CREMLIN workshop: Engineering for advanced neutron instrumentation and sample environment

Sunday 13 May 2018 – Wednesday 16 May

2018 New Peterhof Hotel

Book of Abstracts

May 2018

Dear Colleagues,

It is our pleasure to welcome you to the CREMLIN workshop

“Engineering for advanced neutron instrumentation and sample environment”

jointly organized by the Petersburg Nuclear Physics Institute (PNPI), member of the National Research Center “Kurchatov Institute”, and the German Research Reactor FRM II operated by the Technical University of Munich (TUM).

The workshop is being held at the New Peterhof Hotel, St. Petersburs Avenue 34, Peterhof, Russia, from Sunday, 13th May to Wednesday, 16th May 2018.

The Russian PIK Reactor will become operational and open to the neutron user community towards the end of this decade. In order to define PIK’s specific position within the European neutron landscape and to meet the demands of both European and Russian researchers, the workshop is aiming at developing guidelines for a general instrumentation concept for the PIK reactor and for the supporting structure of sample environment. More specifically, the topics include mechanical construction, neutron components, electronic components, detectors, automatization, instrument control and different aspects of sample environment.

In order to present a broad range of methods and approaches, speakers from the Institute Laue-Langevin (ILL), Forschungszentrum Jülich (FZJ), ESS (European Spallation Source), the Helmholtz research centres of Geesthacht (HZG) and Berlin (HZB), the Laboratoire Léon Brillouin (LLB - CEA), the Joint Institute for Nuclear Research (JINR), Dubna, the Institute for Nuclear Research (RAS), Moscow, and from the organizing institutes PNPI and FRM II/MLZ have been invited.
The talks are given either in Russian or English language, translation will be provided. The poster session on Monday evening is also a platform for discussion; every talk will be summarized in a poster. The visit of the Grand Peterhof Palace and the Conference Dinner offer another opportunity to deepen scientific and personal exchange.

The funding of this workshop by the European Commission via the grant no. 654166 "CREMLIN - Connecting Russian and European Measures for Large-scale Research Infra-structures" is gratefully acknowledged.

Thank you for sharing your expertise and experience.

Yours sincerely,

Sergey Grigoriev

Winfried Petry

PETERSBURG NUCLEAR PHYSICS INSTITUTE
named by B.P.KONSTANTINOV
of National Research Centre "Kurchatov Institute"

MLZ
Heinz Maier-Leibnitz Zentrum

TUM
Technische Universität München

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Status Quo of the Mechanical Construction at PIK

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Control assembly of the neutron scattering instruments that were transferred from HZG to PNPI NRC KI is completed at present time. New two projects: creation of a source of cold neutrons for experimental channel and the construction of neutron guide systems is currently being implemented. The project of neutron guide system is fully adapted to the needs of neutron stations.

Appropriate modernization program for HZG instruments was realized in the course of project PIK-GGBase. For example, new polarizer and analyzer systems were produced for the reflectometer and SANS instruments (incl. new radiofrequency flippers for polarized reflectometer). Design changes for some instruments were done in the form of NG system for PIK reactor. At the same time neutron stations require the deep modernization of existing equipment, incl. new electronic control system and detector system due to heavy loads by the neutron flux. The program of modernization is thoroughly reviewed.

Session I: Engineering for advanced instrumentation: Detectors / 27

Neutron Detectors at PNPI

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He-3 detection technologies necessary for equipping the majority (about 70%) of experimental stations of the PIK reactor either exist at PNPI or can be produced there as there is a technological capacity for their development and realization. Aperture of these detectors is no more than 1 m2 and consequently do not require a large amount of ^{3}He (about 900 liters). ^{3}He is available in Russia, and its price is several times lower than the European one. For this reason, detectors based on ^{3}He is Russia's competitive advantage over Europe, which certainly should be used to the fullest extent. The reason for this is a unique combination of such properties as high efficiency of neutron registration and low γ-background sensitivity.

PNPI actively develops various types of neutron detectors on the base of the Tracking Detector Department (head is A. G. Krivshich). PNPI already possesses technologies necessary for development and production of neutron detectors with aperture up to 300 × 300 mm, which comply with the requirements of current physical experiments. In order to create 2D detectors with aperture of 1000 × 1000 mm and more the LPSC-technologies will be used with the charge division readout.

