Efficient Neutron Sources

Report of Contributions

https://indico.psi.ch/e/ens2019

Contribution ID: **1** Type: **Talk**

Tungsten as Spallation Neutron Production Target Material

Monday 2 September 2019 15:10 (20 minutes)

Tungsten is a good candidate material for spallation neutron production, which is driven by high energy proton beam. It has a high atomic weight and mass density which result in a high neutron yield, and can take intense proton beam thanks to its high melting point, high thermal conductivity and low physical sputtering yield. However, tungsten suffers from drastic degradation of its mechanical and thermal properties under primary proton and secondary neutron radiations already at above 0.1 dpa.

Pure tungsten has been chosen at European Spallation Source (ESS) as spallation target material. The tungsten will be irradiated by a 2 GeV pulsed proton beam with 4% duty factor. Each of 2.86 ms long beam pulse repeated at 14 Hz delivers 357 kJ to the spallation volume, causing temporal temperature increase of up to 100 oC in tungsten. A time averaged beam current of 2.5 mA induces a high radiation damage at a rate of up to 2 dpa per year. It is therefore important to understand the long-term radiation damage effects on tungsten, for a reliable operation of the target.

In order to support the ESS target design, an intensive research program has been executed to study the characteristics of tungsten which is subjected to particle radiations, in collaboration with PSI, Lund University, Darlana University and GSI. In this talk, we present the summary of findings obtained from this research program, which covers the studies of fatigue properties of unirradiated tungsten from various processing routes, characterization of the oxidation behaviour of tungsten in mildly oxidizing, irradiation induced changes in thermal diffusivity, hardness, ductility, and ultimate tensile strength. The obtained results should be valid not only for ESS target but also for other high-power tungsten targets in planning and in operation.

Poster back-up

No

Authors: LEE, Yongjoong (ESS); DAI, Yong (Paul Scherrer Institut); HABAINY, Jemila (LTH); Prof. IYENGAR, Srinivasan (Lund University)

Presenter: LEE, Yongjoong (ESS)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **2** Type: **Talk**

STUDIES ON REFLECTOR MATERIALS FOR COLD NEUTRONS

Neutron scattering techniques and neutron applications in general are powerful and well established tools for research in science and technology. However the tremendous potential of neutrons as a probe of matter or as a research object by itself is limited by the relatively low flux intensity of the neutron sources, as compared with photon sources. In addition, the different processes (production, slowing-down) and devices (moderators, transport systems, collimators, energy-selectors, detectors, etc.) reduce by several orders of magnitude the actual neutron intensity that eventually conveys the experimental information of interest. One of the research lines devoted to reduce part of those loses has been oriented to the search for efficient reflector materials, that may improve the efficiency of guiding surfaces or the actual reflection of neutrons on a containment walls to minimize their leakage. A large body of work has been done in the past, particularly concerning the interaction of slow neutrons with diamond nanoparticles. It has been demonstrated the high reflectivity of this material for UCN and VCN, and proposed that such capacity extends at higher neutron energies, thus bridging the reflectivity gap in the neutron spectrum [1, 2]. In this work we present calculations aimed at evaluating the performance of other materials that seem to behave as very efficient reflector for neutrons over the CN range, as compared with diamond nanoparticles.

[1] E.V. Lychagin et al., Nuclear Instruments and Methods in Physics Research A 611 (2009) 302–305

[2] V. Nesvizhevsky et al., Carbon 130 (2018) 799e805

Poster back-up

Author: Prof. GRANADA, Rolando (Argentine Atomic Energy Commission)

Presenter: Prof. GRANADA, Rolando (Argentine Atomic Energy Commission)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **3** Type: **Talk**

Neutrons for today and tomorrow –The HBS Project for compact accelerator based neutron sources

Monday 2 September 2019 14:00 (30 minutes)

Accelerator driven neutron sources with high brilliance neutron provision present an alternative to classical neutron sources of fission reactors and spallation sources to provide scientist with neutrons to probe structure and dynamics of matter.
The Jülich Centre for Neutron Science has started a project to develop, design and demonstrate compact accelerator driven high-brilliance neutron sources (HBS) as an efficient and cost effective alternative to current low- and medium-flux reactor and spallation sources. The HBS will consist of a high current proton accelerator, a compact neutron production and moderator unit and an optimized neutron transport system to provide thermal and cold neutrons with high brilliance. The project offers construction of a scalable neutron source ranging from university based neutron laboratory to full user facility with open access and service. Embedded within international collaboration with partners from Germany, Europe and Japan the Jülich HBS project will offer flexible solutions to the scientific.
We will describe the currents status of the project, the next steps, milestones and the vision for the future neutron landscape in Europe.

Poster back-up

Yes

Authors: GUTBERLET, Thomas (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH); RÜCKER, Ulrich (Jülich Centre for Neutron Science, Forschungszentrum Jülich); ZAKALEK, Paul (Jülich Centre for Neutron Science, Forschungszentrum); MAUERHOFER, Eric (Jülich Centre for Neutron Science, Forschungszentrum Jülich); CRONERT, Tobias (Jülich Centre for Neutron Science, Forschungszentrum Jülich); BAGGEMANN, Johannes (Jülich Centre for Neutron Science, Forschungszentrum Jülich); VOIGT, Jörg (Jülich Centre for Neutron Science, Forschungszentrum Jülich); DOEGE, Paul (Jülich Centre for Neutron Science, Forschungszentrum Jülich); RIMMLER, Marius (2Nuclear Physics Institute, Forschungszentrum Jülich); PODLECH, Holger (Institut of Applied Physics, Goethe University Frankfurt); BRÜCKEL, Thomas (Jülich Centre for Neutron Science, Forschungszentrum Jülich)

Presenter: GUTBERLET, Thomas (Helmholtz-Zentrum Berlin für Materialien und Energie GmbH)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **4** Type: **Talk**

Repent, the end is nigh or The uncertain future of the short pulse neutron sources

The ongoing refurbishment/optimization of the ISIS Target Station 1 (TS-1) target, reflector and moderators (TRaM) assembly is based on ISIS instrument scientists performance metric. The request coming from this metric is very simple: the degradation of TS-1 instruments time resolutions is completely unacceptable. This is understandable if we keep in mind that the short pulse (less than micro-second), accelerator-based, multi-instrument, spallation neutron sources (such as ISIS, JPARC and SNS) are basically the high–resolution machines. As a consequence of such a strong restriction, the source brightness gains are of secondary importance so it is not a surprise that expected ISIS TS-1 brightness (or efficiency) gain will be an insignificant few tens of percent [1].

