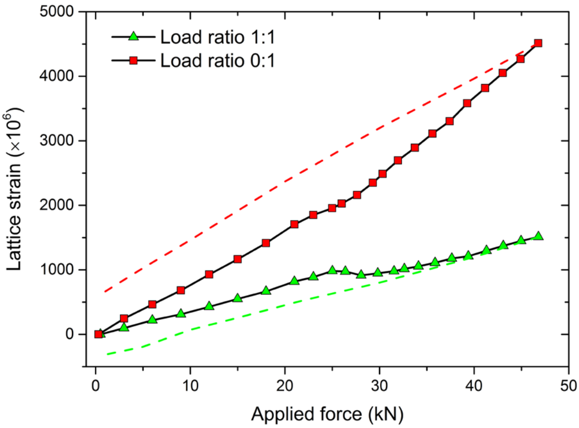

Figure 9: Mechanical data and evolution of the (200) axial lattice strain for load ratios 1:1 and 0:1.

This will allow the simultaneous measurement of two strain components at the same time.

Also the continuous developments of new sample environments or add-ons for existing ones are in progress, e.g. an inductive furnace add-on for the uniaxial rig machine. This helps to cover new upcoming experimental questions of high interest for science and industry.

ACKNOWLEDGEMENTS

We gratefully acknowledge the scientific contributions of Dr. J. Repper and Dr. V. Davydov and the financial support of CCMX, PSI, EPFL, ETHZ and EMPA. We thank N. Chobaut for providing figures 2-4.

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Modern Trends in Neutron Imaging

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ABSTRACT

Neutron imaging is established at the Swiss spallation source SINQ since the start of operation in 1997. The thermal beamline 32 has been selected as host for the NEUTRA facility and the first digital imaging options were developed there at the end of the last century. In 2006, we started with the utilization of cold neutrons at beam port 52, directly looking to the cold D_2 source. The ICON facility has been in use there with great success, and as heavily booked by scientific and industrial users as NEUTRA.

Based on the high performance and flexibility of both the imaging facilities, new techniques and methodological approaches were implemented, often driven by the requests and ideas of the user community.

This report gives an overview about all new features at the SINQ imaging stations and provides outlook to new trends, partly based on the opportunities given by another beam line – the BOA test facility for even colder and polarized neutrons.

1. Introduction

Thermal and cold neutrons can penetrate matter similarly to the more common X-rays. Therefore, the inner content of objects becomes visible when a directed beam is registered behind it. Depending on the attenuation properties of the involved materials their structure and amount can be determined.

Since the early days of neutron research in the 1940s, there were trials to establish "neutron radiography" as a tool for non-destructive testing and film methods were used in similar fashion as X-rays in hospitals.

The main differences to the X-rays with respect to the obtainable contrast is a higher penetration through heavy elements and a higher attenuation and contrast of light elements (hydrogen, boron, lithium) when thermal or cold neutrons are applied. Accordingly, different transmission images can be taken, as demonstrated in Fig. 1, with the same inherent image quality.

It is mainly the lack of availability of suitable neutron beam lines for imaging purposes why this method is much less popular

