International NR Newsletter

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International Society for Neutron Radiology

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NEUWAVE-7
Participants at Fukuroda Falls

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Some words of the president of ISNR

I would like to thank all members of the ISNR for their contributions to neutron radiology in general and the terminology task groups in particular. Here on the sunny south side the community keeps growing with DINGO now taking users for more than a year.

Last year we had the NEUWAVE meeting in Japan, organized by J-PARC Center with support by the Comprehensive Research Organization for Science and Society (CROSS), which I couldn't attend, but according to my colleague Floriana Salvemini it was a very informative event.

For 2016 we all should look forward to meet at the ITMNR-8 at Peking University (PKU), Beijing, China, on September 4-8, 2016 as the major event for the neutron imaging community. Here at ASNTO we prepare for the bit more distant future working still on basics for the WCNR-11 in 2018 here in Sydney. This includes negotiating with venue and service providers, working on homepage and logo design and getting the organisational and scientific committees together. In addition to the world conference we plan to host a workshop on industrial engagement. As a type of training we plan to host local workshops on neutron imaging beforehand to attract potential users in our region. One is planned for this year and another one for 2017.

I would like to thank the IAEA for the strong support and organisation of meetings and workshops in the field of neutron imaging. I want to highlight that CRP "Neutron Imaging in Cultural Heritage" had its final session in Florence. Overall it was a very successful CRP creating new connections and getting an inside view into the museum and exhibition business. Two months after the meeting we had to hear the very sad news that Marco Zoppi passed away. We lost a friend and great supporter of neutron imaging in cultural heritage. He did some fantastic work in this field and during the whole CRP I really enjoyed his friendly and inspiring character.

I am looking forward to move on with taut sails into another successful year of neutron imaging / radiography / tomography / radiology.

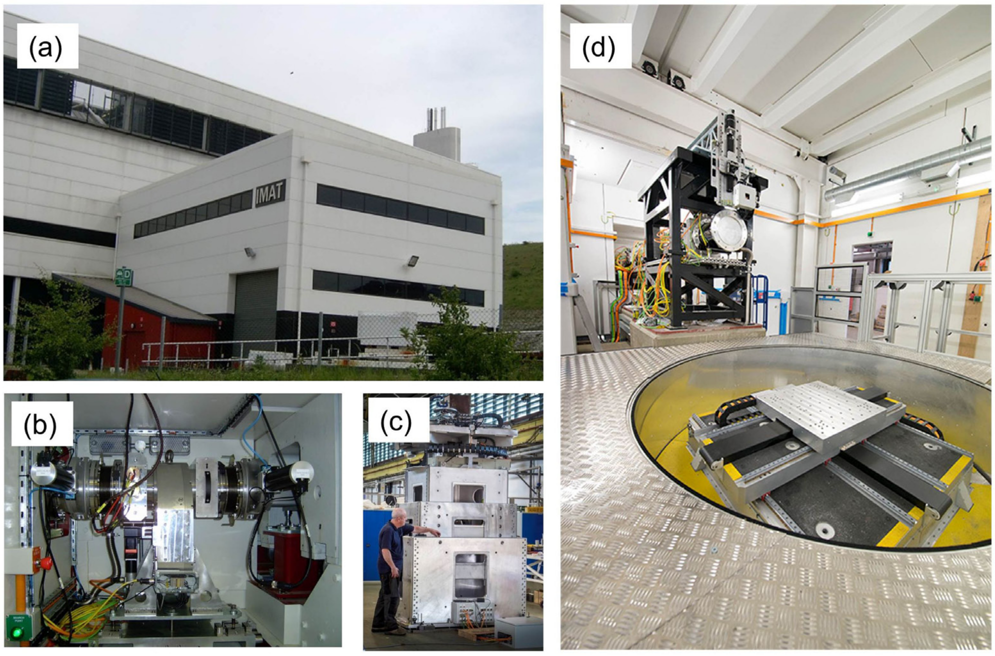
U. Garbe

Facilities

Status of the IMAT imaging and diffraction facility at ISIS

The installation of the new IMAT neutron imaging and diffraction instrument has made good progress. We hope to be able to take first neutron radiographies and tomographies early in the new year. The new instrument will enable white-beam neutron radiography and tomography as well as energy-dependent neutron imaging, the latter being a promising extension of conventional neutron imaging. Energy-selective imaging will allow maximizing the image contrast between given materials as well as mapping of microstructural features such as strains and texture in metals and alloys. The imaging set-up will be combined with diffraction detectors, with the specific aim to support the engineering materials testing and characterisation programme at ISIS.

The figure shows photos of the installation of some of the components. The IMAT extension building provides ample space for instrument equipment, detector electronics,



IMAT facility construction. a) IMAT extension building on the west side of the ISIS target station 2 experiment hall; b) gate valves, beam monitor, filter cartridge and aperture wheel (middle) in pinhole selector area, 10 m upstream of the sample position; c) assembled sample positioning system before installation; d) internal view of the blockhouse with sample positioning system installed (large rotation stage in yellow); not shown: imaging camera and diffraction detectors.

motion control equipment, sample storage, test stands, laboratory space and space for sample environment equipment. The instrument has been built as versatile and flexible as possible to enable swift interchanges between the imaging and diffraction measurement modes and to allow for future upgrades. The imaging and diffraction mode are typically not used at the same time, but a quick change-over time will be possible. Various components have been installed in the experimental area such as monitors, beam defining 'jaws', sample slits, and a fast beam attenuator. A sample positioning system that can carry weights of up to 1500 kg has been installed. The camera box at the sample position (not shown in the figure) is carried by a robotic camera positioning system. The camera robot will allow aligning the box in a flexible way behind the sample, and removing it when not needed. There are substantial Italian in-kind contributions to the beamline, among those a pinhole selector manufactured by CNR Florence and a neutron camera system developed by CNR Messina. Furthermore, a MCP detector built by UC Berkeley will be used on IMAT. The IMAT imaging set-up will be tested in the next ISIS beam cycles at which time first neutron radiographies will be collected. Prototypes of the diffraction detector modules have been constructed and will be installed for the forthcoming scientific commissioning tests. The development and installation of large m2–sized detector arrays for diffraction analysis is carried out in parallel to the commissioning of the imaging set-up.

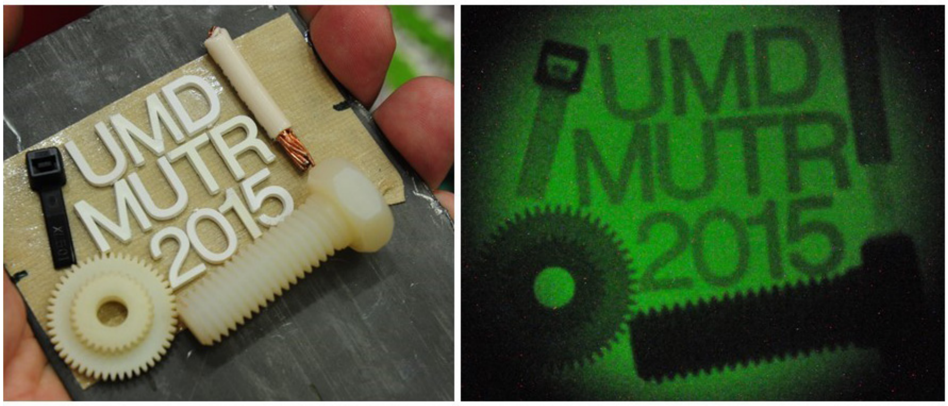
Neutrons were, for the first time, send to the IMAT sample area in September 2015 and time-of-flight monitor spectra of the incident neutron beam were recorded at several locations along the beamline. There were issues found with one of the choppers and with shielding which will be addressed while the instrument set-up is completed. The instrument is installed on a cold liquid hydrogen moderator on the second target station of ISIS. Components such as choppers, monitors and imaging cameras are synchronized with the 10Hz source and thus will enable very flexible selections of neutron wavelengths for neutron beam sizes from 1 to 200 mm using time-of-flight techniques.