Now, when planning for future ISIS-II neutron source is on the horizon, it is worth asking the question if the short-pulse facility is a viable option for a next generation of the accelerator-based, multi-instrument neutron sources. Or in other words, if the high-resolution is a blessing of short-pulse source, is it at the same time its curse in terms of the efficiency?

If we are looking for historical analogy, approximately half a century ago (around the time of the miscarriage of the Superconducting Super Collider project), the particle physics community has defined the future strategy in the field declaring three experimental frontiers: high energy frontier, high precision frontier and high sensitivity frontier. Over the years, this ultra-fine strategy has been silently moved aside (thanks to the success of the Large Hadron Collider) and replaced with the simple mantra: "Luminosity (raw power) is everything". Long pulse neutron sources (like ESS) "adopted"this as a basic idea and developed it into a concept which will assure their bright future. In this work, the possibility to do the same for a short-pulse neutron sources will be discussed.

[1] G. Škoro et al., Physica B: Condensed Matter 551 (2018) 381–385, https://doi.org/10.1016/j.physb.2017.12.060.

Poster back-up

No

Author: Dr GORAN, Skoro (ISIS Neutron and Muon Source, Science and Technology Facilities Council)

Presenter: Dr GORAN, Skoro (ISIS Neutron and Muon Source, Science and Technology Facilities Council)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **5** Type: **Talk**

Spectroscopy Requirements For New Neutron Sources

Tuesday 3 September 2019 12:00 (30 minutes)

In the recent past and at the present time, new ideas and concepts have emerged for new types of neutron sources and moderators. A short list of such ideas includes small scale accelerators [1], dimensionally reduced hydrogen moderators with much increased brightness [2,3,4], and liquid ammonia as a new moderator material [5]. In this contribution we look at the scientific requirements for such sources from the perspective of the neutron scattering instruments, specifically for spectrometers for quasi-elastic and inelastic scattering. Concepts and technologies for both direct and indirect geometry instruments are constantly evolving, and modern neutron optical beam delivery systems are being designed to take full advantage of the source developments. Current trends in spectroscopy include a drive to optimize for smaller samples, to use as many neutrons as possible (repetition rate multiplication), and to make neutron polarization available when needed. Regarding the optical transport from the source to the sample, we will discuss the relationship between moderator size and sample size, and optimized neutron guide illumination. We will also address the impact of the source frequency.

[1] U. Rücker et al., Eur. Phys. J. Plus 131 19 (2016).
[2] J. K. Zhao et al., Rev. Sci. Instrum. 84 125104 (2013).
[3] F. X. Gallmeier et al., Rev. Sci. Instrum. 87 063304 (2016).
[4] K. H. Andersen et al., J. Appl. Cryst. 51 264 (2018).
[5] E. B. Iverson et al., J. Phys.: Conf. Ser. 1021 012067 (2018).

Poster back-up

Yes

Author: Dr EHLERS, Georg (Oak Ridge National Laboratory)

Co-authors: Dr HUEGLE, Thomas (Oak Ridge National Laboratory); Dr GALLMEIER, Franz (Oak Ridge National Laboratory); Dr HERWIG, Kenneth (Oak Ridge National Laboratory)

Presenter: Dr EHLERS, Georg (Oak Ridge National Laboratory)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **6** Type: **Talk**

Large scale data analysis for the operations side of neutron scattering

Tuesday 3 September 2019 16:10 (20 minutes)

Recording neutron data on an event base is current state of the art, as is recording the data produced by the many sensors and probes (temperatures, pressures, voltages, etc.) distributed throughout both the neutron scattering instruments and the wider facility. The enormous archives of data present a great opportunity to apply large scale data analysis techniques to verify expected correlations and explore unexpected ones. In this presentation, I will describe some of our results in doing this, ranging from moderator poison/decoupler burnup monitoring to the nonlinear influence of the proton beam power on the neutron production[1] and instrument detector dead time identification. Furthermore, I will talk about the methods we have used so far, some of the more recent improvements, and present ideas of what might be possible once more sophisticated analysis methods are utilized.

[1] T. Hügle, E. B. Iverson, and F. X. Gallmeier, "Beam power nonlinearity: Twice the power, but not twice the neutrons?,"J. Phys.: Conf. Ser. 1021(1), 012070 (2018).

Poster back-up

Yes

Author: HUEGLE, Thomas (ORNL)

Co-authors: Dr GALLMEIER, Franz (Oak Ridge National Laboratory); Mr IVERSON, Erik (ORNL)

Presenter: HUEGLE, Thomas (ORNL)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **7** Type: **Talk**

High performance target for an accelerator driven neutron source

Tuesday 3 September 2019 16:30 (20 minutes)

The target development for compact accelerator driven neutron sources (CANS) for low energy and high current ion beams started to gain more attention with the upcoming high-brilliance neutron source (HBS) project and the SONATE project. It is in a similar state where the development for fission and spallation targets has been decades ago, namely fast changing and still with a large optimization potential.