Existing 2D PSD ^{3}He-detectors to be able to work in intensive neutron fields (~ 1×10^6 neutron/s) of reactor PIK, it is necessary to change the data readout method from a delay line readout to channel-by-channel readout from the cathode strips. Based on these technologies, one can create ^{3}He-detectors of different structural variations including the capacity to operate in vacuum.

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Detectors for Thermal Neutron Detection Based on Helium-3

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Since the 1980s, helium-3 has been used as a converter in neutron detectors. A high cross section for neutron conversion, low gamma sensitivity, stability of response and flexibility of the design geometry make helium-3 an ideal converter for neutron detection. The so-called helium-3 crisis in 2009 has triggered worldwide research into alternative neutron detection concepts. Although it has become scarce and expensive ever since, helium-3 is still the gold standard of neutron detection.

Starting with a proportional counter, the general principle of thermal neutron detection is explained. Various types of detectors such as linear position-sensitive detectors (LPDs), the multi-tube concept, and 2D position-sensitive multi-wire proportional chambers (MWPCs) with delay line encoding as well as single-wire readout are elucidated. Common stopping gases and their effect on neutron detection, gamma sensitivity and limits for efficiency, count rate and position resolution are discussed.

Finally, for each type of detector existing installations in instruments such as SANS, a powder diffractometer, a multi-analyzer for cold TAS and a large area detector for the Extreme Environment Diffractometer at HZB will be presented and explained.

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Boron-Based Thin Film Detectors at the European Spallation Source ERIC

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The European Spallation Source (ESS), a next generation neutron spallation source, is presently under construction in Lund, Sweden. The first 15 instruments have been selected from conceptual proposals submitted by groups from around Europe. These instruments present numerous challenges for detector technology in the post Helium-3 crisis era, which is the default choice for neutron detectors for instruments built until today and due to the extreme instantaneous rates expected across the ESS instrument suite. Additionally a new generation of source requires a new generation of detector technologies to fully exploit the opportunities that this source provides.

During 2016, all the instruments have had the initial scope of the instrument determined within the construction phase of ESS. The current baseline detector requirements is presented. A strategy outline as to how these requirements are being tackled by is shown, as well as ongoing developments. A particular feature of the instruments is a dramatic increase in channel count.

In particular for ESS, over half of the detectors will be based upon thin film converters of ^{10}Boron Carbide. The highlights of the developments so far over the past 6 years are shown. In particular, examples of how these have been tested to determine that scientific requirements are met are shown, based upon demonstrating key aspects of scientific performance. Additionally for the first time, simulation of detailed detector and instrumental performance has been used to refine and determine the detector design. The state of the art of these simulation techniques is shown as well as future prospects.

Many of the lessons and experiences during these development since 2010 are relevant to future detectors for PIK instruments.

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Development of Neutron Detectors for the Spectrometers of the IBR-2 Reactor

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The different types of instruments for condensed matter investigation on the external beams of the IBR-2 pulsed research reactor in Frank Laboratory of Neutron Physics of Joint Institute for Nuclear Research (FLNP JINR) require different neutron detectors for them. This leads to the necessity of developing a variety of detectors in the Laboratory that are used in experiments. The neutron detection systems developed and used at the instruments on the external beams of the IBR-2 pulsed research reactor (gaseous 3He based detectors: 1D and 2D detectors (MWPC), "ring" detectors; 6Li scintillator based detectors with wavelength shifting fibers, detectors and monitors with solid 10B converters etc.) as well as the current status and projects carried out at FLNP on development of detectors and data acquisition systems will be presented.

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Sample Environment for Diffraction

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Diffraction techniques (either photons, electrons or neutrons based) are located at the forefront of the characterisation for new materials. Compared to lab-based sources the distinct features of neutrons make neutron diffraction a unique tool for structure investigations in various classes of materials. At the moment, diffraction studies at ambient conditions contain a minor portion of the beamtime for diffractometers at large scale facilities and are usually employed in the field of synthetic chemistry, i.e. new materials, where robotics is actively used for sample change. The applied materials tend to be studied closer to their real operation/application conditions, e.g. ferroelectrics at high electric and magnetocalorics at high magnetic fields, materials for electrochemistry *vs.* electrochemical potentials, membranes for SOFC at high temperatures and diverse gas atmospheres/pressures *etc.*

Features of neutrons along with the recent developments in neutron optics enable neutron diffraction to deliver high-quality experimental data at unique and somewhat extreme environmental conditions typically ranging from mK to thousands of K, different and often aggressive gas atmospheres, hundreds kbar pressures, strong tension/torsion forces *etc.* In the current contribution an overview of sample environments routinely used in neutron diffraction at neutron facilities all over the world will be presented and discussed in brief.