W. Kockelmann

New imaging facilities in the United States

On July 10, 2015, the University of Maryland installed a neutron imaging beam line at the MTUR facility. The MUTR reactor is a 250 kW TRIGA reactor that was installed in 1970 and has five experimental ports. The initial setup allows for a field of view of about 5 cm with a spatial resolution of about 250 µm. The first demonstration images are shown below. Tests of tomography and time series radiography are planned for 2016.

Contact: Tim Koeth, http://www.ipr.umd.edu/faculty/koeth



First neutron radiography acquired at the University of Maryland's MUTR facility.

On 25 AUG 2015, NIST completed installing the shielding for the new cold neutron imaging instrument on cold neutron guide NG6 in the NCNR guide hall. The instrument features a 9.5 m flight path, an optical rail for installation of components, a cold neutron spectrum peaked about 0.5 nm, with a neutron flux at the sample position of 1.4 × 10^8 cm^{-2} s^{-1} for an L/D = 200. This second instrument complements the heavily utilized thermal neutron imaging facility at BT2 and will provide users access to energy selective imaging methods including Bragg-edge imaging and phase imaging with a Talbot-Lau interferometer. Most importantly, this new instrument will be the home of the neutron microscope based on Wolter Optics, which will increase the time resolution for high resolution imaging by a factor of 100 (1 s instead of 2 minute acquisition times for spatial resolution of 10 µm) and improve the image resolution through magnification of the neutron image by a factor of 10, to resolve 1 µm features. A demonstration of the spatial resolution is expected in summer 2016.

Contact: Daniel Hussey, daniel.hussey@nist.gov

Left, photo of the cold neutron imaging instrument on the end of NG-6. Right, first radiograph taken at the instrument of a stainless steel bottle opener.

Upgrade of the NECTAR facility at FRM II

The NECTAR facility is one of the first systems that went into operation after the start of FRM II in 2005. Ten years later, it was upgraded in 2015 to extend the flexibility of the imaging system according to the need of the user community. The detector system was re-designed in a way, so that quick scintillator exchange and field of view (FOV) selection became possible according to the requirements of the experiment.

The new detector system is mounted on the existing rail system of the old instrument with a new solid support structure offering the option of additional, heavy shielding against gamma radiation. On top of the support structure a 5 cm thick layer of borated polyethylene acts as base of the camera box and simultaneously shields the CCD against scattered neutrons from below, increasing the signal-to-noise ratio. The camera box was designed in an L-shaped structure with a fixed and a moving part. In the fixed component the scintillator (e.g. PP/ZnS(Ag)) as well as the thin foil mirror is inherited. Compared to the old system, the scintillator can now be easily exchanged with a simple sliding mechanism instead of loosening 24 screws and removing the front cover as needed before. Another advantage of the new system is the the foil mirror, which has a lower neutron interaction in front of the CCD detector and increases the signal-to-noise ratio further. The walls of the box were constructed with aluminum sheets, overlapping in the corners to ensure the light tightness of the entire box. All inner surfaces of the aluminum sheets are coated with light absorbing photo coating and plastic rivets connecting the sheets among each other to allow a quick and easy disassembling in the case of service works.

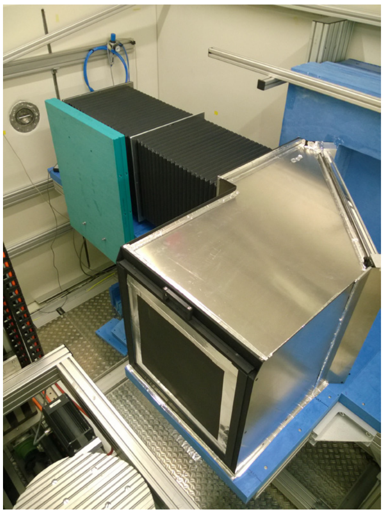


Photo of the new detector system during comissioning phase. Fission neutrons are coming from the left.

The moving part of the detector box consists of a linear axis on which the CCD detector is mounted. A light-tight bellow connects the fixed part of the detector box with the CCD detector and allows a direct connection of connectors and cooling supply from outside of the housing. The movable approach was chosen for a flexible selection of the field-of-view (FOV), ranging from 180x180 mm^2 to 300x300 mm^2 with the NIKKOR 85 mm lens system available at NECTAR. In addition, a remote focusing unit was implemented in the upgrade to increase the performance of the instrument and an auto-focus routine is currently under development.

Photo of the autofocusing unit with the NIKKOR 85 mm lens (bellows were removed).

In the absence of neutrons a small laser beamer in the housing will project pattern on the light emitting surface of the scintillator and will be used for focusing. Actually an ANDOR DV 434 and a DV 934 iKon-M CCD camera are available for measurements with the new detector set-up. The support unit for a pco.1600 camera is under construction.

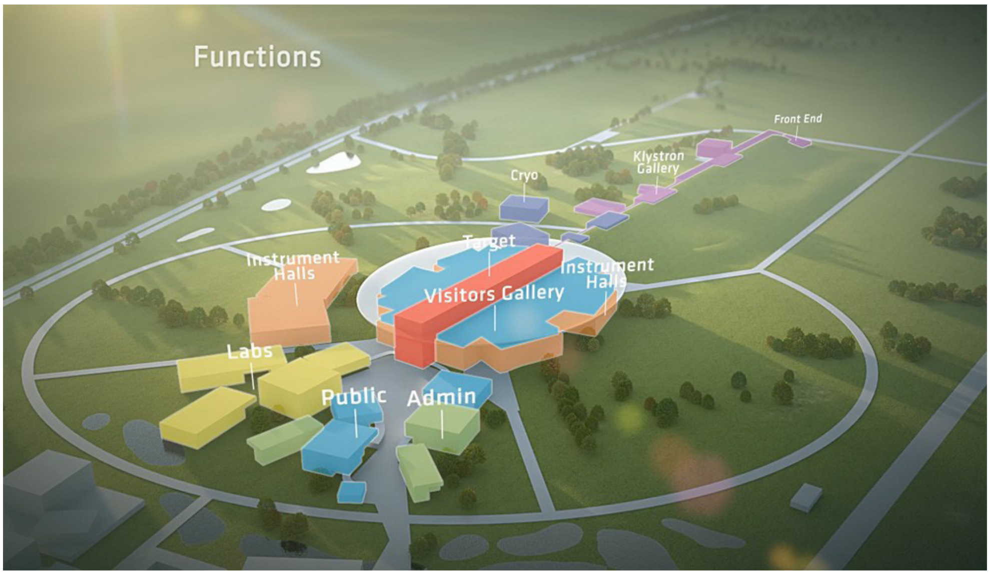
During the upgrade, also the control software was exchanged with NICOS and is now similar to the control software used at the instrument ANTARES, which is the other tomography system at FRM II operated with cold neutrons. This allows users after an introduction to the software at one system to start much faster with experiments at the other facility. In the frame of the software upgrade, also the golden ratio method was implemented besides the equi-distant angles tomography and both methods are available as button-to-press methods. Especially the golden ratio method allows a better usage of the beam time since the tomography can be stopped any time and even in the case of problems during the experiment the acquired data can be used for reconstruction without directional reconstruction artifacts.

T. Bücherl

New and/or ongoing projects

ODIN at the European Spallation Source

The European Spallation Source (ESS) is planned to become the brightest neutron source in the world. It is under construction in Lund (Sweden) by the ESS ERIC (European Research Infrastructure Consortium), a collaboration of 17 European countries. The construction project aims for completion in 2025 with 16 instruments operational and 6 instruments under construction still in 2025. First instruments are expected to start commissioning when the source produces the first neutrons in 2019.