The neutrons for a CANS are produced by nuclear reactions of light ions like protons or deuterons in the low MeV-range in a suitable target material. The cross sections for the neutron production depend on the particle energy, the particle type and the target material. For energies in the 10 MeV range, low Z-materials like lithium or beryllium (LENS, RIKEN) are generally used due to the high neutron yield. But by increasing the ion energy above 30 MeV, the performance of high Z-materials is improving and other target materials are becoming more favorable like tungsten or tantalum.

Within the HBS project we started to develop a high performance tantalum target for a 70 MeV proton beam and an average power of 100 kW. The choice of material and the target design circumvents many problems commonly used beryllium targets have. At the workshop on Efficient Neutron Sources, we will present the material and design choices we made for a high performance tantalum target.

Poster back-up

Yes

Authors: ZAKALEK, Paul (Jülich Centre for Neutron Science JCNS und Peter Grünberg Institut PGI JCNS-2,PGI-4: Streumethoden Forschungszentrum Jülich GmbH D-52425 Jülich, Germany); DOEGE, Paul-Emmanuel (JCNS, Forschungszentrum Jülich GmbH); BAGGEMANN, Johannes (Forschungszentrum Jülich); MAUERHOFER, Eric (Jülich Centre for Neutron Science, Forschungszentrum Jülich); GUTBERLET, Thomas (Jülich Centre for Neutron Science, Forschungszentrum Jülich GmbH); VOIGT, Jörg (Jülich Centre for Neutron Science, Forschungszentrum Jülich); BRÜCKEL, Thomas (Jülich Centre for Neutron Science, Forschungszentrum Jülich); RIMMLER, Marius (2Nuclear Physics Institute, Forschungszentrum Jülich); CRONERT, Tobias (Jülich Centre for Neutron Science, Forschungszentrum Jülich); Mrs BÖHM, Sarah (NET, RWTH Aachen University, 52062 Aachen, Germany); RÜCKER, Ulrich (Jülich Centre for Neutron Science, Forschungszentrum Jülich); Mrs LI, Jingjing (IEK, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany)

Presenter: ZAKALEK, Paul (Jülich Centre for Neutron Science JCNS und Peter Grünberg Institut PGI JCNS-2,PGI-4: Streumethoden Forschungszentrum Jülich GmbH D-52425 Jülich, Germany)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **8** Type: **Talk**

A next-generation inverse-geometry spallation-driven ultracold neutron source

Monday 2 September 2019 14:50 (20 minutes)

The concept of a next-generation spallation-driven ultracold neutron (UCN) source capable of delivering an integrated flux of about 1E9/s is presented. A novel "inverse geometry" design is used with 40 liters of superfluid 4He (He-II) as converter cooled with state-of-the-art sub-cooled cryogenic technology to ~1.6 K. Our design is optimized for a 100 W maximum thermal heat load constraint on the He-II and its vessel. We use a modified Lujan-Center Mark-3 target for UCN production as a benchmark, then present our baseline inverse geometry source design that gives a total UCN production rate of PUCN=2.4x10E8/s. In our geometry, the spallation target is wrapped symmetrically around the He-II volume and moderators to permit raster scanning the proton beam over a relatively large volume of tungsten spallation target to reduce the demand on the cooling requirements, which makes it reasonable to assume water edge-cooling is sufficient. Our design is refined in several steps to reach PUCN = 2.1E9/s under our other restriction of 1 MW maximum proton beam power. We also study effects of the He-II scattering kernel used and reductions in PUCN due to pressurization to reach PUCN = 1.8E9/s. Finally, we estimate the UCN transport efficiency to show that the total extracted rate out of the source can be Rex ≈ 6E8/s from a 18 cm diameter guide. These extracted rates are around an order of magnitude higher than the strongest proposed sources so far, and is around three orders of magnitude higher than existing sources.

Poster back-up

No

Authors: LEUNG, Kent (North Carolina State University); MUHRER, Guenter (European Spallation Source ERIC); HUEGLE, Thomas (Oak Ridge National Laboratory); ITO, Takeyasu (Los Alamos National Laboratory); LUTZ, Erik (North Carolina State University); MAKELA, Mark (Los Alamos National Laboratory); MORRIS , Christopher L (Los Alamos National Laboratory); PATTIE, JR. , Robert Wayne (Los Alamos National Laboratory); SAUNDERS, Alexander (Los Alamos National Laboratory); YOUNG, Albert (North Carolina State Univerisy)

Presenter: MUHRER, Guenter (European Spallation Source ERIC)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **9** Type: **Talk**

Technical parameters of exploitation a cold neutron source on mesitylene beads on IBR-2 nuclear research facility

Wednesday 4 September 2019 15:00 (20 minutes)

Abstract
Cold neutrons with wavelengths over 4 Å emitted by high-current neutron sources have been employed in physical research since the 1980s. The cold-neutron flux is enhanced by using neutron moderators cooled to low temperatures. In these, neutrons are retarded when passing through different substances such as water, heavy water, ice, paraffin, beryllium, liquid hydrogen, liquid and solid methane, and various hydrocarbons. A neutron gradually loses its kinetic energy through multiple collisions with the nuclei of the moderator material.
In a modernization of IBR-2 reactor in 2006 was project of creation a cold neutron source. The source included three combine moderators around a reactor core. Moderators have a similar principle of work but different configuration of head part. The combine moderator is a different technical construction witch consist of a cold chamber (20K –100K) for getting neutrons with long wavelengths and warm chamber (in some of it a water pre-moderator) for thermal neutrons. The substance for slowing neutrons on IBR-2 cold source was choose a mezetilene on solid phase and beads form.
In the presentation will be shown steps of creation the combine moderator of the "central"direction (CM201) of IBR-2 reactor on mezetilene pellets. Calculations and choosing a different various of configuration CM 201 moderator. Technical equipment for the moderator system. Experiment on full scale model of moderator CM201. Will be shown a dependent a neutron spectrum from temperature of moderator. The results of the test exploitation combine moderator (CM202).