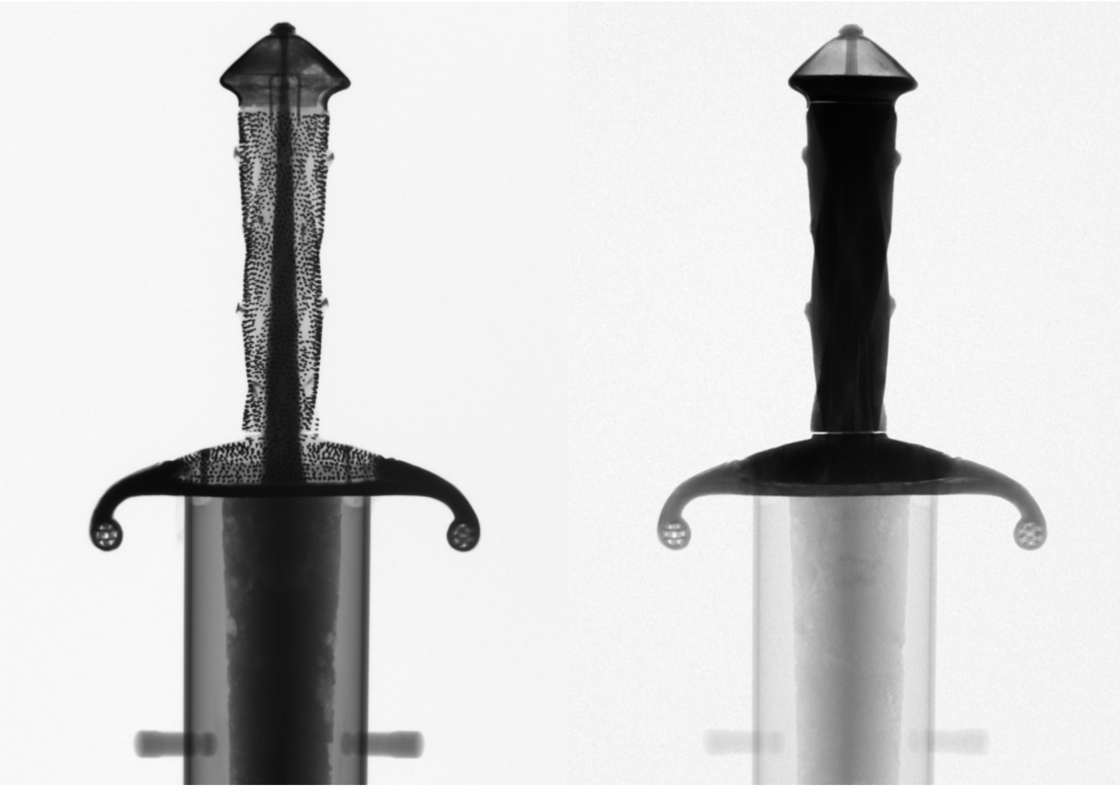

Fig. 1: Investigation of the "sword from Zug" [2], a find piece attributed to the 15th century, by means of X-rays (150 kV) – left, and thermal neutrons – right. Metals provide high contrast for X-rays, while the wooden handle is better visible with the neutrons.

than X-ray imaging, which is practiced in each hospitals and in many dedicated research labs. It was found out in an international survey [1] that only 46 facilities are presently in operation, but about 15 can be declared to be state-of-the-art.

Nevertheless, the methodical progress in neutron imaging has been significant and the new possibilities and techniques provide many unique features for research and practical applications.

An important step forward was the development of digital neutron imaging detectors which enabled the better utilization of the neutrons by orders of magnitude. Beside this higher efficiency, the digital image data can be used now directly for quantitative investigations of the observed materials and process.

A very impressive extension of neutron radiography was the implementation of neutron tomography, where the three-dimensional structure of objects is derived by volume recon-

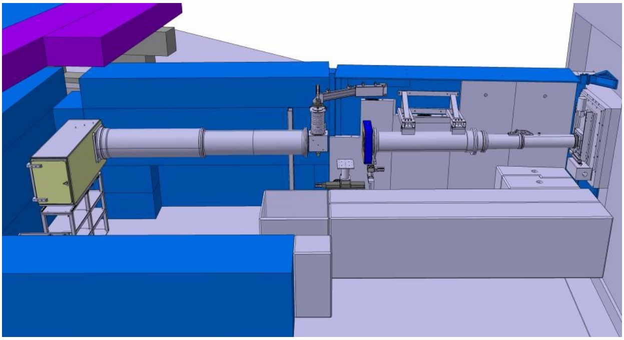

Fig. 2: General layout of the NEUTRA facility at beam port 32 of SINQ; the beam is provided from the right; two independent positions can be used for investigations

struction of several single projections with the help of mathematical tools. Due to the computer power today, it became possible to study even large volumes and to investigate it in virtual manner.

2. Neutron imaging facilities at SINQ, PSI

SINQ was built as a "clever beam dump" of the "high intensity proton accelerator (HIPA)" which was upgraded for this purpose from former 100 μA to the world-wide unique intensity of 2200 μA, corresponding to 1 MW beam power. The major customer of the spallation source has been the "Laboratory for Neutron Scattering", but options for neutron irradiations and neutron imaging were accepted and implemented too.

2.1 NEUTRA [3]

The thermal beam is extracted tangentially from the D_2O moderator and starts from a 2 cm aperture with a divergence of 1.2° and delivers a circular flat field of either 15 or 35 cm in diameter. Accordingly, two beam positions are provided with either high intensity ($2*10^7$ cm^{-2} s^{-1} mA^{-1}) or a large field-of-view (FOV).

Both positions are equipped with camera based detection systems [4], where the neutron intensity signal is obtained by the light conversion in a neutron sensitive scintillator screen. Although several other detector options have been tested and made available (imaging plates, amorphous silicon flat panels, pixel detectors), the camera systems were found presently most appropiate due to their high flexibility with respect to FOV, pixel size, dynamic range, read-out and sensitivity. An overview picture of NEUTRA is given in Fig. 2.

A typical exposure time for largest FOV, 2048*2048 pixels, full usage of the dynamic range is generated within about 20 s using the standard setup. However, using intensified systems, some binning, thick scintillator screens and sacrifying neutron statistics the exposure time can be reduced to less than 0.1 s.

An additional feature at NEUTRA is the availability of X-rays provided by a 320 kV tube which can be inserted alternatively into the beam at the beam exit where the similar conditions regarding collimation and intensity distribution are obtained.

With the same setup we can generate two transmission image data sets, one for neutrons, the other for the X-rays. Through proper data fusion techniques, a pixel-wise comparison or superimposition can be provided.

2.2 ICON [5]

Based on the very positive experiences from the NEUTRA usage, ICON was built from scratch at the empty beam port 52 in only 2 years until 2006. It has a higher flexibility to tune the beam by different possible apertures and an optional Be filter position.

As a new approach, a neutron energy selector (donated by Risø Research Centre, DK) was implemented for the wavelength band from 2.8 to 6 Å with a dispersion $\Delta\lambda/\lambda \sim 15\%$. This opens many new opportunities for neutron imaging research (see below). Further reduction of the energy band down to 2% can be achieved with a band filter device TESI [6].

As cold neutrons deliver higher contrasts for most of the materials compared to thermal neutrons, it was the aim for ICON to study small samples with high spatial resolution. For this purpose, a micro-tomography setup was designed and built [7], where an optimized lens system can extract the scintillator image to the camera. Images with up to 6.5 μm pixel size can result.