ESS plan.

The ODIN project

Amongst the first three instruments endorsed by the ESS Scientific Advisory Committee (SAC), subsequently approved by the ESS Steering Committee (now ERIC council) for construction and hence scheduled for starting commissioning in 2019 is the imaging instrument ODIN (Optical and Diffraction Imaging with Neutron). Corresponding to the design of ODIN, which is dedicated to the strengths of the long pulse source of ESS, ODIN promises to be the most flexible and powerful neutron imaging beamline ever built. Bridging the gap between real space imaging and scattering based contrast methods ODIN strives for efficiently covering more than 8 orders of magnitude in length scale, from spatially resolved lattice distortions on the sub-Angstrom scale to macroscopic structure scales and sample sizes ranging to tens of centimeters.

ESS construction status in Oct. 2015 with growing parts of cast accelerator tunnel and started piling of target station.

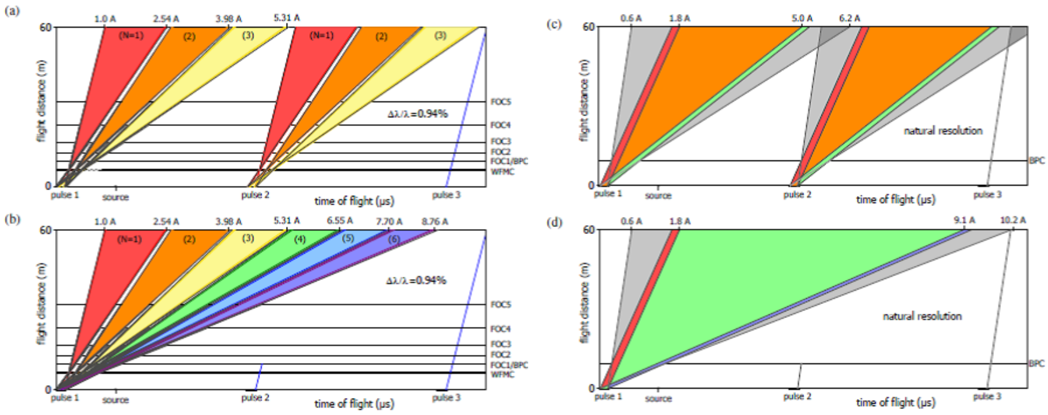
This becomes possible only due to the development of modern wavelength-resolved neutron imaging techniques, which are highly demanded by the ever growing user community that covers most likely the widest range of disciplines in the field of neutron research. Neutron imaging serves industry directly in numerous applications from engineering to energy research, but just as much also fundamental and material science in the context of magnetism, soft matter, biology, geology and even cultural heritage.

ODIN will be able to exploit all strengths of the ESS source by taking advantage of time-of-flight (ToF) methods and flexibly tailoring the wavelength resolution to the requirements of various application, which is enabled by the unique long-pulse time structure of ESS. However, ODIN will also be competitive, if not world leading, in conventional applications in the thermal and cold wavelength ranges, normally requiring two separate dedicated beamlines. Therefore ODIN has been designed unlike any other instrument, to be world leading amongst imaging instruments, whether built at continuous or at pulsed neutron sources.

Key design features of ODIN

The corresponding conceptual design features in particular a bi-spectral extraction and a 50m long guide system optimized by ESS driven HZB, KU, TUM and PSI contributions to the ESS design update phase as well as a complex wavelength frame multiplication (WFM) chopper system specified in detail at TUM.

The chopper system can be regarded as the heart of the instrument. The WFM system is using a pair of optically blind choppers to re-define the wavelength resolution. Five frame overlap (FO) choppers with increasing distance from the source re-limit the so-called wavelength frames generated by the WFM choppers in time. Additional choppers allow to select either an extended wavelength band from 1 – 8.8 Angstrom for which several features of the instrument are optimized or the natural bandwidth (4.5 Angstrom) at the given instrument length. In the former mode, every second ESS pulse is suppressed. If only a smaller wavelength band is sufficient, half of this range can be selected, thereby using every ESS pulse and hence giving twice the intensity. In the latter case the required

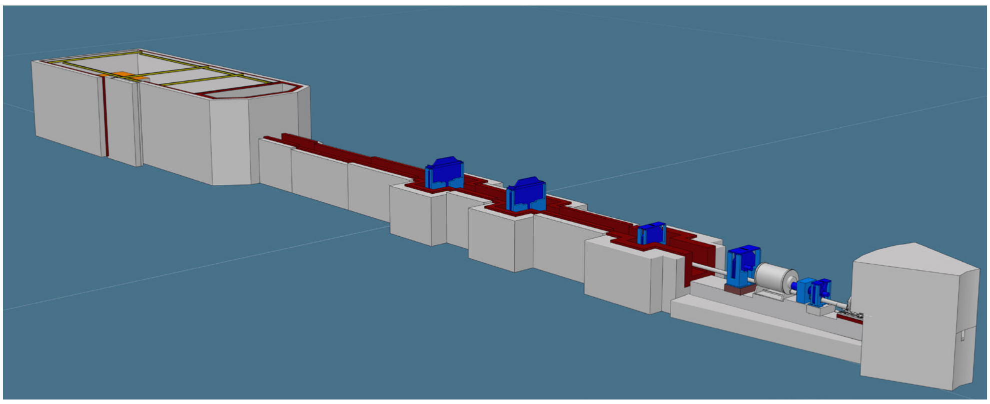


Some of the various ODIN ToF modes enabling high flexibility in order to tailor the wavelength band and resolution to the requirements of measurements allowing for most efficient measurements over a wide range of applications.

wavelength band can then be chosen from the full extended range – in low resolution cases even beyond - by adjusting the phase of band pass (BP) choppers. The WFM wavelength resolution is tuneable in the range $\Delta\lambda/\lambda$= 0.2 – 0.9 % by changing the distance of the WFM chopper pair. These modes are indispensible for polarized and Bragg edge or diffraction based applications addressing magnetic and crystalline sample features, respectively. Yet another instrument mode is accessible by parking the WFM chopper cascade in an open position and using only the BP choppers. The wavelength resolution varies from about 2 – 10 % over the named wavelength range in this mode, however the intensity is increased by about an order of magnitude and more as compared to the WFM modes. This mode enables combining imaging with small angle scattering, hence mapping macroscopic inhomogeneities and quantifying microscopic structures beyond spatial resolution locally. Finally in a conventional white beam mode, also the BP choppers can be stopped or only used to set upper or lower limits to the bandwidth used, for structural investigations utilizing wavelength integrated attenuation contrast with high flux and hence potentially highest spatial and time resolution e.g. in kinetic studies.

Schedule and current status of ODIN

The preliminary design phase of ODIN started in January 2014, originally meant to finish end of 2015 with a tollgate review (TG2 review) in order to enter phase 2, the final design. While phase 1 saw already significant progress in preliminary design in terms of



Current status of the ODIN CAD model featuring guide, choppers, heavy shutter, shielding (partly) and endstation; Note: the front part from the monolith (right) to the start of the individual shielding of ODON will be covered by a common bunker shield around the monolith.