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Sample Environment for Inelastic Scattering

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The overwhelming majority of neutron spectroscopic experiments is carried out at non-ambient conditions for diverse reasons ranging from cooling the sample to improve the signal-to-noise ratio over situating the studied system into a precise point on its phase diagram to "playing" with its hamiltonian. The latter case, consisting e.g. in applying magnetic fields to quantum spin systems, calls for magnet performances at the edge of technical possibilities and for a careful non-magnetic design of the spectrometers. The equipment used in most other cases is usually less demanding to its environment. Here a pool management and sharing among a number of instruments, not reserved to inelastic scattering only, is a serious option calling for design standardisation of the devices as well as of the neutron instruments themselves. A common denominator for extreme sample environment conditions are restrictions on the maximum sample size, making spectrometer layout with a well optimised focusing geometry an important asset. In this lecture we will review the typical repertory of sample environment devices together with examples of good practices and pitfalls in the related instrument design.

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Sample Environment for Reflectometry

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For hard matter samples the sample environment (SE) is covering a huge number of different fields, starting from a simple sample holder for normal ambient conditions to SE used for in situ growth of a thin layer by beam epitaxial growth or pulsed laser deposition. In between is a wild zoo serving all the different scientific investigation on your instrument. In soft matter and biology, it is not less diverse starting by simple liquid cells reaching to a set of such cells moved into the beam by a sample changer and filled by externally controlled pumps and valves starting a chemical reaction studied in situ by neutrons.

Most of the sample environment is bought from the shelf and luckily the variety is huge and most of the time it is pushed button ready for daily use. Additionally we have sample environment developed in collaboration or purely by users themselves dedicated to a single scientific question.

All these SE devices have to be adapted to the individual environment of the reflectometer where it is going to be used, for simple geometric constraints, influence of magnetic fields to the rest of the instrument, maximum load of the sample table, *etc*.

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Engineering Challenges in Single Crystal Neutron Diffraction

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Neutron single-crystal diffraction is the tool of choice to determine the accurate positions of hydrogen atoms in solids and the arrangements of magnetic moments. Since neutron fluxes are low compared to those available at synchrotron X-ray facilities, there has been a major effort to maximize the exploitation of the available scattering d ata. To achieve this much emphasis has been recently placed in the provision of large area detector systems. The best performing single crystal diffractometers, like D19 diffractometer at the ILL, being equipped with a 120° x 32° multiwire proportional counter provides very high data quality for crystallographic work in structural chemistry and physics. Slightly less precise single-crystal Laue method has been implemented by using large area of neutron-sensitive image plates on Koala (ANSTO) and using CDD camera on CYCLOPS (ILL). Finally the 5C1 diffractometer at the LLB which combines a large area detector and a hot polarized neutron beam shows an unprecedented efficiency in the measurement of spin densities. When constructing a large area diffractometer a special attention should be paid to the modern sample environment. This includes superconducting magnets, cryostats, 3He dilution inserts, photo -excitation devices. In the talk a review of all these various instrumental aspects will be given.

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Dilatometer for Neutron Diffraction *in-situ* Investigations

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Analysis of new advanced materials and their processing properties often requires investigation under high temperatures and forces. Current equipment for fast and controlled cooling/quenching experiments does almost not exist, but is desirable to mimic industrial material processing, because the heating and cooling rates significantly influence the resulting microstructure and/or the formation of precipitates and thus determine mechanical properties. Therefore, a DIL 805A/D quenching and deformation dilatometer (TA Instruments, Hüllhorst, Germany), enabling precise temperature control during heating and cooling as well as in tension or compression tests, has been modified for use at the HZG neutron instruments at MLZ. Such a modified dilatometer is currently in use at a HZG synchrotron beamline at PETRA III, DESY (Hamburg, Germany) demonstrating attractive possibilities for *in-situ* investigations. As synchrotron and neutron radiation offer different contrast properties, having both opportunities delivers the largest benefit. One of the experiments that require neutron diffraction is an investigation of the ordering and disordering beta phase transformation in TiAl alloys. We will present more details of this research project. In addition, other selected future investigations taking advantage from the neutron dilatometer at the instruments STRESS-SPEC and SANS-1 at MLZ and few recent synchrotron investigations will be shown.