ICON operates also two beam positions, one at the end of the flight tube at 12.5 m from the aperture with large FOV for extended objects and supported by a sample

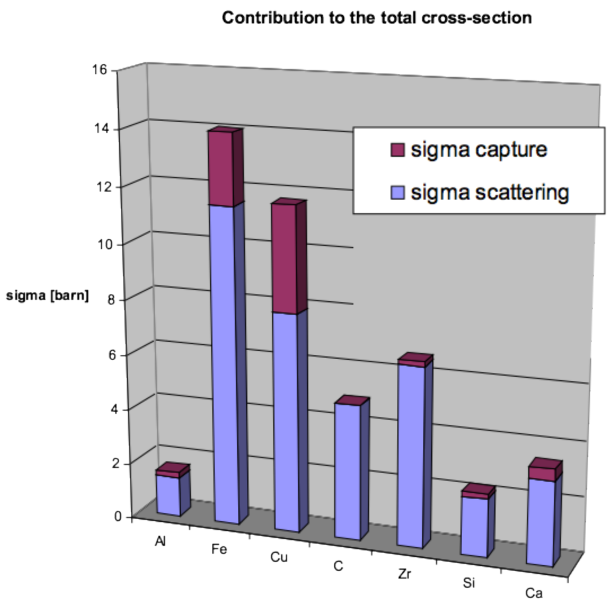

Fig. 3: Ratio of the capture and scattering contribution to the total cross-sections of common structural materials in a white thermal spectrum

stage with 500 kg lifting capacity. The other position delivers optimal conditions for either the micro- or the midi-system (FOV: 15 cm squared).

2.3 BOA

The former FUNSPIN facility [8] was converted into a universal test beam line and shared in its usage between different groups. It is fed by a bending and polarizing guide insert with vertically aligned blades. The properties of the BOA beam line and its options for neutron imaging are well described in [9].

Compared to NEUTRA and ICON the advantages of BOA are the colder spectrum, the high degree of polarization (95%) the tunable high beam intensity and much space for experimental installations.

3. Neutron scattering aspects

The attenuation of the initial beam in neutron imaging experiments is for most common materials given mainly by scattering (see Fig. 3). Nevertheless, the neutrons attenuated in the directed beam are considered to be absorbed and to contribute to the total cross-section Σ_{tot}=N*(σ_a+σ_s). The scattered neutrons are mostly considered as disturbing when the material density has to be quantified from experimental data when the inverted Beer-Lambert law is applied (intensity distributions with (I) and without the sample (I_0)):

(1) $$N = \ln\left(I_0/I\right)/(\sigma_a + \sigma_s)$$

Whereas (1) is valid for many structural materials on first order and for small sample thickness, strong deviation can be found for hydrogen which is dominated by its very strong incoherent scattering behavior. For the quantification of water and other hydrogenous materials it is often required to correct the secondary scattering component by means of suitable Monte-Carlo tools [10].

The experiments in neutron imaging are commonly performed with the full neutron spectrum (white beam) and the image data (described quantitatively by the cross-section σ) are therefore spectrum (ϕ) averaged and weighted with the detector efficiency ε:

(2) $$\sigma_{eff} = \frac{\int \sigma(E)\cdot\varphi(E)\cdot\epsilon(E)dE}{\int \varphi(E)\cdot\epsilon(E)dE}$$

If the spectral range is narrowed, especially in the cold energy range, access to the Bragg edges of the structural materials becomes possible. Varying the energy bands, a direct visualization of crystalline structures becomes visible on the macroscopic scale (see Fig. 4). Such neutron imaging data complement well to diffraction measurements [11].

Using two independent imaging detection systems, one in forward direction and the other aside the beam direction, simultaneous measurement of the transmission and the diffraction properties of a sample can be performed. This principle was found useful to characterize the local properties of single crystals – and their imperfections [12]. For poly-crystalline material of sufficiently large grain size (~mm) one can use the projections of individual grains formed by diffraction, to produce the three-dimensional mapping of grain shapes and orientation [13] The diffraction spots at the second detector can be used also to specify the lattice planes of the sample.

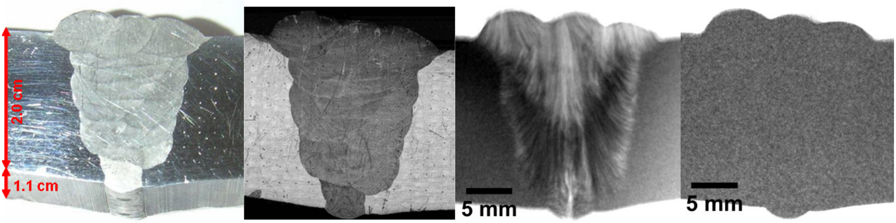

Fig. 4: Inspection of a weld connection of stainless steel (photos left); measurements at 4.2 Å and with the whole spectrum (white beam)

4. Phase contrast and dark-field imaging

Next to the attenuation contrast according to (1), alternative image data can be derived. They are based on the wave properties of the neutrons and their specific interaction with matter.

According to de Broglie's relation

(3) $$\lambda = \frac{h}{m \cdot v}$$

the wavelength of neutrons with the velocity v and their mass m can be determined to be in the order of a few Å (1 Angstrom = 10^{-10} m) – h = Planck's constant. As wave functions, neutrons can provide also phase shifts during interaction with matter.