CAD drawings and planning, late ESS baseline changes and decisions lead to a delay of the TG2 review for ODIN, currently assumed to take place in around March 2016. In particular a significant change of the ESS moderator concept and design led to the need of a complete re-optimisation of the already specified ODIN guide system, and blocked resources for shielding calculations and simulations caused a very late and limited start of this key activity in the design process. At the occasion of the TG2 review it is also planned to hand over the lead of the project from ESS to the ESS in-kind partner TUM and to have a plan established to construct the instrument as a consortium of ESS with the in-kind partners TUM and PSI. In-kind refers to the circumstance that the ESS partner countries are intending to spend a significant part of the ESS budget, which they are contributing, in their own country. This way more than one third of the ODIN budget and about one half of the ODIN budget will be spent at and through PSI and TUM, respectively. TUM intends to also employ the future lead scientist and engineer. A plan for the respective Work Units has been elaborated. For this purpose ESS, TUM and PSI are also preparing a memorandum of understanding and install a consortium with an In-kind Consortium Executive Board supervising the project. The specific contributions will be agreed in contracts with the ESS and have to pass various national and ESS committees for approval. These are all critical processes potentially influencing the construction schedule.

2016 – A critical year for ODIN

On the one hand 2016 is the year in which the ODIN project has to pass the tollgate review TG2 between phase 1 (preliminary design) and phase 2 (detailed design) of the instrument construction project and on the other hand all critical agreements have to be put in place and critical staff has to be hired in order to enable TG2 to take place on time at about March 2016. A significant delay of this date immediately impacts on the schedule of tendering and ordering long lead-time components, which is critical to the delivery date of ODIN end 2019. Significant risks to the schedule are associated to hiring the required staff, namely the lead scientist and engineer, at TUM, but also to timely preparation of required documents, approval and signature of agreements and release of funds in Germany and Switzerland.

Another critical moment for the project will be a "Scope Setting Meeting" scheduled for early 2016. This meeting shall clarify the final scope and budget of the instrument against the background of a scarce instrument construction budget and a cost category of 9 Mio including a 10% contingency, which has been set for ODIN by ESS. This number contrasts the proposed budget of around 14 Mio for the full scope of ODIN and an estimated cost of around 12 Mio € for a basic version stripped bare of polarization, modulation and other auxiliary equipment enabling advanced methods, which however shall be added during a staged upgrade path during (initial) operation. Bearing in mind that ODIN as a multipurpose instrument advances all promising cold and thermal imaging modes, the current 9 Mio € cost category budget compares particularly unfavorable not only with the costs for imaging instruments at other state-of-the-art spallation neutron sources but also with foreseen commitments for scattering techniques like reflectometery, SANS, diffraction and spectroscopy. The outcome is hence not only critical to the ODIN construction process but through the realizable scope also for the imaging community in general. The team is currently working hard in order to verify its options in terms of scope and cost.

M. Strobl, M. Morgano, P. Schmakat

Review on conferences and workshops

The 6th European Conference on Neutron Scattering (August 30th – September 4th 2015) in Zaragoza (Spain)

The community for neutron scattering presented latest results and methodical improvements during the ECNS2015 in Zaragoza, Spain, in one week in August/September in the large conference center, located close to the Zaragoza University. Fortunately, the temperatures were moderate and little lower than in the weeks before – with 37° C as the highest.

In plenary talks and in 4 parallel sessions about 230 oral presentations were given (15 minutes, including discussion – hard to perform). The poster sessions filled nearly the whole foyer area, where also the lunch breaks were celebrated simultaneously.

Neutron imaging activities were well presented and visible with about 20 talks about facilities, applications, detectors and methodical improvements. As the share of about 10% in the contributions is considerably high, it can be concluded that our visibility in the neutron scattering community is high in the meantime. Although the overlap to scattering methods and their applications is demonstrated, the synergy has to be highlighted even more in the future.

Beside scientific presentations and discussions we were informed about latest developments and problems with neutron sources in the future. The reactors at HZB (Germany) and LLB Saclay (France) will be shut down before 2020 (for political and economic reasons), while the ESS is at the horizon in full operation some time later. The imaging community is affected by this process by the CONRAD and IMAGINE facilities and ODIN, respectively.

The "Hälg Price" of the European Neutron Scattering Association (ENSA) was given to Helmut Rauch who presented his neutron research over more than 40 years, some neutron imaging activities included. However, his focus was mainly on quantum mechanical aspects in fundamental neutron research.

No decision was made yet for the next ECNS, but the neutron scattering community will go to Korea for the next ICNS in 2017.

E.H. Lehmann

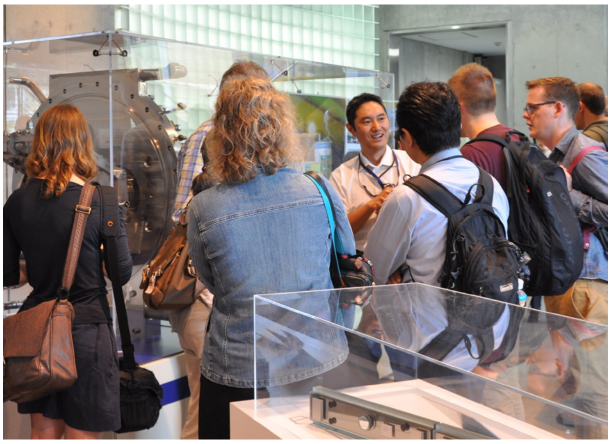
Not the conference center, but the impressive cathedral in Zaragoza

J-PARC Center hosted the NEUWAVE-7 workshop in 2015

The seventh workshop on NEUtron WAVElength dependent imaging was held from May 31th to June 3rd 2015, in Mito, Japan. The workshop, organized by J-PARC Center with support by the Comprehensive Research Organization for Science and Society (CROSS), was attended by 55 experts from 10 different countries, and 30 oral presentations were held. This year's workshop also afforded a unique opportunity for participants to visit the world's first pulsed-neutron imaging instrument, RADEN, in its newly completed state, which had been discussed throughout the NEUWAVE series beginning at NEUWAVE-2 in 2009.

The workshop started with a walking discussion to Fukuroda Falls consisting of a one-hour trip by local train and bus, followed by a two-hour hike through a beautiful mountain forest under perfect weather conditions, ending at the falls. There, we enjoyed the full view of Fukuroda Falls from nearby observation platforms (see picture on the front cover).

The first session of the scientific and technical parts of NEUWAVE-7 was dedicated to reports from neutron imaging facilities. Progress and recent results were presented from J-PARC, SNS, HFIR, PSI and the compact Hokkaido University Neutron Source (HUNS). A session on constructing and future instruments was also held, and the progress of IMAT at ISIS and ODIN at the ESS were reported. Recent developments in Bragg-edge, resonance absorption and polarized neutron imaging methods and applications were major topics in this workshop. In particular, a session on cultural heritage was held with three contributions, in which Bragg-edge imaging was utilized to investigate position-dependent crystal information of historical objects. It is expected that this technique provides a unique approach of sample analysis in this research field.



Participants of MLF tour at a mercury target chamber.

On the last day, participants visited the pulsed neutron facility at the MLF of J-PARC. Since the MLF was not in operation at the time, the visitors were able to access many areas of the MLF experimental halls, including the interior of the neutron instruments at each beam line, and detailed explanations were given by each beam line scientist.

The next workshop, NEUWAVE-8, will be held in 2016 in Oxfordshire, UK.

T. Kai

AUNIRA Trainings Workshop (Advanced Use of Neutron Imaging for Research and Applications)

After a first successful Trainings School on Neutron Imaging held at HZB in 2013 in Berlin, which was initiated and supported by the IAEA, another such event took place at PSI during Sept. 28th to Oct. 2nd 2015. Whereas the Berlin event was done to involve many participants, in particular from developing countries, and to present all basics in neutron imaging, AUNIRA wanted to train experts and users at the neutron imaging beam lines at PSI with more advanced technics and capabilities.

Participants and lecturers in front of the SINQ building at Paul Scherrer Institut

Therefore, the number of participants was limited for two reasons: the practical work at the beam lines does not perform well with too many persons; the financial support by the IAEA was also limited. In this manner, the decision about the participation was quite challenging since the offer was done world-wide on the related homepage: www.indico.psi.ch/event/aunira. In the end, 24 external participants from 18 countries were elected and some additional Swiss users were involved, partly only for the lectures in the morning sessions.