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Present Status of Neutron Scattering Environments at Low Temperatures

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Today neutron scattering experiments at low temperatures are standard at most neutron scattering facilities. Basically there are two approaches to reach temperature down to 50 mK. So called dry and wet systems. I will show both princples with their techniques and advantages and disadvantages.

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High Pressure Cells for Neutron Scattering

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A number of high pressure clamp cells (HPCC) was made magnetic and nonmagnetic for diffraction, inelastic and SANS at RT and LT down to 100 mk and H up to 10 Tesla. For HPCC from TiZr alloy for powder diffraction the maximum pressure rise is 15 kbar. The 2-layer nonmagnetic HPCC up to 40 kbar for studing single crystal by polarized neutrons were used. The maximum pressure of 2-layer and 3-layer HPCCs for inelastic neutron scattering studies on powder is 17 kbar and for single crystals is 33 kbar. Today, the nonmagnetic HPCC for SANS have max. P of 14 kbar. Pressure mediums used Fluor inert: FC77, FC75 and FC84/87-mixture. Some of the HPCCs have hard steel outer support and hard inner thin cylinder [1]. Other HPCCs made from hard Al, CuBe, TiZr, Ti and NiCrAl alloys [2].

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2. R.A. Sadykov, Th. Strassle, A. Podlesnyak, L. Keller, B. Fak, J. Mesot. Journal of Physics: Conf. Series 941 (2017) 012082 doi :10.1088/1742-6596/941/1/01208.

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Pulsed Laser Deposition Cell for *in-situ* Experiments with Neutron Reflectometry

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Phenomena and effects on interfaces and in individual atomic layers play a key role in the modern material science, especially in the field of nanotechnologies (nanoelectronics, photonics, plasmonics, *etc.*). The pulsed laser deposition (PLD) technique is a versatile tool with a capability of using a wide variety of materials to produce such structures. Neutron radiation offers a unique possibility for *in situ* investigation of multilayer thin films growing processes and for investigation of the as-grown structures. In particular, the method of spin-sensitive neutron polarization reflectometry (NPR) (in the low temperatures (<15 K) and high magnetic fields (>1 T) is extremely sensitive for the structural and magnetic properties of materials.

Drawing on our own in situ PLD experience at synchrotrons and neutron facilitates and in view of the very wide range of scientific tasks that can be solved by such approach, we have developed a series of mobile PLD setups for various in situ and in vacuum synchrotron and neutron techniques. All devices have a mobile configuration and have to be compatible with the existing and future beamlines and instruments. In the presentation, we will give an overview of the experimental chambers and concepts and their application fields.

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Neutron Scattering Experiments under Illumination and with Time-Resolution

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The structure-dynamics-function relationship in proteins is still a field of great scientific interest. Photoactive proteins form a specific c lass, whose function can be activated by i llumination. Depending on application, samples can be activated by permanent illumination or by light pulses in time-resolved experiments. Subsequently, modulated structure and dynamics can be observed *e.g.* by small angle and quasielastic neutron scattering (SANS and QENS, r espectively). Illumination of samples, with and without time resolution, requires a dedicated setup with light source, focusing optics, optical fiber, and active cooling of the sample in order to prevent efficient back-transfer to the ground state. Time-resolved experiments impose further needs, *e.g.* temporal synchronization of actinic light pulse and neutron probe as well as selective data storage. We will discuss the examples of Orange Carotenoid Protein and Bacteriorhodopsin.

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Modernization of Sample Environment Systems on IBR-2 Reactor Spectrometers in FLNP

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At present, many spectrometers of the IBR-2M reactor have carried out a comprehensive modernization of the control systems and management of experimental facilities.This paper presents the main approaches to the construction of control systems at the IBR-2M.