The visibility of phase contrast effects driven by modern imaging methods can provide additional features in material research similar to the approach in X-ray studies where e.g. human tissue can be better distinguished in several cases. One particular effect is the enhancement of edges (see Fig. 5), which can be attributed to change of the refractive index (bc= coherent scattering length) at the outside:

(4)
$$n = 1 - \beta = 1 - \frac{\lambda^2 \cdot N \cdot b_c}{2\pi} \approx 1 - 10^{-6}$$

This very small deviation from 1 is sufficient for the visualization with high resolution detection systems.

The differential phase shift can be derived as independent material parameter directly from image data when a grating interferometer setup is used [14] - see Fig. 6.

This device is in use at ICON for the determination of the "dark field image". By these image data it is possible to detect features driven by (ultra) small-angle scattering properties, however not in reciprocal space (as usual) but in real space. Due to this, scattering properties can be visualized spatially resolved.

Since neutrons interact with magnetic structures because of their magnetic moment, they are ideal for the visualization and investigation of magnetic domain structures in metals [15], but also scattering from non-magnetic materials can be detected with the setup in Fig. 6. Fig. 7 shows an example of magnetic structures in a Goss-oriented FeSi-electrical steel sheet, widely used as core material in transformer applications. The large domain walls in horizontal direction are observable but also slightly disoriented grains, where smaller surface lance leaf domains

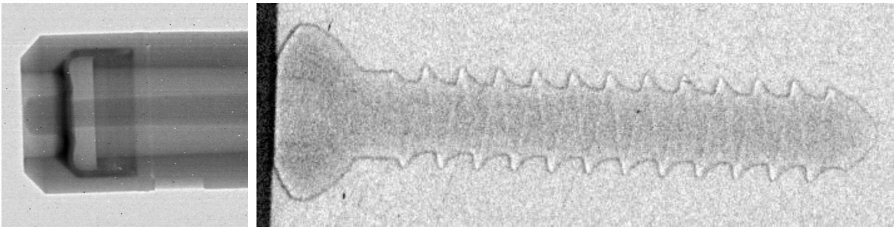

Fig. 5: Refraction based edge enhancement: steel sensor (left), Ti screw (right) – with phase contributions of opposite sign

provide a stronger contrast in the Dark-field signal and can be visualized. The big advantage is, that magnetic structures can be made visible in a bulk material. The sheet shown here has a thickness of 300 µm and is measured in transmission. In this point all other methods for the investigation of magnetic structures finally fail. Also the spatially resolved investigation of scattering properties from for example porous media can be made using the dark-field image without a scanning approach for a field of view of 64 mm x 64 mm.

5. Use of polarized neutrons

Neutrons have spin ½ and two states (up and down) are allowed therefore. In addition, the neutrons carry a magnetic moment and interact with magnetic fields.

With respect to neutron imaging, the usage of polarized neutrons – the sorting out of only one spin orientation – provides the opportunity to investigate magnetic phenomena. As demonstrated in pilot experiments by means of the de-polarization analysis [16] magnetic fields can be visualized under various conditions, in particular around superconducting magnets.

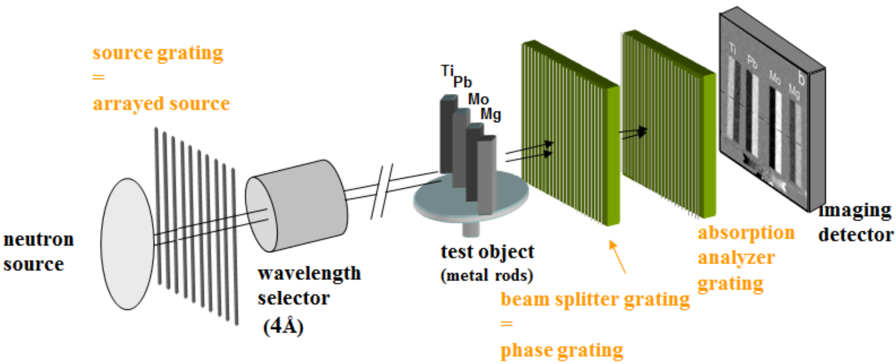

Fig. 6: Layout of a neutron grating interferometer setup as used at the ICON neutron imaging facility for the study of phase contrast phenomena and "dark field" features like magnetic domain structures [15]

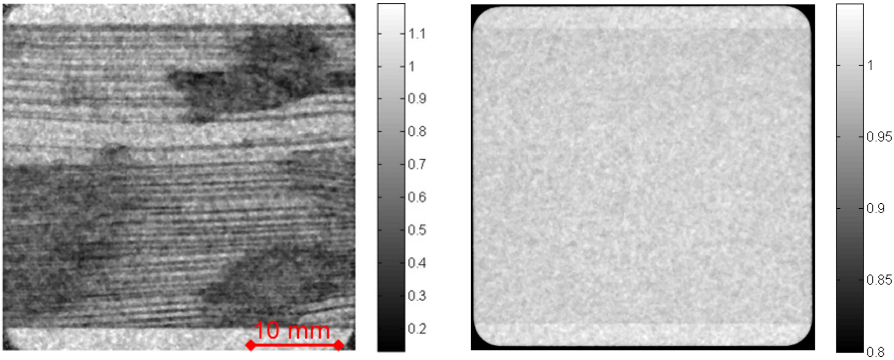

Fig. 7: Dark-field image of a Goss-oriented FeSi-electrical steel sheet. Large domain walls are visible as dark lines but also areas providing a stronger contrast. These areas are slightly disoriented grains building smaller surface domains for the reduction of the stray-field energy. For comparison you see the simple transmission neutron image (right) without any visible structure.