The structure of AUNIRA consisted of 1 hour presentations on all relevant modern topics in neutron imaging, including detailed discussions about it. The lectures were mainly given by the members of the NIAG group at PSI, including 3 PhD students, but also by external experts (Kardjilov, HZB; Strobl, ESS; Petermans, Belgium). These 15 lecturers made a nearly perfect job while their presentations mirror well the current state of the art in neutron imaging.

In the afternoon, practical exercises were performed at the SINQ beam lines NEUTRA, ICON and BOA. Since AUNIRA was scheduled within a shutdown week of SINQ for administrative reasons, only from Wednesday on the neutrons were available. However, as preparation and for comparison, X-ray imaging was performed with the implemented sources at NEUTRA (320 kV), ICON (120 kV) and with a nano-focus tomography system. Simultaneously, we performed exercises in image processing starting with common image treatment up to tomography visualization training with half of the participants.

Next to the topical work, we celebrated a visit to the nearby nuclear power plant Leibstadt with a visit of the public relation center and a presentation about reactor safety. Another excursion was done for a wine tasting to convince the participants that Switzerland grows also drinkable wines of high quality (and price).

At the end of the workshop, on Friday afternoon, all participants presented their results of experiments and image data analysis. This session gave a clear impression how good the messages and the knowledge from AUNIRA were transferred to the participants.

E. H. Lehmann

News from the Board

In the chapter "News from the Board" the board members inform on the status of ongoing or newly established activities as well as on important decisions made in board meetings.

Joseph Bevitt PhD as deputy of president announced

Joseph Bevitt

EXPERIENCE

Dr Joseph Bevitt is an instrument scientist on the DINGO radiography/tomography/imaging station at the ANSTO Bragg Institute, and head of the Institute's User Office. Joseph manages access to the 13 world-class neutron beam instruments at the OPAL nuclear research reactor, provides scientific and technical advice to users, is responsible for the peer-review of proposals, coordination of all neutron beam time, outreach activities and workshops.

As an instrument scientist on DINGO, Joseph's primary interest is the application of neutron tomography in the areas of palaeontology, archaeology, and cultural heritage. His main research activities involve the use of neutron-CT for the study of vertebrate physiology and evolution, the investigation of ancient disease and early medical practices, and to determine methods of manufacturing of ancient cultural artefacts. Joseph also has expertise in the monitoring of kinetic processes in materials using neutron and X-ray diffraction, spectroscopy and thermogravimetric methods.

As Executive Officer and Project Manager, Office of the DVC (Research), he managed the implementation of two Australian Government's university-sector research-assessment exercises at the University of Sydney, and as Executive Officer for the NSW Synchrotron Consortium, promoted the use of the newly constructed Australian Synchrotron to the university sector, and coordinated usage by researchers from 12 universities and the NSW state government research organisations.

Task groups

A first initiative by the newly elected board of members was the establishment of so called task groups on some specific topics being of relevance and importance for our community. As an example, some discordance in the run-up to the elections at WCNR, mainly caused by different interpretations of the regulations of ISNR, resulted in the task group "Constitution". In a similar manner other topics were identified and related task groups created. Each task group has a convener, being a board member or officer and being responsible for the performance of the group. The convener reports on a regular basis to the board of members on the ongoing activities.

Task group "Terminology"

The task group has decided to elaborate a 1st edition of an ISNR terminology document. The first step was however to agree on an approval process for the document and in particular the corresponding terminology. Agreement has been found on a basic two step process in which the Task Group decides on a proposed terminology which is subsequently presented to the ISNR board for consideration and approval.

Work on the document has started with preliminary agreed Introduction and Scope sections outlining the context, scope and process to derive an agreed edition of the Terminology document. Some key excerpts summarize that as follows:

"This first edition of ISNR terminology is the first attempt by the society to establish a terminology on its own, for its very own framework and concerns. This is undertaken in the light of growing dissents on terminology, which before has been lent from strongly related fields such as X-ray radiology (medical and scientific), non-destructive testing and neutron science communities. As fast progress in all these fields and in particular also related to more scientific impact has led to inconsistent use of terminology within and among the related communities, this has led to ambiguity, contradicting use of terms and lack of conciseness also in the field represented by ISNR."

"Against this background it has become necessary for our community to develop an own scheme of terminology that clarifies the use of high level terminology as much as it defines an extensive set of terms to concisely describe and reflect the diversity of established methodology and applications and to enable extensions in developing and evolving fields.

It is essential for such terminology to be as much as possible consistent with definitions in related fields but also with the general public use of terms in order to enable best possible interdisciplinary communications as well as broad public impact. Indeed in the light of established inconsistencies such endeavor poses some challenges and will not always allow for full equivalence of terms and definitions."

Currently the first core part identifying the context of our terminology and the high level terms in the respective field of the ISNR as well as a first scheme for an extensive terminology is under preparation by the convener for discussion within the task group.

It is the aim that these parts shall be available for discussion by the board at the next meeting at ITMNR in 2016 in Peking, China and that a complete 1st edition of the terminology document can be discussed and approved finally at the next World conference in 2018 in Sydney, Australia.

M. Strobl

Task group "Characterization and standardization"

The characterization and standardization task group is approved and is operating. The participants are communicating, exchanging experience and defining the working program.

Many imaging facilities were upgraded recently by exchanging their film based, analog detector systems by digital ones, e.g. the facilities at the ETRR-2 reactor in Egypt, at BATAN in Indonesia, Malaysia, Thailand, etc.. This raises the question of comparing the spatial and time resolutions and to draw some gains in the performance of the facilities.

Some test samples dedicated for characterization of the neutron imaging performance in radiography and computed tomography experiments were developed at Paul Scherrer Institute (PSI) by Dr. Anders Kästner recently. Three different types of samples targeting the characterisation of resolution and contrast in radiography and CT measurements will be distributed among facilities from different class and the results will be analyzed. A new contrast sample is designed to quantify the ability to distinguish between different materials with the used neutron energy spectrum. In addition two sample types are proposed to quantify the resolution; one for radiography using a slated Gd edge and the other a container with Ti spheres with different diameters for computed tomography. These samples are a revision of the resolution and contrast samples used in the first IAEA round robin carried out in 2011-2012.

The convener and the members of this group continue to work on the adaptation of the present available standards and strategy to the current state-of-art installations. The strategy for the definition of new standards in neutron imaging will be presented to the Board for consideration, revisions and approval in the near future.

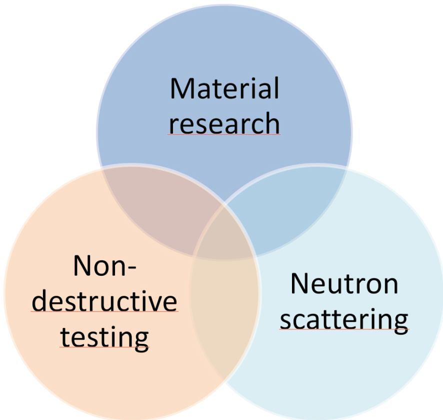
N. Kardjilov

Task group "Contact to other organizations"

Collaboration and networking within ISNR.

The different members of ISNR are linked to their national neutron sources as the bases for the neutron imaging facilities and their dedicated research and application activities. They are surrounded by other research partners who have organisations and networks due to their often larger size and longer traditions.

As shown in the figure, there are three major communities of such research partners, where the neutron imaging activities fit in partly. As neutron scattering, material research and non-destructive testing have own societies, conference series and other network activities it is wise to join their events in a selective manner.



Relation and involvement of Neutron Imaging with respect to other research communities.