To connect the spectrometer hardware to PC the USB-RS485/232 interface is used.
Control system of executive mechanisms is based on interface RS 485. AC4 USB-RS485 adapter (OWEN) communicates with a PC via the RS485 group up to 32 stepper motor controllers OSM42 or OSM88 (Onitex) by RS485 link.Data acquisition system from sensors is also based on the RS485 interface. AC4 adapter communicates with a PC via the RS485 group up to 32 controllers LIR915 (SSI-RS485, "SKB IS"). Controllers LIR915 are used for information retrieval from the absolute multi-turn angular sensors MCD (FRABA Inc.).
To connect devices with RS232 interface to the RS485 line. RS485-RS232 converters are used. As part of spectrometers temperature controllers such as LakeShore (LakeShore Cryotroniccs Inc.) is used, DT670 sensors and thermocouples as E and K.

This paper presents examples of successful modernization of sample environment systems of the IBR-2M spectrometers.

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A New Linear and Ring Neutron Scintillation Detector Based on SiPM and Lightguides

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We developed linear neutron detectors based on ZnS/LiF scintillators and solid-state photomultipliers (SiPM) for neutron intruments. The developed detectors use for light readout a lightguide with diffuse reflection. The light readout by this method is more effective than the wavelenght shifting fibers - up to 80 photoelectrons. These detectors are successfully tested on time-of-flight diffractometers at spallation sources IN-06 and RADEX of INR RAS. The efficiency of thermal neutrons registration can reach 70%. Due to the miniaturized sizes of photodetectors, these detectors can be connected to systems with a large sensitive area, including curved ones. It is also possible to create multi-layer detectors to increase efficiency. The proposed schemes will make it possible to create highly efficient, compact and lightweight detectors that do not require high voltage (because used solid-state photomultipliers).

A ring neutron detector for time-of-flight diffractometers with minimal blind areas has been developed based on this linear scintillation detectors. Also we developed neutron counters with trapezoidal lightguide. A ring detector based on these counters has no blind areas.

These detectors have proved to be an effective and inexpensive alternative to helium-filled detectors.

Poster session / 7

Development of the Data Acquisition System Electronics for the Project of Wide-Aperture Backscattering Detector for the HRFD Diffractometer at the IBR-2 Reactor

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In the framework of the project for "Development of Experimental Facilities for Condensed Matter Investigations with Beams of the IBR-2 Facility" a wide-aperture backscattering detector for the HRFD diffractometer is being developed in FLNP.
Creation and operation of the new detector will result in a significant increase in the recorded data flow, which, in turn, requires further development of the data acquisition system.

Today, DAQ systems consisting of two types of blocks are being used to collect and accumulate data from an array of point detectors operating on IBR-2 spectrometers: one digital, capable of recording and accumulating data from 1 to 240 point detector elements, and several 32-channel analog blocks that receive, discriminate, convert, and transmit signals from the detector preamps to the MPD-240 digital unit. For communication with the computer the fiber optic transceiver of the unit together with the USB2.0 interface are used.

The new DAQ architecture based on the upgraded MPD-32 units that include 32-channel discriminators with a digital coding part, high-speed interconnection interfaces, and the computer interface USB3.0 is suggested. The developed system will allow a 50 times increase of the bandwidth of the data acquisition system and will satisfy the new requirements.

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Instrument Control Software at the IBR-2

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The presentation will de devoted to the software package Sonix+, which has been developed as a unified control software for neutron instruments. It has been installed at almoust all instruments of the IBR-2 reactor, as well at some instruments at other centers of the Russian Federation (totally about 20 installations). The modular organization of the software and use of the Python language for describing the experiment script make it relatively easy to adapt it to the specific features of various instruments.

The universal GUI based on the set of PyQt widgets can be used to control the experiment without further refinement. It provides all the necessary functions, including, preparing a task for the experiment, launching it, monitoring the current values of the parameters, and spectra visualizing. In addition, there are an instrument tuning program and other useful tools.

The WebSonix service is devoted for remote measurement supervising and instrument control. It includes the central website and modules for communication with instrument control computers. Service was designed as a universal tool and can be easily adapted to the specific features of any instrument.

The Journal system provides automatic data logging of measurements.