Poster back-up

Yes

Authors: Mr ROGOV, Anatoly (Joint Institute for Nuclear Research); Mr SMELYANSKY, Ivan (Joint Institute for Nuclear Research); Dr MUKHIN, Konstantin (Joint Institute for Nuclear Research); Dr BULAVIN, Maksim (Joint Institute for Nuclear Research); Mr SKURATOV, Vitaly (Joint Institute for Nuclear Research)

Presenter: Dr MUKHIN, Konstantin (Joint Institute for Nuclear Research)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **10** Type: **Talk**

Nanodiamond application for Cold Neutron enhancement in Compact Neutron Sources

Wednesday 4 September 2019 15:50 (20 minutes)

Nanodiamond Particles (NDP) are new candidates for neutron reflection. They have a large scattering and low absorption cross-section for low-energy neutrons. Very Cold Neutrons (VCN) are reflected in NDP with large scattering angles while Cold Neutrons (CN) have a quasi-specular reflection at small incident angles. A new scattering process has been added in Geant4 in order to examine the directional reflection of CN in an extraction beam made of NDP layers. Impurities in NDP are responsible for the up-scattered neutrons, especially hydrogen which has a high scattering cross-section. Other impurities are also considered in Geant4 in order to produce a more accurate model of NDP scattering. The new scattering process was used to model possible configurations of target-moderator-reflector in compact sources. A typical beam of 13 MeV proton striking a Beryllium target was chosen. Para-hydrogen is placed as a cold moderator in order to produce CN. NDP are placed around the extraction beam for scattering the CN toward the exit of the beam. The results show that CN exiting the extraction beam can be increased thanks to the implemented NDP layer.

Poster back-up

Authors: Mr JAMALIPOUR, Mostafa (a. Dep. of Physics, University of Milano-Bicocca, Milan, Italy); Dr ZANINI, Luca (b. European Spallation Source (ESS), Lund, Sweden); Prof. GORINI, Giuseppe (a. Dep. of Physics, University of Milano-Bicocca, Milan, Italy)

Presenter: Mr JAMALIPOUR, Mostafa (a. Dep. of Physics, University of Milano-Bicocca, Milan, Italy)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **11** Type: **Talk**

ASSESSMENT OF THE EFFECT OF BURNOUT IN THE PULSE RESEARCH NEPTUNIUM REACTOR

Monday 2 September 2019 16:00 (20 minutes)

After modernization in 2011, the IBR-2 pulsed reactor at the Joint Institute for Nuclear Research has been successfully used by researchers from dozens of countries to carry out experiments on extracted neutron beams in solid-state physics. However, the capability of reactor operation is limited by the life-time from 2032 to 2035.Iin order to maintenance this area of research, it is necessary to create a new world-level neutron source by the mid-2030s. The pulsed neutron source, which is currently developed by the Joint Institute for Nuclear Research (JINR) is a research reactor of periodic action with nuclear 237NP nitride fuel.
One of the characteristics which determines the capability of the reactor operation is changing reactivity effect during the life-time. The change of reactivity is summarized from the negative effect of neutron absorption by the neptunium nucleus and the positive effect of plutonium-238 accumulation as a result of neutron capture by the neptunium nucleus. It is expected that the total reactivity effect in a neptunium reactor will be little or even positive, and its assessment depends on the library of neutron data used to calculate the critical state. The current paper describes assessment of the comparative effect for several of the most used databases (ENDF / B-VII.1, JEFF −3.2, JENDL −4.0, ROSFOND −2010, TENDL −2017, BROND −3.1) with energy spectrum of the neutron flux density in the Neptune reactor core, which was calculated using the MCNP5 package.

Poster back-up

Yes

Authors: Ms PROTSENKO, Elena (JINR); Dr SHABALIN, Eugene (JINR)

Presenters: Ms PROTSENKO, Elena (JINR); Dr SHABALIN, Eugene (JINR)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **12** Type: **Talk**

Neutron Radiography Imaging of Argon Bubble Flow in Liquid Gallium in External Horizontal Magnetic Field

Wednesday 4 September 2019 09:00 (20 minutes)

This work is dedicated to neutron imaging of two-phase liquid metal systems with relevance to theoretical and applied magnetohydrodynamics, as well as computational fluid dynamics. Specifically, argon bubble flow in liquid gallium in with and without the presence of external magnetic field is studied using high frame rate neutron beam transmission signal recordings obtained at the NEUTRA beamline, SINQ, PSI.

This is motivated by the fact that, among other non-invasive measurement methods available for liquid systems, optical measurements are impossible due to metal opacity, ultrasound Doppler velocimetry and transit time technique yield no information regarding bubble shapes and are imprecise in case of oscillating bubbles, while X-ray transmission methods are limited to thin liquid metal samples, which may not be representative of systems to which the probed small scale system is later upscaled. Neutron radiography allows one to potentially sidestep these issues and perform direct observations of phase distributions within metal flow.

Detailed data from such experiments would prove very useful in understanding the physics of multiphase flows, magnetohydrodynamic of otherwise, as well as for verification of numerical models. As such, the end goal of the study, a part of which this work represents, is to produce the tools that would enable as detailed and direct comparisons as possible between experiment and simulation.

The objective of the present work is to construct a robust image processing pipeline capable of extracting as much physical information as possible out of two phase flow snapshot series. The caveat is that, due to high bubble velocities and the required large field of view, the signal-to-noise ratio within the obtained images is inherently low. As a result, generating usable results is much less trivial and requires special considerations.

The first version of the developed neutron image processing routine is shown be sufficiently robust and capable of reliable recognition of bubble shapes and free surface of metal, performing velocimetry and analyzing data. This is verified by numerical simulations that reproduced the experimental setup *in silico*, where results are in good agreement with what is seen from the experiment and is expected from theoretical considerations.