There are national organizations and international activities of the three communities:

1. Non-destructive testing: many countries organize the activities within societies like in Germany (DGzfP) or Germany (SGzfP). In addition, there are conferences on regional (e.g. European) or international level (World Conference on NDT – e.g. in Munich 2016). Next to research activities, the societies organize trainings and educational programs and take care for certification and standardization.

2. Neutron scattering societies are organized in several countries (e.g. Switzerland: SGN=Schweizer Gesellschaft für Neutronenstreuung) on national level. The large conferences are ICNS (next one in Korea in 2017), ECNS (last one in Zaragoza/Spain in 2015). Some additional networking is possible within "Framework Programs" of the European Community like NMI3 or SINE2020.

3. Material research is widely spread, but has a strong interface to industry. Major conferences are held in the MRS and TMS series in USA each half year. Also Material Research Societies are present on national, European (EMRS) and international level.

Neutron imaging techniques can contribute in different areas of these research units. However, it needs time and efforts to find the best possible approach to the different communities. Participation in conferences with own contributions with examples of investigations and the search for partnership, often via the X-ray lane, might be a good approach.

There are other research partners, mainly given by the interaction with the users of the neutron imaging facilities in various research fields: electro-chemistry, archaeology, construction materials research, palaeontology, soil physics, nuclear materials, … Here it is important to learn how neutron imaging techniques can be applied usefully. The visit of selected meetings with dedicated presentations will help to broaden the user basis.

Participants of the IAEA School at HZB in 2013.

IAEA in Vienna has the task to control and to supervise all nuclear activities on global level, in particular around the research reactors. One of the utilization aspects for research reactors is neutron imaging where the level of instrumentation is quite different. As long as the reactor based neutron sources exist, they should be used best possibly for neutron imaging purposes in the different countries.

It is a major task of IAEA to organize meetings, to send missions into several countries or to invite experts from developing countries to advanced labs with the aim to raise the knowledge and the quality in neutron imaging.

Until now, there were organized two trainings schools for neutron imaging with strong support by the IAEA: at HZB in Berlin in 2013 (Advanced Neutron Imaging for Industrial Applications) and at PSI in 2015 (AUNIRA = Advanced Use of Neutron Imaging for Research and Applications).

C. Grünzweig, E. H. Lehmann

Task group "Constitution"

The three members of the task group responsible for revising the ISNR Constitution (Les Bennett, Thomas Bücherl and Markus Strobl) have worked through various versions and are at 4th iteration at present. We have had a lot of good and interesting discussion via email and are heading towards a document that should represent present practice as well as clearly define the operation and procedures both of the Society and of the Board. Our intent is to have a version ready for presentation and discussion with the Board in the meeting at ITMNR-8.

L. Bennett

Task group "Promoting young scientists and technicians"

The following actions have been taken to promote young scientists and technicians training in the area of neutron imaging for fundamental research and various industrial applications.

Workshop and School:

1. The IAEA workshop was held jointly with the PSI Autumn School on "Imaging Methods for Scientific & Industrial Applications" from September 28 to October 2, 2015. This training workshop is aimed to introduce and deliver concise and the most recent information on use of neutron imaging both for basic research and industrial applications. Textures covered the topics neutron sources, beam-line design, imaging detectors and digital image processing for Neutron Imaging (NI). Additionally, special techniques used in NI had be thoroughly discussed such as energy selective imaging, neutron grating interferometry, imaging with polarized neutrons, dynamic neutron imaging and diffractive imaging. The workshop also included hands-on-experiments and exercises in small groups at the state of the art facilities of SINQ/PSI, including the application of modern tools for data treatment and analysis.

2. The ITMNR-8 LOC has made preparation to hold a small Neutron Imaging School with 30 young students on September 4, 2016, before the main meeting of ITMNR-8. This school is mainly for beginners of neutron imaging, such as students and young scientists who have entered this field recently or want to learn and use this technique for particular applications. The courses will be given by top experts in the world.

Teaching and Student Cultivation at Universities

Teaching neutron imaging in neutron scattering courses of the university and in special lectures at the local universities in Lund, Sweden and Copenhagen, Denmark (University of Copenhagen, Danish Technical University) and numerous European neutron schools (Oxford, England; PSI, Switzerland, etc.) In addition we try to identify young talented students in particular at the local universities and to involve them in undergraduate and PhD projects and to take responsibility to keep successful PhD candidates in the field of neutron imaging through networking with other institutes and through project funding for Post-docs. Furthermore we are trying to bring students to experiments and establish connections between different projects and beam times, in order to allow the students to broaden their spectrum in the field, overlook the context of their work and establish networking between the young scientists and students, which provides them with a perspective in the field potentially. (By Markus Strobl)

IAEA TC Program

The young scientists from China Institute of Atomic Energy (CIAE) have been financially supported by IAEA with the TC Program of "Development and Application of the Neutron Imaging Facilities at CARR". Dr. Wang has been training in PSI under the guidance of Dr. Lehmann for 6 months. Dr. WEI will depart to HZB for learning Energy Selective Imaging and Polarized Imaging with Dr. Kardjilov in 2016.

D. Chen

Task group "NR Newsletter"

The task group NR Newsletter is convened by Thomas Bücherl who is collecting topics being of some interest for the ISNR community. As soon as this list has reached a certain length, but at least once a year, a new NR Newsletter will be released. The main challenge is to find volunteers writing short articles on the topics. Actually this is mainly covered by board members, but all other ISNR members are requested to send in contributions, too. These contributions may be related to new or upgraded facilities or new and interesting products in Neutron Imgaing (NI), upcoming conferences and workshops or reviews thereof, new or improved techniques (hardware and software), new publications, scientific highlights etc. and can be mailed to thomas.buecherl@tum.de.

T. Bücherl

Task group "ISNR website"

The task group "ISNR website" is closely linked to the task group "NR Newsletter" (both convened by Thomas Bücherl) as information sent for publication in the NR Newsletter will be first published on the website, thus making the NR Newsletter a summary of previous activities while the website is showing the actual status. For example Ulf Garbe has proposed to have all 3 to 6 months "scientific highlights" on our website. These contributions can originate by the members of ISNR or any user of a NI-facility. Please use this possibility and send in highlights of your NI facilitiy.

For these reasons a completly new version of the ISNR website will be set online within the next weeks. It is not completely finished yet and requires input of all ISNR members for further improvement, extensions and debugging. Any suggestion is highly welcomed.

For the beginning please check your personal data as soon as the new website is online. ISNR members will receive a notification via email.

T. Bücherl

Task group "Publications"

A database of neutron imaging publications

We plan to set-up a publication database on the ISNR website to help members and users of neutron imaging facilities keeping track of neutron imaging studies and of work of colleagues. The database will be useful to direct new academic and industrial users to relevant publications, method descriptions and case studies for certain imaging application. The field of neutron imaging and the application range has diversified significantly, with developments of methods such as magnetic, phase contrast, dark field contrast, monochromatic beam and energy-selective imaging. Accordingly, the number of neutron imaging publications is steadily increasing. The database will make people aware of publications in specialized-subject journals and conference proceedings and of work published in PhD and master theses, and last but not least, of the original publications in neutron radiography and tomography.

A basic version of a neutron radiography publications database already exists on the RadSci Consultancy website (http://www.radsci.co.uk). The site has links to reference lists which include reviewed papers, PhD theses and MS/MSc theses back to 2012. These lists have now been updated. The RadSci database will be supported by the task group until such time that publications are listed on the ISNR site. For the time being we ask to email new and missing papers to Thomas Bücherl (thomas.buecherl@tum.de) or John Rogers (john@radsci.co.uk). In any case, to establish and maintain a working database (a good example is the Munich phase contrast X-ray and neutron imaging database: http://www.e17.ph.tum.de/index.php/services/gbpub.html) we rely on support from the community. Any help from volunteers who know how to set-up a web portal and/or are willing to help populating the database is welcome.