The BOA beamline provides good conditions for polarized neutron imaging due to the high degree of polarization of the beam, the high beam intensity, and the cold spectrum. The first trials have been performed successfully using a preliminary setup, [9].

6. Improving the spatial resolution

Currently, the spatial resolution in neutron imaging is limited by different reasons to about 15 μm. Compared to the conditions at synchrotron light sources and also common X-ray sources this is at least an order of magnitude worse.

Therefore, it is a real challenge to improve the spatial resolution in neutron imaging towards its physical limits. We initiated the project "neutron microscope" to improve all components in a digital detection setup: scintillator, lens systems, collimator, camera and neutron supply. Designed for a FOV of only 5 mm the goal of the project is to come close to about 5 μm in spatial resolution (pixel size 1.5 μm).

7. Working in the time domain

There are many processes worth following with adequate time resolution. The migration of moisture in porous media, the formation of water droplets in fuel cells, the building of ZrH in nuclear fuel cladding, the two-phase flow in heat exchangers or the distribution of fuel or lubricants in running engines are prominent examples where neutron imaging techniques can be used very successfully.

In many cases, the neutron beam intensity is the limiting factor how fast the process can be observed. When repetitive processes are under investigation we can use a stroboscopic approach with triggered and intensified detection system, where identical narrow frames from each cycle are stacked until the image gets valid.

With the help of fast read-out detection systems and their high sensitivity we can observe today frame rates up to about 20fps with reasonable image quality.

The measurements have to be tuned to the needed conditions and a high flexibility is available nowadays.

8. ESS and ODIN

A neutron imaging facility will be among the first instruments to be installed at the upcoming European Spallation Source (ESS). The project ODIN was already approved and the design work was initiated. As a time-of-flight facility, it will provide unique options in

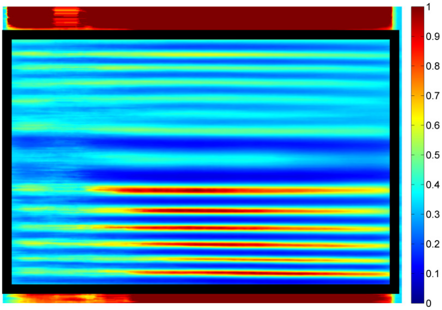

Fig. 8: Details of the magnetic field lines inside a rectangular coil derived from depolarization neutron imaging analysis at the BOA beam line. The setup is about 50 mm wide [9].

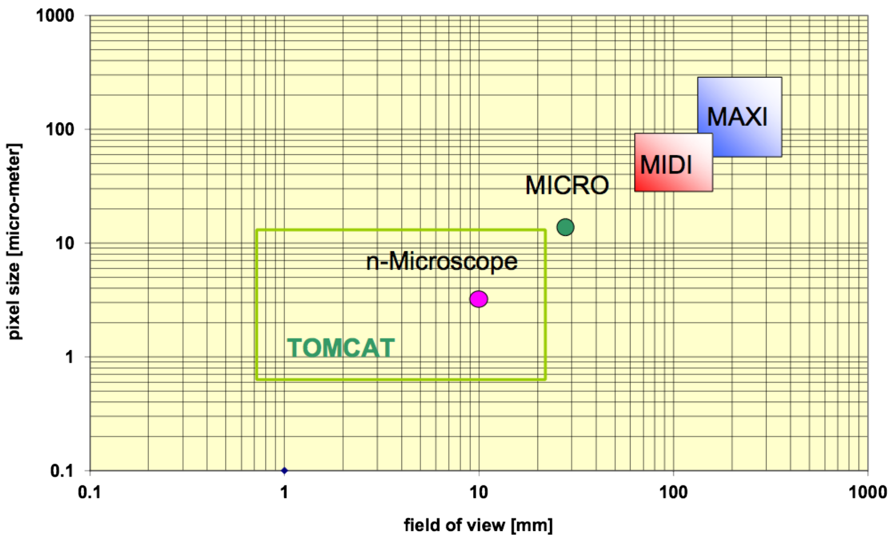

Fig. 9: Application range of the future "neutron microscope" with respect to resolution (pixel size) and field-of-view, compared to the existing set-ups (MAXI, MIDI, MICRO) in neutron imaging. Additionally we sketch the domain for X-ray imaging at the SLS facility TOMCAT.

particular for the high degree of energy resolution where improved image data are expected compared to those shown in Fig. 4. Although ODIN will provide nearly all common features of modern neutron imaging capabilities, the ultimate goal will be to tune the energy band in a manner that transmission and diffractive studies become possible with highest possible performance.

This approach will perfectly bridge the demands of neutron scattering and neutron transmission imaging and new features for material research will be made available.