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Study of the Heat Flow Due to the Heat Exchange Gas in a Shaft Cryostat Based on GM

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On the basis of developments of top loading cryostats ([1], [2], [3]) a horizontal loading cryostat for cryomagnetic research at the diffractometer DN-12 of IBR-2 [4] had been developed. In this regard, it is necessary to study the value of the heat flow associated with the heat exchange gas in the horizontal shaft. For this purpose an express GM cryostat has been performed. This cryostat has a stainless tube shaft and a copper thermal bridge. The cryostat can be rotated 180 degrees relative to the vertical axis.
Heatinflow which is introduced by helium heat exchange gas in the shaft of the angle of inclination and pressure have been investigated.

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3. Budagov J.A. *et al.* 2008 JINR Communication E13-2008-110.
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Session IV: Engineering for advanced instrumentation: Mechanical construction / 11

Mechanical Design in Neutron Instrumentation

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The Forschungszentrum Jülich (FZJ) has a long history in neutron scattering. Today the Jülich Centre for Neutron Science (JCNS) is developing and operating several instruments at different outstations. The most important is the FRM II in Munich.

The talk will start with an overview on the engineering and manufacturing infrastructure at the FZJ. The scientific institute JCNS is strongly supported by the engineering institute ZEA-1 and JCNS's in-house workshop using a broad range of engineering and manufacturing tools.

The two most recent instruments developed for FRM II are the thermal time-of-flight spectrometer TOPAS and the time-of-flight powder diffractometer POWTEX. The mechanical design of both instruments will be presented. After a brief overview, some specific requirements will be described followed by the detailed presentation of chosen solutions in the design, prototyping and manufacturing.

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Minimizing Activation, Size and Costs and Yet Maximizing Efficiency – a Challenge for Engineering of Instruments for Research Using Neutrons

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Engineering in the field of research with neutrons is a great challenge due to the materials which come into contact with neutrons and thus become radioactive.

The selection of suitable materials is essential: They have to a) guarantee the required functionality in each component of an instrument and b) minimize its activation at the same time.

In neutron research facilities shieldings are necessary to reduce the background of neutron and gamma radiation as far as possible in order to perform high quality measurements and to meet the radiation protection requirements. These constitute yet another challenge for the engineers as well as floor load limits in the available space. In addition, the cost factor must not be neglected.
An overview of suitable engineering materials as well as different designs of shielding elements will be presented and explained in detail as well as unexpected challenges, unconventional solutions and lessons learned.

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Engineering and Sample Environment of SANS

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PA20 is the last SANS instrument built at LLB and opened to user community in 2015. The main components of PA20 such as the monochromation, the collimation, the sample area and the detection, will be described into details with emphasis on the engineering design choices and its specificities.

Also the sample environments proposed by the instrument in daily use will be presented with their characteristics and their impact on the instrument design.

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PIK Reactor Neutron Guide System

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The construction of the high-flux PIK reactor is coming to the final stage. Its neutron guide system design is almost frozen and will be presented in details during the talk. The reasons behind design choices will also be discussed.

The guide system is fed by 2 beam tubes: one equipped with cold neutron sources and the other is thermal one. In total 13 cold and 5 thermal instrument will use neutron beams provided by the neutron optics. All guides were optimized with respect to the instrument beam requirements and many geometrical constraints. Some special features like a special guide tilting the beam will be discussed as well as future opportunities for further system expansion.

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Neutron Optics

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Neutron optics are currently used to define neutron beam properties at the sample position (direction, divergence, energy, resolution, polarization, *etc.*). Since the primary neutron flux is low, optical devices have to be highly efficient. Main concepts and components for designing the optics of neutron instruments are presented. It includes reflection optics such as neutron guides and supermirrors but also diffraction optics with mosaic crystal monochromators and a nalyzers. Neutron filters that are used to remove unwanted radiation from the beam are briefly described.

New instruments require neutron optical devices enabling experiments under extreme conditions to be performed. As a direct consequence, neutron optics should be then capable to efficiently focus large beams into very small volumes at the sample position. Vertical focusing may lead to huge gain factors in neutron flux, up to more than ten, depending on the geometrical compression. Therefore, focusing devices are also dealt with, in detail, in the presentation.

Some examples of applications in the field of neutron optics at the Institut Laue-Langevin are given.