Poster back-up

Yes

Author: Mr BIRJUKOVS, Mihails (University of Latvia, Department of Physics, Laboratory for Mathematical Modelling of Environmental and Technological Processes (VTPMML))

Co-authors: Mr DZELME, Valters (University of Latvia, Department of Physics, Laboratory for Mathematical Modelling of Environmental and Technological Processes (VTPMML)); Mr JAKOVICS, Andris (University of Latvia, Department of Physics, Laboratory for Mathematical Modelling of Environmental and Technological Processes (VTPMML)); TRTIK, Pavel (PSI Villigen); THOMSEN, Knud

(Paul Scherrer Institut)

Presenter: Mr BIRJUKOVS, Mihails (University of Latvia, Department of Physics, Laboratory for Mathematical Modelling of Environmental and Technological Processes (VTPMML))

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **13** Type: **Talk**

Neutron scattering on compact neutron sources

Tuesday 3 September 2019 14:00 (30 minutes)

Recent technical improvements in the accelerator and target technology coupled with the concept of compact moderator open the possibility to conceive efficient neutron source for imaging and neutron scattering base on low energy accelerators. This is the concept of the Compact Accelerator driven Neutron Sources (CANS). Low power tests and McStas simulations show that instruments installed on such a source may have similar performances than those available on medium flux research reactors [1]. Considering the high flexibility of a compact source design, we have now to consider the option of conceiving a source fully adapted to a single family of instruments having similar source requirements. Within such a concept, available CANS have to organized themselves in a strong collaboration process with the other ones in order to fullfill the broad band requests of the users.

[1] F. Ott et al. Performances on Neutron Scattering Spectrometers on a Compact Neutron Source, ICANS XXII, IOP Conf. Series: Journal of Physics: Conf. Series 1021 (2018) 012007

Poster back-up

No

Authors: MENELLE, Alain (Laboratoire Léon Brillouin, CEA Saclay); Dr OTT, Frédéric (Laboratoire Léon Brillouin, CEA Saclay)

Presenter: MENELLE, Alain (Laboratoire Léon Brillouin, CEA Saclay)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **14** Type: **Talk**

Neutron Noise and delayed neutron backgrounds at spallation facilities.

Tuesday 3 September 2019 14:30 (20 minutes)

Any discussion on neutron source efficiency should not only consider how to maximise the number of 'useful neutrons'at the sample but also how to minimize 'useless neutrons'.
It is well known that the lower power and thick shielding on ISIS target station 2 (TS2) results in very low backgrounds. This is one of several factors that allows a wide variety of instruments to produce world class science despite the relatively weak source strength. Background 'noise' can come from a large number of sources, such as sky-shine, target shine, instrument to instrument & sample environment etc. As a result of the effective shielding on ISIS TS2 some of these backgrounds are reduced to extremely low levels and the dominant and limiting backgrounds for some experiments becomes lesser considered backgrounds such as atmospheric neutrons or delayed neutrons. In this work we will outline recent work on ISIS TS2 to measure delayed neutrons and photons after it was found they may be limiting some low contrast reflectivity measurements. Whilst delayed neutrons may be relatively familiar issue in a reactor they are less well known from spallation facilities. In fact the term delayed should not be taken to imply delayed fission neutrons but instead to simply mean neutrons not linked in time to a proton beam pulse. The main cause is likely to be photo neutrons as a result of high energy gamma ray interactions in the target reflector and moderator. The beryllium reflector in particular has a low threshold for photo nuclear interactions. The work includes neutron and gamma measurements as well as neutronics simulations to both attempt to measure and explain the delayed neutrons at ISIS.

Poster back-up

Yes

Authors: LILLEY, Steven (STFC); Dr CAZZANIGA, Carlo (STFC); Dr KANE, Christy (STFC)

Presenter: LILLEY, Steven (STFC)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **15** Type: **Talk**

Simulating neutron tracks in the new TS1-TRAM at ISIS with FLUKA code: some insights towards an optimised and more efficient target-moderator-reflector assembly for high power spallation sources

Monday 2 September 2019 16:20 (20 minutes)

In 2020 the ISIS Target Reflector and Moderator assembly (TRAM) at target station 1 (TS1) will be replaced with a new design incorporating lessons learnt from the design of the ISIS 2nd target station with a particular focus on maintainability. The new TRAM will be made up of a 10 plate Tantalum clad Tungsten target, 2 water moderators in the upper part,2 cryogenic moderators (liquid Methane and liquid Hydrogen respectively) in the lower part and a solid Beryllium reflector.

A detailed FLUKA model of the new TS1 TRAM at ISIS has been built and used to get both scientific and engineering relevant information, such as: neutron and other secondary particle production, energy deposition profile, particle fluence energy spectrum, decay heat, overall radionuclide inventory etc.
The comparison between the FLUKA predictions and the corresponding MCNPX simulations has been performed for several physical quantities (i.e. spatial profile of energy deposition in each TRAM region, decay heat, moderators brightness), showing a generally good agreement (within the statistical accuracy) with only few exceptions.
Exploiting an advanced use of the FLUKA code, it has been possible to track the TRAM escaping neutrons in such a way to assess quantitatively the contribution of the different target plates to the overall neutron leakage as well as the effective contribution of the water moderators to a couple of ISIS-TS1 instrument beam lines. The results of these calculations provide some useful hints that could help to address a more efficient design of the whole target-moderator-reflector assembly for high power spallation source.
A general overview of the work done will be given and the most relevant results will be discussed.