9. Conclusions and Outlook

The Neutron Imaging & Activation Group (NIAG), previously organized within the "Spallation Neutron Source Division (ASQ)" was merged together with the "Laboratory for Neutron Scattering" and the new "Laboratory for Neutron Scattering & Imaging" was formed. This closer contact to scattering methods will be used for a deeper understanding from both sides and more synergies will be expected, e.g. for further ESS facilities.

Modern neutron imaging requires a high flexibility with respect to the individual setup for the particular research task. The PSI installations are well prepared to provide nearly all of the presently available imaging techniques.

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Announcements

SGN/SSDN MEMBERS

Presently the SGN has 199 members. New members can register online on the SGN website: http://sgn.web.psi.ch

SGN/SSDN ANNUAL MEMBER FEE

The SGN/SSDN members are kindly asked to pay their annual member fees. At the last general assembly of the society, the fee has been increased from CHF 10.- to **CHF 20.-**. It can be paid either by bank transfer or in cash during your next visit at PSI. The bank account of the society is accessible for both Swiss national and international bank transfers. The coordinates are as follows: Postfinance: 50-70723-6 (BIC: POFICHBE), IBAN: CH39 0900 0000 5007 0723 6

The SGN is an organization with tax charitable status. All fees and donations payed to the SGN are **tax deductible.**

YOUNG SCIENTIST PRIZE OF THE SWISS NEUTRON SCATTERING SOCIETY

At the general assembly 2013, it was decided that the SGN sponsors a prize for young scientists using neutrons as an important probe. The prize comprises CHF 1000 and will be awarded in 2015 for the second time. The announcement of the prize can be found on page 25.

PSI FACILITY NEWS

Recent news and scientific highlights of the three major PSI user facilities SLS, SINQ and SμS can be found in the **quarterly electronic newsletter** available online under: http://www.psi.ch/info/facility-news

SINQ CALL FOR PROPOSALS

The next deadline for the submission of beam time requests for the Swiss spallation neutron source ‘SINQ’ (http://sinq.web.psi.ch) is:
Nov 15, 2014

NEUTRON BEAM TIME AT SNS FOR THE SWISS NEUTRON COMMUNITY

An actively shielded 16 Tesla magnet has been realized at the Spallation Neutron Source SNS in Oak Ridge, USA, as a collaboration of the Swiss neutron community and SNS. In return, beam time is available at SNS for Swiss users. Swiss neutron scatterers are therefore encouraged to apply for beamtime at SNS.

REGISTRATION OF PUBLICATIONS

Please remember to **register all publications either based on data taken at SINQ, SLS, SμS or having a PSI co-author** to the Digital User Office: https://duo.psi.ch. Please follow the link 'Publications' from your DUO main menu.

OPEN POSITIONS AT ILL

To look for open positions at ILL, please have a look at the following webpage of ILL: http://www.ill.eu/careers

PHD POSITIONS AT ILL

The PhD program of the Institut Laue-Langevin, ILL, is open to researchers in Switzerland. The contact person at ILL is Anne-Claire Dupuis (PhD@ill.eu). The Swiss agreement with the ILL includes that ILL funds and hosts one PhD student from Switzerland.

SWISS PHD POSITION AT ILL

ILL funds and hosts one PhD student from Switzerland. This position will become vacant in 2015, and a call for a new PhD grant can be found on page 26.

Winners of the Young Scientist Prize 2014 of the Swiss Neutron Scattering Society, sponsored by SwissNeutronics

The first Young Scientist Prize of the society has been awarded to two young researchers for their outstanding achievements using neutron scattering in the framework of their PhD theses. The prize was awarded at the Neutron Scattering Session of the Swiss Physical Society Meeting, July 2nd, 2014 at the University of Fribourg.

The winners Qianli Chen and Simon Gerber together with SGN president Henrik Ronnow.

THE PRIZE WAS AWARDED TO

Dr. Simon Gerber

in recognition of his outstanding scientific achievements using neutron scattering in the field of unconventional superconductivity and magnetism.

Dr. Qianli Chen

in recognition of her achievements involving innovative use of neutron scattering in the field of materials science.

Young Scientist Prize 2015 of the Swiss Neutron Scattering Society, sponsored by SwissNeutronics

CALL FOR NOMINATIONS

The Swiss Neutron Scattering Society hereby announces the call for nominations for the 2nd Young Scientist Prize of the Swiss Neutron Scattering Society.

The prize will be awarded to a young Scientist in recognition of a notable scientific achievement in the form of a PhD thesis. The science should include the use of neutron scattering, and eligible nom-inees should have a clear affiliation with Swiss Neutron Scattering (be member of the Swiss Neutron Scattering Society, be based in Switzerland, or have conducted experiments at Swiss neutron facili-ties). The PhD must have been awarded within two years of the announcement of this Call. The prize amounts to 1'000 CHF and is sponsored by SwissNeutronics. The prize will be awarded at the European Neutron Scattering Conference in Zaragoza, August 30th - Sept. 4th 2015, where the recipient is expected to give a presentation.

Nominations for the prize should be submitted to the Swiss Neutron Scattering Society, Dr. Urs Gasser: (Urs.Gasser@psi.ch).

The deadline for nominations is January 31st, 2015. Nominations should include:

- A nomination letter including the motivation for the award
- A CV and publication list
- Digital copy of the nominated work (PhD thesis)
- Letter documenting the acceptance of the nomination by the nominee
- Letters of support from authorities in the relevant field are accepted

Nominations for the prize will be treated confidentially. Nominations for the prize will be evaluated by a Selection Committee appointed by the board of the Swiss Neutron Scattering Society. The nom-inations will be acknowledged, but there will be no further communication.