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Polarizing Neutron Optics

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Polarizing neutron optics found numerous applications in polarized neutron techniques. Stacks of bent polarizing supermirrors on thin substrates are used as multichannel polarizers and analyzers (“benders”). Solid state benders were also designed and can be made quite compact. Highly polarized white beam is produced by successive reflections from two polarizing supermirrors/monochromators. They can be used to polarize the beam without changing its direction. To meet this end, S-shaped benders and transmission polarizers (V-cavity, multichannel V-cavity, transmission bender, compact V-bender) are also designed. Since the apertures of the collimation slits and the detector are quite different, the design of polarizers and analyzers often differ. A wide-angle analyzer can be built with numerous benders turned with respect to each other or by using tapered channels (fan analyzers). The fan analyzers with the geometry of straight or curved channels can be used, depending on the instrument requirements. Inverting the geometry, one can develop a focusing polarizer. Neutron spin optics was recently proposed to widen the functionality of neutron optics. NSO devices may play an important role in developing alternative schemes of measurements, especially with small samples, which are often of special interest.

The contribution was supported by the Federal target program of Ministry of Education and Science of Russian Federation (project No. RFMEFI60717X0194).

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PLCs for Neutron Instrument Control

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The Jülich Centre for Neutron Science (JCNS) at Forschungszentrum Jülich developed more than 10 neutron instruments during the last decade, which are operated at the JCNS outstations in Garching (MLZ), Grenoble (ILL) and Oak Ridge (SNS). In order to reduce development and maintenance efforts a completely standardized approach for the implementation of the control and data acquisition systems has been chosen. All software and electronics are based on a common framework called Jülich-Munich standard. Key components of the framework are the Tango process control software and the use of standardized industrial automation technology in the front-end. The presentation concentrates on the architecture and components in the front-end including Siemens S7 PLCs and ET200 decentral periphery systems as well as the fieldbus systems PROFINET and PROFIBUS.

Session VI: Engineering for advanced instrumentation: Electronics and Software / 18

Benefits from Standards in Instrument Control

Jens Krüger

TUM - Research Reactor FRM II

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Designing an instrument for scientific application for neutron scattering is a challenge, since every intrument must be more or less unique around the world to attract the scientists.
This uniqueness leads often to a "unique" instrument control.

The talk will show ways how to control these unique instruments with standard components.
The good selection of hardware and software for the instrument control is very important, since it must fulfil the requirements and should help to standardize the components.
The benefits of using standard components become really visible, if you have to create more than one instrument at the same time at the same place.

Session VI: Engineering for advanced instrumentation: Electronics and Software / 10

Electronic Design in Neutron Instrumentation

Klaus Bussmann

FZJ

Corresponding Author(s):

The neutron scattering instruments of the Jülich Centre for Neutron Science JCNS with all substations are continuously developed and improved. A key role is taken by motion control solutions that are tuned to specific requirements of science or developed as a standard for cross-instrumental tasks. Alongside with the mechanics, the electric motor with its different characteristics as an electromechanical converter and with the support of current control technologies is a central element for the automation of a neutron instrument. The development of new hard- and software products is extremely fast with short innovation cycles.

The talk "Electronic Design" shows the current tools to plan and implement JCNS-automation solutions with the focus on drive technologies and feedback systems with the connection to industrial components. In addition to the planning tools, an overview of the used motors with various encoder-systems is given as well the presentation of the implemented examples of motion control solutions, currently the vacuum control-system of the time-of-flight instrument TOPAS.

Feasibility studies for future neutron scattering instruments are also shown and a very short outlook on trends for new automation products is given.

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CREMLIN WP 4 Workshop:

Towards Recommendations on the state of the art user system for PIK:

International Workshop on Engineering for advanced neutron instrumentation and sample environment

Sunday - Wednesday, May 13-16, 2018
New Peterhof Hotel, St. Petersburg, Russia

Objectives:

This CREMLIN Workshop is devoted to bringing experts and practitioners in the field of neutron instrumentation and sample environment on site to the PIK reactor and share their knowledge with Russian and international instrument scientists and users.

The workshop is an event within CREMLIN WP4 "Science Cooperation with the PIK research reactor in the field of neutron sources", contributing to the main objective No. 3: To help in the development of a state-of-the-art supporting structure at the PIK reactor (sample environment and supporting laboratories, user access system, data management and storage, etc.)