W. Kockelmann

Task group "Small or low cost systems"

Neutron Imaging can be performed nowadays with sensitive digital imaging systems also at low intense neutron sources within reasonable exposure time. Compared to film methods where dose rates of 1E09 cm-2 were required for a valid image about 3 orders of magnitude less exposure is needed with new detector technologies.

Therefore, neutron imaging can be performed at even small sources like 250 kW TRIGA reactors or at accelerator driven sources if a suitable beam line is made available.

A neutron imaging program can be started today very soon if the following conditions are fulfilled: source with thermal (or cold) neutrons, well defined beam line, neutron imaging detector and qualified operators. Looking through the data collection of neutron sources, the potential for neutron imaging installations is quite high (on the order of 20 to 100 world-wide).

Why does this not simply happen?

- The know-how to build such facilities is mainly communicated on the large (and expensive) conferences, where the access of newcomers is quite limited
- At the sources themselves there is a dominance either by other established programs (irradiation, NAA, scattering, isotope production) and no space is left for a suitable neutron imaging installation
- The driving force for neutron imaging, a scientific or applied program, can only be established when the performance can be demonstrated by a running system - which has to be build first.
- The cost to build a new installation is on the order of several 10 kEuro to 1 MEuro, depending on the layout and performance. This money is often not made available, while ignoring the cost of the neutron production.

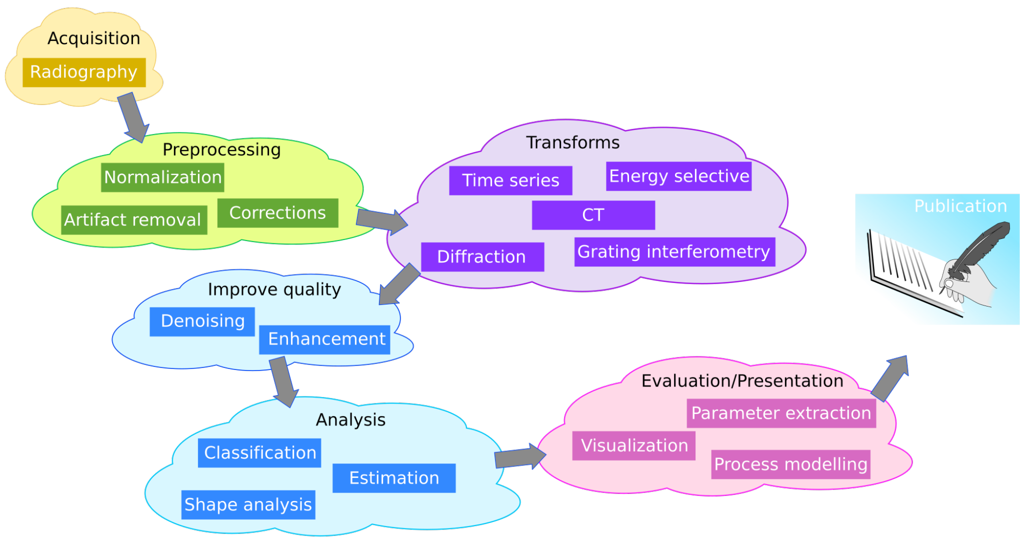
Even it is accepted that neutron imaging can play an important and competitive role – compared to the also progressing X-ray methods – it depends from case to case if and what happens. As ISNR, we can promote the methods and technologies best possibly, push the operators of sources (like the "Union for Compact Accelerators", the research reactor operators or spallation source designers to consider neutron imaging installations at their existing or upcoming devices.

IAEA is supporting this process by sponsoring trainings schools (like AUNIRA at PSI), pays for missions to the advanced facilities and organizes meeting to selected topics (standardization, cultural heritage studies, nuclear material investigations). In 2016, a "Consultancy Meeting on Development of Guidelines for Major Upgrades and New Designs of Neutron Imaging Facilities" will be held. The outcome might be very important for the future work of this task group.

E. H. Lehmann

Task group "Computational imaging"

The part that distinguishes imaging from analog radiology is the ability to store and perform computations on the acquired image data digitally. This ability makes it possible to perform open beam correction to obtain transmission images as a basic example and advanced techniques like for example computed tomography and grating interferometry would not be possible to achieve without the help of a computational step. This is the realm of computational imaging – computational methods to transform and extract information that is inherent in the measured data but not directly available from the radiographs. The processing chain continues with denoising and image enhancement to finally reach a condition that can be used in the analysis of the image data to give answers to the questions about the constitution of the sample or the observed process. The entire chain is shown in the figure below. Often at least the same amount of time is spent on the preparation and analysis of the data as the acquisition before the data is ready for publication. The time spent on analysis increase with the complexity of the sample and the preformed experiment.



Processing chain describing what happens to the imaging data after acquisition.

Considering the fact that some of these operations are an inherent part of the image acquisition process, astonishingly little room is given for the development of new methods and adaption of existing methods to neutron imaging. The algorithms are as important components as any beamline components, only you cannot touch or see them and they can often be used with the very same computer you use to read this newsletter.

The aim of the computational imaging task group of ISNR is to promote the development of computational methods for neutron imaging. A first step this year has been to perform a survey to investigate the interest and readiness to participate in a common effort to develop new methods and provide tools for the neutron imaging user community. Earlier this year you were asked to fill out a survey on the topic computational imaging for neutron imaging. The motivation for the survey was to provide an overview of the data analysis habits of the neutron imaging community. Who is performing the analysis and to what degree members of the neuron imaging community develop their own tools chains for their analysis alternatively how much commercial tools are used. In the follow-up questions the participants were asked for the reason of these choices. The second part of the survey was devoted to details about software development with questions to determine who is developing their own tools and what the motivation for this work is. The survey was sent to all ISNR members; we received 53 completed responses, this corresponds to about 20% of the members. From the responses we could read that today most are using commercial tools for a majority of the evaluation tasks. For many typical measurements this is an adequate choice, but when you have the ambition to perform experiments beyond this category, something new is needed. This has also been realized among the participants of the survey who are both interested in developing their own tools as well as contributing to open source projects. Making new methods available to the neutron imaging user community is a great and resource demanding task requiring dedicated manpower. It cannot be relied upon that this work is performed during free moments of a few enthusiasts. One initiative to provide some manpower is made within the European project SINE2020, which is also reported in this new letter and we are looking forward to the outcome of this project.

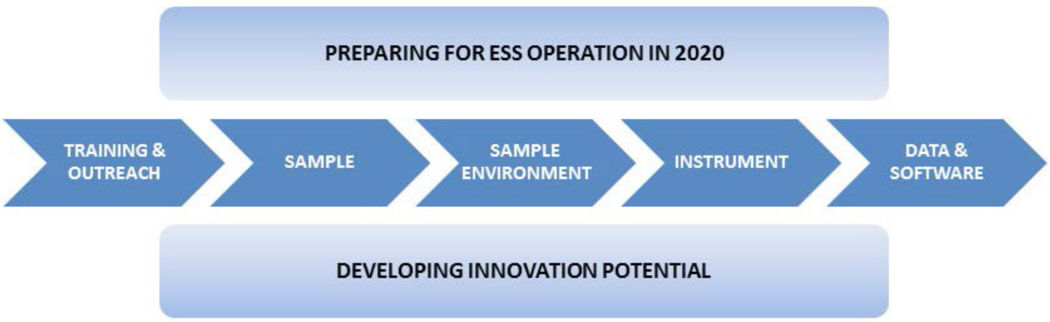
A. Kaestner

Software

SINE2020 and its benefits for neutron imaging

SINE2020, world-class Science and Innovation with Neutrons in Europe for 2020, will qualitatively improve and provide new services in the eco-system of neutron RI's, enabling the next generation of users from the scientific and innovation communities to ensure the success of major investment in European research infrastructure. It is a European collaboration between 17 partners from 12 countries funded by the 7th European Framework Program Horizon2020. This will be realized in a program consisting of ten work packages.