Poster back-up

Author: Dr QUINTIERI, Lina (Rutherford Appleton Laboratory-STFC-UKRI)

Co-author: STEVEN, Lilley (Rutherford Appleton Laboratory-STFC-UKRI)

Presenter: Dr QUINTIERI, Lina (Rutherford Appleton Laboratory-STFC-UKRI)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **17** Type: **Talk**

Moderator Choices for SNS Second Target Station (STS)

Wednesday 4 September 2019 14:00 (30 minutes)

Moderator performance is impacted by the choice of moderator materials, the moderator size and temperature, position with regard to the neutron production zone, the moderator environment including pre-moderator and reflector material choices and sizing. The neutron production zone is defined by the proton beam characteristics such as beam energy, beam footprint and profile, beam power and pulse length, and the target characteristics such as element atomic number, material density, target dimensions, and the choice of the cooling medium and its volume fraction. Many of the choices are constrained by engineering considerations such as for temperature, stress, material fatigue requirements, the need of heat removal, radiation-induced material degradation, and the requirement of safely containing the high radionuclide activity at all times at any operational scenario. Considering all options and constraints, STS, a short-pulse spallation source of 700 kW power at 15 Hz repetition rate, is best served by liquid para-hydrogen moderators pre-moderated with ambient temperature light water and placed in wing arrangement relative to a solid tungsten rotating disk target and surrounded by beryllium reflector. Two moderators located above and below the target disk illuminate the 22 neutron beam lines. Moderator geometries have been identified that provide the highest brightness of cold neutrons to the neutron scattering instruments which is the core strength of STS. Neutronics design analyses are presented to show the concept and performance of the moderators.

Poster back-up

Yes

Authors: Mr GALLMEIER, Franz X. (Oak Ridge National Laboratory); Mr REMEC , Igor (Oak Ridge National Laboratory)

Presenter: Mr GALLMEIER, Franz X. (Oak Ridge National Laboratory)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **18** Type: **Talk**

Boron-10 based Neutron Detectors at ESS

Tuesday 3 September 2019 14:50 (20 minutes)

In Lund, Sweden, the European Spallation Source (ESS) is currently under construction. In order to cope with the expected high neutron fluxes at ESS and reduce the dependence on Helium-3 gas, which future availability is uncertain, alternative neutron detector technologies are being developed. Here we present an overview of a new generation of neutron detectors for neutron scattering based upon boron carbide thin films, presenting a summary of some of the most recent developments from the ESS Detector Group and Collaborators. The focus will be on the Multi-Grid and Multi-Blade detectors, explaining their working principles and presenting the most recent update on the performance of the Multi-Grid detector. The detectors were first conceptualized at ILL. Thereafter the Multi-Grid design was jointly developed by ILL and ESS, and the the Multi-Blade design jointly by ESS, Lund University, Perugia University and Wigner Institute. Both detectors use boron carbide films coated on Aluminum sheets, and the coating technology of the thin films has been a core part of the work. Neutrons are detected using the neutron capture reaction in Boron-10 coupled with a Multi-Wire Proportional Chamber (MWPC). The two detectors are intended for different instruments within ESS, the Multi-Grid for Spectroscopy and the Multi-Blade for Reflectometry. The Multi-Grid has been developed based on the requirements for the upcoming CSPEC (Cold Neutron Spectroscopy) and T-REX (Thermal Neutron Spectroscopy) instruments at ESS. For these, large area detectors are needed, which is one of the main design parameters for the Multi-Grid. Conversely, the Multi-Blade is a small area detector, were the demand instead concerns beyond the state-of-the-art count rate capabilities and position resolution. These demands are based on the requirements for ESTIA and FREIA instruments. It was found that the performance matches or outperforms Helium-3 based detectors. Furthermore, by demonstrating the technology on the current state of the art instrumentation, the scientific performance for the instrument class intended could be evaluated. Using these new technologies, the Helium-3 needs for ESS can be reduced by over 90 %, while at the same time the ESS instruments requirements for detectors can be achieved and the cost of neutrons detectors reduced. Finally, this new development path for neutron detectors enable future performance gains to be anticipated.

Poster back-up

Yes

Author: Mr BACKIS, ON BEHALF OF THE DETECTOR GROUP AND COLLABORATORS, Alexander (European Spallation Source)

Presenter: Mr BACKIS, ON BEHALF OF THE DETECTOR GROUP AND COLLABORATORS, Alexander (European Spallation Source)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **19** Type: **Talk**

Deuterated clathrate hydrates for neutron moderation and reflection in future high-flux sources of very cold neutrons

Wednesday 4 September 2019 14:30 (30 minutes)

Fully deuterated clathrate hydrates are a promising class of materials for diffuse neutron reflection and for moderation to much lower energies than current cold neutron sources. These inclusion compounds are available with a variety of weakly neutron absorbing guest molecules. Due to their large unit cells they offer better diffusion properties than common reflector materials within a much larger cold-neutron wavelength range up to 2 nm (Clathrate Structure II) or 2.4 nm (CS I). There, they outperform not only graphite or beryllium, possessing much smaller Bragg cut-offs and larger absorption, but also the best imaginable nanostructured materials. Local modes of the guest molecules offer interesting opportunities for neutron moderation. They provide incoherent inelastic scattering channels able to remove kinetic energy stepwise from the neutron, without being suppressed due to typical low densities of phonon states at low energies, as there are no kinematic restrictions due to dispersion relations. Inelastic magnetic scattering in fully deuterated O2-clathrate hydrate has recently been identified as a promising moderator material [1]. It possesses an experimentally established non-dispersive inelastic neutron scattering signal with 0.4 meV energy transfer due to the zero-field splitting of molecular oxygen. Based on calculated cross sections for magnetic neutron scattering and a stationary neutron transport equation for an infinite, homogeneous medium with Maxwellian neutron sources, strong cooling effects are to be expected, requiring only ordinary liquid-helium temperatures, no external magnetic field and no neutron polarisation. An experimental program has been started at the ILL to measure S(q,omega) in absolute units not only for this material but also for other clathrate hydrates to investigate the strength of various molecular rotational and local translational modes. The goal is to establish a data base for a realistic modelling of moderator/reflector geometries in novel neutron sources.