Lead beneficiary: TUM. Related CREMLIN Deliverable: The discussions foreseen within this workshop will contribute to and sharpen the D4.5 "Recommendations on the state-of-the-art user system for PIK (DL: public)

Agenda

Sunday, 13 May 2018	**Arrival and transfer to the hotel** (check-in: no earlier than 2 p.m.)
Monday, 14 May	
8:00 – 8:45	**Registration**
8:45 – 9:15	**Welcome and Introduction**
9:15 – 9:45	**Overview:** Vladislav Tarnavich (PNPI*): Status quo of the mechanical construction at PIK*
 9:45 – 10:15 10:15 – 10:45	**Session I: Engineering for advanced instrumentation*: Detectors*** · Dimitry Ilyin (PNPI): *Neutron detectors at PNPI* · Thomas Wilpert (HZB): *Detectors for thermal neutrons detection based on Helium-3*
10:45 – 11:15	**Coffee Break and group picture**
 11:15 - 11:45 11:45 – 12:15	**Session I: Engineering for advanced instrumentation*: Detectors*** · Richard Hall-Wilton (ESS): *Boron-based thin film detectors at ESS ERIC* · Sergey Kulikov (JINR Dubna): *Development of neutrons detectors for spectrometers of the IBR-2 reactor*
12:15 - 13:15	**Lunch**
 13:15 – 13:45 13:45 – 14:15 14:15 – 14:45 14:45 – 15:15	**Session II: Standards for sample environment** · Anatoliy Senyshyn (FRM II – TUM) : *Sample environment for diffraction* · Jiri Kulda (ILL): *Sample environment for inelastic scattering* · Stefan Mattauch (JCNS – FZJ): *Sample environment for reflectometry* · Arsen Goukassov (LLB): Engineering challenges in single crystal neutron diffraction
15:15 – 16:00	**Coffee Break**
 16:00 – 16:20 16:20 – 16:40 16:40 – 17:00 17:00 – 17:20 17:20 – 17:40	**Session III: Special aspects of sample environment** · Victoria Kononikhina (HZG): *Dilatometer for neutron diffraction in-situ investigations* · Harald Schneider (ESS): *Present status of neutron scattering environments at low temperatures* · Ravil Sadykov (IHPP, Moscow*): High pressure cells for neutron scattering* · Alexander Goikhman (BFU Kaliningrad): *PLD Cell for in-situ experiments with neutron reflectometry* · Maksym Golub (Tartu University*), Neutron scattering experiments under illumination and with time resolution*
18:00 – 19:30	**Poster-Session I (Detectors and sample environment)**
20:00	**Workshop Dinner** (at the participants' own expense)
Tuesday , 15 May	
 8:30 – 9:00 9:00 – 9:30 9:30 – 10:00	**Session IV: Engineering for advanced instrumentation*: Mechanical construction*** · Peter Harbott (FZJ): *Mechanical design in neutron instrumentation* · Elbio Calzada (FRM II - TUM): *Instrument engineering* · Sylvain Désert (LLB): *Engineering and sample environment of SANS*
10:00 – 10:30	**Coffee break**
 10:30 – 11:00 11:00 - 11:30 11:30 – 12:00	**Session V: Engineering for advanced instrumentation*: Neutron components*** · Petr Konik (PNPI): PIK reactor *neutron guide system* · Pierre Courtois (ILL): *Neutron optics* · Nikolay Pleshanov (PNPI): Neutron polarizing optics
12:00 – 13:00	**Lunch**
 13:00 – 13:30 13:30 – 14:00 14:00 – 14:30	**Session VI: Engineering for advanced instrumentation*: Electronics and software*** · Harald Kleines (JCNS – FZJ): PLCs for instrument control · Jens Krüger (TUM): Benefits from standards in instrument control · Klaus Bussmann (JCNS - FZJ): Electronic design in neutron instrumentation
14:30 – 15:00	**Wrap-up**
15:00 – 15:30	**Coffee Break**
15:30 - 19:00	**Visit of th Peterhof Palace**
20:00 – 21:00	**Working Dinner and workshop close**
Wednesday, 16 May	**Departure**