The package concerning neutron imaging directly is WP10, which covers the topic Data treatment software with partners from PSI, ISIS, LLB, DTU, and ESS. PSI will take the leading role for neutron imaging within this work package of SINE2020. The aim of the project is to make data processing and analysis methods available to the neutron imaging user community of today and also in the future directing the focus towards the possibilities offered by the new pulsed spallation sources. A central keyword in this work is interoperability making it possible to use the same tools on imaging data from different instruments and facilities. Initially, efforts will focus on the collaboration between European partners but nothing will prevent non-European partners to contribute on different levels of the development. An important aspect of the project is that all contributions shall be developed as open source. Open source development has in particular three important benefits;



Principal objectives and specific aims of SINE2020.

1) The tools will be freely available to the neutron imaging community,

2) anyone with sufficient knowledge in software development can contribute to the project and

3) the tools are open for verification and comparison with other methods and it also makes it easier to reproduce published results when the processing steps and tools are known.

For the imaging part of WP10 we intend to provide a platform for processing and analyzing neutron imaging data. Currently, there are several local efforts at different neutron sources to provide tools for solving this task. Some are based on commercial tools while others are developments from scratch using one of the common programming languages or based on open source tools like ImageJ. These tools have parts in common, which has the consequence that the development efforts are inefficiently utilized. With a common initiative it would be possible to focus on the core tasks instead of repeatedly implement the same thing. One of the future core tasks would be to make efficient implementations of the efforts of PhD students without spending too much time and efforts on the infrastructure since this should already be available. Their work would risk falling into oblivion or be restricted to a narrow user community centered on a few (one) enthusiasts if they are not embedded into tools that available to a wider user base.

As quality assurance we have arranged for an advisory committee who will observe and guide the focus of the development. With this committee we hope to avoid too specific developments and to reach wider acceptance of the developed methods and tools and that users and facilities beyond the participants of SINE2020 will use the tools and contribute to the project.

A. Kästner

Upcoming conferences and workshops

First Announcement: 8th International Topical Meeting on Neutron Radiography ITMNR-8 - "Neutron Imaging for Applications in Industry and Science"

The 8th International Topical Meeting on Neutron Radiography (ITMNR-8) will be held at the Peking University in Beijing, China from September 4 - 8, 2016. This meeting will follow the traditions of previous ITMNRs. The main meeting will last for three and a half days with oral and poster presentations as well as a half-day of scientific/technical excursion. Prior to ITMNR-8 there will be a Neutron Imaging School for young scientists and students. As the previous ITMNR-7, a Review Workshop will be held after the main meeting.

The language of all meetings will be English.

Neutron imaging technology is initially developed from neutron radiography with film, and now neutron radiography is still widely used for Non-Destructive Testing (NDT). However digital neutron imaging, especially tomography, has got great development in recent years. So, in this announcement the term "imaging" will include conventional radiography, tomography and other digital imaging methods.

This will be the 8th conference in the series being coordinated by the International Society for Neutron Radiology (ISNR). The previous seven meetings were held in Pembroke (Canada) 1990, Rikkyo University (Japan) 1995, Lucerne (Switzerland) 1998, State College (USA) 2001, Garching (Germany) 2004, Kobe University (Japan) 2008 and Kingston (Canada) 2012. The meetings are an international gathering of individuals most active in neutron imaging and its applications. Each meeting of the ITMNRs had a specific topic.

Focus and Scope

Nowadays neutron imaging has been applied in many fields, especially in industry for advanced manufacturing, materials and processes, product maintenance as a powerful NDT tool. Neutron imaging is also an important tool for the research activities in multi disciplines, such as archaeology and cultural heritage, geology and paleontology, agriculture and biomedical science etc. The special focus of ITMNR-8 is therefore on Neutron Imaging for Applications in Industry and Science. We hope this conference will further promote the applications of neutron imaging technology around the world, in particular in China. The sessions will cover topics to include neutron imaging:

- Applications in industry,
- Usage in multi research disciplines,
- Facility developments focused on applications,
- Specific detectors developments,
- Neutron imaging methods improvements, and
- Simulation studies for facility design and quantification.

Scientific Program

ITMNR-8 will consist of three components:

A. Neutron Imaging School, September 4, 2016. This school is mainly for beginners of neutron imaging, such as students and young scientists who have entered this field recently or want to learn and to use this technique for particular applications. The courses will be given by top experts in the world and include:

   - Fundamentals of Neutron Imaging
   - Neutron Imaging Facilities
   - Neutron Tomography
   - Resolution and Standardization of Neutron Imaging
   - Industrial Applications of Neutron Imaging
   - Advanced Technologies of Neutron Imaging
   - Accelerator-based Neutron Source
   - Energy Selective Neutron Imaging
   - Video Show: Examples of Neutron Imaging Experiments and Imaging Processing

B. Main Meeting, September 5 - 8, 2016. Oral and poster sessions will be held as plenary for the participants to be able to attend every presentation. A visit to the China Advanced Research Reactor (CARR) at the China Institute of Atomic Energy (CIAE) and/or an excursion to the Great Wall at Juyongguan Pass will be arranged. The proceedings will be published in a scientific journal.

C. Review Workshop, September 9-11, 2016. This workshop will be held in Mianyang, a city in Southwest China, about 1400 km from Beijing. The participants will visit the China Mianyang Research Reactor (CMRR) at the China Academy of Engineering Physics (CAEP) and discuss the presentations and the conclusion of ITMNR-8.

Committees

International Advisory Committee

Muhammad Arif (USA)
John Barton (USA)
Les Bennett (Canada)
Thomas Bücherl (Germany)
Dongfeng Chen (China)
Frikkie De Beer (South Africa)
Ulf Garbe (Australia)
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Ke Yuan (Peking U, Secretary)
Yubin Zou (Peking U)

Important Dates

Abstract submission deadline	May 6, 2016
Notification of Acceptance	June 6, 2016
Early-bird registration deadline	July 8, 2016
Full paper submission deadline	August 22, 2016
Neutron Imaging School	September 4, 2016
Topical meeting	September 4 - 8, 2016
Review workshop	September 9 - 11, 2016

Venue

The topical meeting will be held on the campus of Peking University, which is about 16 km from city center of Beijing and about 34 km from Beijing Capital International Airport. Information on Peking University can be found at http://english.pku.edu.cn/. Beijing is a famous historic and cultural city, see http://www.mybeijingchina.com/beijing-attractions/.

Further Details

The Second Announcement of ITMNR-8 will be distributed early 2016, which will include information about abstract submission, neutron imaging school and review workshop details, early-bird registration, hotel reservation, accompanying person program, full paper submission, transportation, visa application, etc.

Contact

Email: ITMNR-8@pku.edu.cn
Web site: http://indico.pku.edu.cn/e/conf/ITMNR-8/ (will be opened soon)

D. Chen, Z. Guo

Other Conferences

NEUWAVE-8
8th Workshop on Neutron Wavelength-dependent imaging
12-15 June 2016, Abingdon, UK

19th WCNDT 2016
19th World Conference on Non-Destructive Testing
June 13-17, 2016, Munich, Germany

ITMNR-8
8th International Topical Meeting on Neutron Radiography
September 4-11, 2016, Peking University, Beijing, China

WCNR-11
11th World Conference on Neutron Radiography
2018, Sydney, Australia

New publications

If you are aware of some new publications related to neutron radiography, imaging etc. please send me the references. Until the database on publications on the ISNR website is completed please refer to the website of John Rogers (www.radsci.co.uk).

Editor

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