[1] O. Zimmer, Neutron conversion and cascaded cooling in paramagnetic systems for a high-flux source of very cold neutrons, Phys. Rev. C 93, 035503 (2016)

Poster back-up

No

Author: ZIMMER, Oliver (Institut Laue Langevin)

Presenter: ZIMMER, Oliver (Institut Laue Langevin)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **20** Type: **Talk**

Imaging nested-mirror assemblies for efficient beam transport with tailored spectra

Tuesday 3 September 2019 10:30 (20 minutes)

A mirror system for neutron transport with high brilliance transfer from a source or a divergent beam to an instrument is presented. The assembly of nested short elliptical (or very short flat) mirrors located halfway between two common focal points M and M' images cold neutrons by single reflections from an area around M onto an area of similar size at M'. An absorber on the straight line MM' blocks the direct view onto the source, with little impact on the transported solid angle. The simple geometry with well-defined, non-grazing angles of reflection off the individual mirrors opens up versatile possibilities to tailor beam size, divergence, wavelength spectrum and polarization to experimental needs. A common small-wavelength cut-off of the transported spectrum can be set by proper choice of the m values of supermirrors. Monochromatic beams can be generated using bandpass supermirrors. Adjustable apertures far away from the instrument define the size and the divergence of the beam at the sample, thus keeping background radiations low. The absence of mirrors in the harsh radiation environment close to an intense source simplifies the maintenance of beam tubes and increases mirror lifetimes.

[1] O. Zimmer, Imaging nested-mirror assemblies –A new generation of neutron delivery systems?, J. Neutron Res. 20, 91-98 (2018)

Poster back-up

No

Author: ZIMMER, Oliver (Institut Laue Langevin)

Presenter: ZIMMER, Oliver (Institut Laue Langevin)

Session Classification: Talks

Track Classification: Neutron Guides

Contribution ID: **21** Type: **Talk**

Neutronic optimization for new neutron source in J-PARC

Monday 2 September 2019 12:10 (20 minutes)

In J-PARC, 3 GeV and 1MW proton beam induces a carbon target and a mercury target to provide muon beam and neutron beam, respectively. The facility, called the first target station, “TS1”, starts to operate from 2008 and operates with 500kW stably as of June 2019. As a future plan, the second target station, “TS2”, is being planned. TS2 has a tungsten rotating target to provide both neutron and muon, and higher neutron brightness are expected by adopting higher density of proton beam, closer moderators to the target, flatter moderator and so on. The rotating target cooled by helium gas is also expected to increase neutron and muon intensities with a coexistence of them. In order to provide high intensity neutrons, optimization studies of TS2 were performed. As a result, it preliminary indicates that the neutron brightness is increased 10 times higher than that of TS1.

Poster back-up

Author: Dr HARADA, Masahide (JAEA)

Presenter: Dr HARADA, Masahide (JAEA)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **22** Type: **Talk**

The SNS Moderator Test Station

Wednesday 4 September 2019 16:30 (20 minutes)

We describe a Moderator Test Station for the Spallation Neutron Source. We will leverage the Beam Test Facility (BTF) at the Spallation Neutron Source (SNS) to provide a moderator neutronics test stand with which we will verify the anticipated performance gains expected and required from innovative moderator concepts central to the SNS Second Target Station (STS), as well as pursue moderator upgrade concepts for the First Target Station (FTS) once the STS is available. These concepts include high brightness parahydrogen tube moderators, high volume parahydrogen moderators, single-crystal reflector-filtered moderators, and very cold neutron moderators, of interest for STS, liquid methane and ammonia at intermediate temperatures and controlled off-equilibrium spin distributions in liquid and supercritical hydrogen at low temperatures for FTS, and exotic moderator configurations of extruded continuously replenished solid methane or ammonia, pelletized mesitylene with liquid helium cooling, convoluted moderators, or spin-polarized moderator materials.

The SNS BTF, already operational, incorporates an ion source and a 2.5 MeV Radio Frequency Quadrupole (RFQ) substantially the same as the SNS front end. We will use a proton beam chopper similar to that already used in the SNS at the RFQ exit, various proton beam transport components, a neutron-producing lithium target, a cryogenic moderator test stand, a reflector-shielding assembly, and a performance assessment neutron beamline. The MTS will provide the ability to test large-volume and compact moderator concepts in a prototypic wing configuration, measuring the wavelength-dependent transverse brightness distribution with imaging detectors and wavelength-dependent emission time distributions with time-focused analyzer arrays of the moderator concept central to STS gains and FTS upgrades with significantly faster and in greater detail than at currently available test facilities. We here describe the planned layout of the Moderator Test Station neutron test beamline and moderator cryostat assembly, as well as outlining the current list of moderator configurations to be tested.

Poster back-up

Yes

Author: Dr IVERSON, Erik (ORNL)

Co-authors: Dr GALLMEIER, Franz (Oak Ridge National Laboratory); Dr GRAMMER, Kyle (Oak Ridge National Laboratory); Dr HUEGLE, Thomas (Oak Ridge National Laboratory); Dr LU, Wei (Oak Ridge National Laboratory); Dr REMEC , Igor (Oak Ridge National Laboratory)

Presenter: Dr IVERSON, Erik (ORNL)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **23** Type: **Talk**

First steps toward the development of SONATE, a Compact Accelerator driven Neutron Source

Monday 2 September 2019 14:30 (20 minutes)

Facilities providing bright thermal neutron beams are of primary importance for various research topics such as condensed matter experiments, neutron-imaging or medical applications. Currently these are mainly spallation sources and nuclear reactors. However, these later facilities are aging and the political context does not favor the building of new ones. This is the case in CEA-Saclay (France), where the Orphee reactor is planned to shutdown in 2019. Therefore, another local facility, affordable by one country, able to provide high brilliance neutron beams has to be built. At CEA-Saclay, a compact accelerator driven neutron source, SONATE, is investigated in taking advantage of the IPHI accelerator able to deliver a 3 MeV proton beam with an intensity up to 100 mA. In the future, SONATE is foreseen to operate with 20 MeV protons to increase the neutron brightness. In addition to the difficulties to operate such high intensity accelerators, the other challenges regard the target-moderator-reflector (TMR) design which is crucial to maximize the neutron flux at the detector location. At CEA-Saclay, with the IPHI accelerator several experiments were performed between 2016 and 2019 and Geant4 simulations are developed to demonstrate the feasibility and to find the best TMR configuration for the future SONATE facility. These developments will be reported as well as the future steps expected to be performed.