Call for PhD grant at ILL

Switzerland is entitled to send one PhD student to ILL for the duration of the PhD project. We hereby call for proposals to fill this position.

The student will be employed and financed by the PhD program of ILL. Besides working with the Swiss university supervisor defined in the proposal, each thesis student will work with an ILL supervisor. The ILL supervisor will be responsible for ensuring that, from a practical and technical point of view, the thesis progresses under the appropriate conditions during the student's stay at ILL. He/she shares responsibility for the scientific aspects of the student's work with the university supervisor. The university supervisor has ultimate scientific and administrative responsibility for the thesis (for more information please go to http://www.ill.eu/science-technology/phd-students/phd-recruitment/).

TYPE OF RESEARCH

Proposals from all areas of science using neutrons are welcome. The ILL PhD Program focuses currently on four fields of science: Nanoscience, Soft Condensed Matter, Biology, and Magnetism. However, high-quality proposals from other fields will also be considered.

REQUIREMENTS

The application has to be submitted by the direct supervisor of the PhD student. Any researcher working in Switzerland with the authorization to supervise PhD students is entitled to participate. The criteria for evaluation are the scientific quality and originality of the project as well as qualifications and track record of the applicant (supervisor) and the designated PhD student (if already known).

The application consists of the following four documents and a cover letter containing the name of the proposed supervisor at ILL and a statement that the ILL supervisor is informed about the proposal and willing to act as a supervisor:

A.) Summary of the proposal (max. 1 page)

B.) Proposal (max. 5 pages) structured as follows:
1. Abstract
2. Background
3. State of the Art and Objectives
4. Detailed Research Plan (including a time table)
5. Importance and Impact
6. References

C.) CV of Applicant (Supervisor) (max. 2 pages) plus publication list of the past 5 years

D.) CV of PhD candidate (if available)

Please convert the documents into pdf (max. size 2 MB per document; nomenclature: A_LastNameApplicant.pdf, B_LastNameApplicant.pdf etc.) and send it to the secretary of the Swiss Neutron Scattering Society, Dr. Urs Gasser: urs.gasser@psi.ch

Deadline: December 15th, 2014
Decision: January 9th, 2015
Starting date of the Project: February 2015
Duration: 3 years.

Conferences

(an updated list with online links can be found here:
http://www.psi.ch/useroffice/conference-calendar)

SEPTEMBER 2014

- 35th Risoe International Symposium on Materials Science: New Frontiers of Nanometals, September 1-5, 2014, Roskilde, Denmark
- 18th JCNS Laboratory Course Neutron Scattering, September 1-12, 2014, Jülich and Garching, Germany
- Taiwan National Synchrotron Radiation Research Center Annual Users' Meeting and 20th Anniversary of Operation, September 4-5, 2014, Hsinchu Taiwan
- ECIS Training Course, September 4-7, 2014, Haifa, Israel
- ECIS2014: 28th Conference of the European Colloid and Interface Society, September 7-12, 2014, Haifa, Israel
- SGK/SSCr Annual Meeting 2014, September 8, 2014, Dübendorf, Switzerland
- ESPS2014: European Symposium of Photopolymer Science, September 9-12, 2014, Vienna, Austria
- SISN Learning days (Giornate didattiche) 2014, September 13-22, 2014, S. Giovanni, Valle Aurina (BZ), Italy and ILL Grenoble, France
- Annual Meeting of the German Biophysical Society, September 14-17, 2014, Lübeck, Germany
- XTOP 2014: The 12th Biennial Conference on High-Resolution X-Ray Diffraction and Imaging, September 14-19, 2014, Grenoble, Frane
- ICCBM15: 15th International Conference on the Crystallisation of Biological Macromolecules, September 14-20, 2014, Hamburg, Germany
- 2nd International Conference on Science at Free Electron Lasers - Science at FELs 2014, September 15-17, 2014, PSI Villigen, Switzerland
- 16th HERCULES Specialized Course (HSC) on 'Non-atomic resolution scattering for biology and soft matter', September 15-19, 2014, Grenoble, France

- PNCMI: International Conference on Polarised Neutrons for Condensed Matter Investigations, September 15-19, 2014, Sydney, Australia
- Crystallography in Material Science: Novel Methods for Novel Materials (EMRS Symposium N), September 15-19, 2014, Warsaw, Poland
- E-MRS 2014 Fall Meeting, September 15-19, 2014, Warsaw, Poland
- MECC14: 7th Mid-European Clay Conference 2014, September 16-19, 2014, Dresden, Germany
- Multiphysics Modeling and Simulation, September 17-19, 2014, Cambridge, UK
- DENIM 2014: Engineering workshop in the field of neutron scattering instruments, September 18-19, 2014, Cambridge, UK
- SISN 2014: Learning Days School Session 2, September 19-22, 2014, Ismaning. Germany
- BioCrys2014. FEBS Practical & Lecture Course, September 20-27, 2014, Oeiras, Portugal
- Deutsche Tagung fuer Forschung mit Synchrotronstrahlung, Neutronen und Ionenstrahlen an Grossgeräten 2014, September 21-23, 2014, Bonn, Germany
- 92nd Annual Meeting of the German Mineralogical Society, September 21-24, 2014, Jena, Germany
- EMAS 2014. Regional Workshop., September 21-24, 2014, Leoben, Austria
- International school "CRYSTALLOGRAPHY AND NEUTRONS", September 21-24, 2014, Oleron, France
- JDN 22: 22émes Journées de la Diffusion Neutronique, September 21-26, 2014, Ile d'Oléron, France
- NAP2014. 4th International Conference on Nanomaterials: Application & Properties '2014, September 21-27, 2014, Alushta, Ukraine
- Physical Chemistry 2014. 12th International Conference on Fundamental and Applied Aspects of Physical Chemistry, September 22-26, 2014, Belgrade, Serbia
- MSE congress 2014: Materials Science and Engineering, September 23-25, 2014, Darmstadt, Germany
- NMI3-II General Assembly 2014, September 24-25, 2014, Zaragoza, Spain
- ESS Science Symposium on 'Surface and Interface Reconstruction: A Challenge for Neutron Reflectometry', September 24-26, 2014, Bernried, Germany
- 10th NOBUGS conference: New Opportunities for Better User Group Software, September 24-26, 2014, Tsukuba, Japan
- HEC-17. 17th Heart-of-Europe Bio-Crystallography Meeting 2014, September 25-27, 2014, Berlin, Germany
- ICANS XXI: 21st Meeting of the Collaboration on Advanced Neutron Sources, September 29 - October 3, 2014, Mito, Ibaraki, Japan

OCTOBER 2014

- Summer School: Theory and Practice of Modern Powder Diffraction, October 5-8, 2014, Ellwangen, Germany
- WCNR10: 10th World Conference on Radiography, October 5-10, 2014, Grindelwald, Switzerland

- Introductory Course on Synchrotron EXAFS and XANES for Chemical Speciation on Environmental Systems, October 6-9, 2014, ALBA Synchrotron near Barcelona, Spain
- ic-cmtp3: 3rd International Conference on Competitive Materials and Technology Processes, October 6-10, 2014, Miskolc, Hungary
- GTBio 2014, October 7-10, 2014, Grenoble, France
- COMSOL 2014: multiphysics modeling and simulation, October 8-10, 2014, Boston, MA, USA
- International Symposium on Crystallography - 100 years of History, October 12-15, 2014, Fortaleza, Brazil
- 6th AONSA Neutron School, October 12-17, 2014, Serpong, Jakarta, Indonesia
- XVIII International Conference on Crystal Chemistry, X-ray Diffraction and Spectroscopy of Minerals, October 13-15, 2014, Yekaterinburg, Russian Federation
- 3rd JCNS Workshop on neutron instrumentation: From spallation to continuous neutron sources: a positive feedback on neutron instrumentation, October 19-23, 2014, Tutzing, Germany
- 12th International Conference on X-Ray Microscopy, October 26-31, 2014, Melbourne, Australia
- Symmetry Relationships between Crystal Structures with Applications to Structural Phase Transitions, October 27-31, 2014, Varanasi, India
- Solution scattering from biological macromolecules. EMBO Practical Course, October 27 - November 3, 2014, Hamburg, Germany
- Neutron Scattering in Magnetic Fields Above 15 Tesla, October 29-30, 2014, Berlin, Germany

NOVEMBER 2014

- European User Office Meeting, November 3-4, 2014, ALBA Synchrotron, Spain
- Annual meeting of the 'German Society for Biominerals', November 6-8, 2014, Dresden, Germany
- Fourth Niels Bohr International Academy Meeting on ESS Science, November 10-14, 2014, Copenhagen, Denmark
- Hand-on course on the Pair Distribution Function method, November 12-14, 2014, ALBA Synchrotron, Spain

DECEMBER 2014

- BESSY II - Tender X-ray Workshop, December 1-2, 2014, Berlin, Germany
- 6th joint BER II and BESSY II User Meeting, December 3-5, 2014, Berlin, Germany
- Neutron School 'Fan du LLB', December 8-11, 2014, Saclay, France

JANUARY 2015

- BESSY II - From PICO to FEMTO: Time-resolved studies at BESSY II, January 26-27, 2015, Berlin, Germany

MARCH 2015

- Hybrid Materials 2015: Fourth International Conference on Multifunctional, Hybrid and Nanomaterials, March 9-13, 2015, Sitges near Barcelona, Spain

JUNE 2015

- 5th European PEFC and H2 Forum, June 30 - July 3, 2015, Lucerne, Switzerland

JULY 2015

- ICM2015: 20th International Conference on Magnetism, July 5-10, 2015, Barcelona, Spain
- AOCNS-2015: 2nd Asia Oceania Conference on Neutron Scattering, July 19-23, 2015, Sydney, Australia

AUGUST 2015

- ECNS 2015: 6th European Conference on Neutron Scattering, August 20 - September 4, 2015, Zaragoza, Spain

SEPTEMBER 2015

- SAS2015: 16th International conference on Small-Angle Scattering, September 13-18, 2015, Berlin, Germany
- Autumn School for Neutron Imaging, September 28 - October 2, 2015, PSI Villigen, Switzerland

AUGUST 2016

- ECM-30: European Crystallographic Meeting, August 28 - September 1, 2016, Basel, Switzerland

Notes

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