Poster back-up

No

Authors: THULLIEZ, Loïc (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); LETOURNEAU, Alain (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); CHAUVIN, Nicolas (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); SCHWINDLING, Jérôme (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); SELLAMI, Nadia (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); MENELLE, Alain (LLB, CEA, CNRS, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); OTT, Frédéric (LLB, CEA, CNRS, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France); ANNIGHÖFER, Burkhard (LLB, CEA, CNRS, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France)

Presenter: THULLIEZ, Loïc (IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **24** Type: **Talk**

Physical Design and Progress of Multi-purpose Physics Neutron Diffractometer of CSNS

Tuesday 3 September 2019 15:50 (20 minutes)

The multi-purpose Physics Neutron Diffractometer will be built at the China Spallation Neutron Source in the coming year. It is a time of flight diffractometer dedicated to the study of complex crystalline materials and the disordered materials by pair distribution function (PDF) technique. The MP diffractometer will be able to determine the PDF of the materials from atomic to nanometer scale. In this manuscript, we present the main physical parameters of this diffractometer through Monte Carlo simulation. In particular, the moderator choice, guide system, placement of the chopper system, the shielding design and the detector choice and its layout are investigated. The best momentum transfer resolution $\Delta Q/Q$ is expected to be 0.3% at the backscattering direction, the flux at the sample position is of the order of 107/cm2/s and the momentum transfer range from 0.1 to 50 Å-1. The construction progress of this diffractometer is also presented in the manuscript.

Poster back-up

No

Author: YIN, Wen (Institute of Physics, Chinese Academy of Science)

Presenter: YIN, Wen (Institute of Physics, Chinese Academy of Science)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **25** Type: **Talk**

EXPERIMENTAL NEEDS FOR NEUTRON SCATTERING METHODS IN THE CHARACTERIZATION OF NUCLEAR MATERIALS AND COMPONENTS

Wednesday 4 September 2019 09:20 (20 minutes)

This contribution will discuss some experimental needs for efficient utilization of neutron techniques to characterize nuclear materials, more specifically small-angle neutron scattering (SANS) and neutron diffraction. SANS provides fundamental information on micro-structural evolution under irradiation in structural materials; neutron diffraction is indispensable for stress measurements in nuclear welds and for monitoring crystallographic phase changes under thermo-mechanical treatments or irradiation. The utilization of these techniques in such complex fields is challenging, both concerning instrument development and needed flux. Namely, concerning SANS some of the main requirements can be summarized as follows: efficient handling of hot neutron irradiated samples (10-20 mSv/h), capability to investigate also miniaturized irradiated samples, developing polarized SANS for deep metallurgical characterization of magnetic steels, developing GISANS/reflectometry for thin ion irradiated samples. High spatial resolution is first of all needed for stress measurements in nuclear welds, since the most critical stress gradients, next to the weld or in the heat affected zones, may often develop over distances smaller than 1 mm; adequate neutron flux is also mandatory for obtaining bulk averaged results and comparing both with mechanical testing and with numerical predictions. These items will be discussed making reference to recent experimental work carried out on fusion reactor materials.

Recent references:
R. Coppola, M. Klimenkov, A. Möslang, R. Lindau, M. Rieth, M. Valli, Micro-structural effects of irradiation temperature and helium content in neutron irradiated B-alloyed Eurofer97-1, Nucl. Mat. En. 17 (2018) 40-47
R. Coppola, M. Klimenkov, Dose Dependence of Micro-Voids Distributions in Low-Temperature Neutron Irradiated Eurofer97 Steel, Metals, 2019, 9, 552
R. Coppola, F. Crescenzi, W. Gan, M. Hofmann, M. Li, E. Visca, J.-H. You, Neutron diffraction measurement of residual stresses in an ITER-like tungsten-monoblock type plasma-facing component, Fus. Eng. &Des. (2019) in print

Poster back-up

No

Author: COPPOLA, Roberto (ENEA)

Presenter: COPPOLA, Roberto (ENEA)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **26** Type: **Talk**

Development and Applications of Supermirror

Tuesday 3 September 2019 10:00 (30 minutes)

The introduction of the concept of supermirror in 1967 [1] and its technological realization [2] laid the foundation for increasing the efficiency of the transport of neutrons and of polarization analysis techniques due to the large increase of the maximal angle reflection by a factor of m when compared with the angle of total reflection of Ni. A complete guide system based on supermirror technology was implemented for the first time at the Swiss Spallation Source SINQ at PSI in 1994 using mostly mirrors with m = 2 [4]. The following years witnessed enormous increases in the performance of beamlines for neutron scattering thanks to the combination of new guide concepts, e.g. ballistic guides [5] and non-linearly tapered parabolic and elliptic guides [6], with supermirror whose performance has been improved continuously [7]. Supermirror with high reflectivity on metallic substrates [8] promote new applications namely extending neutron guides close to the moderators and focusing of neutron beams. As a result of the continuous developments of the deposition techniques for supermirror and the improved super-polishing of substrates on an industrial scale, non-magnetic and polarizing supermirrors are available with large angles of reflection, excellent reflectivity, and high polarization if magnetic materials are used. Here we report on the state-of-the-art and on the limitations of the performance of supermirror and possible applications.

[1] V. F. Turchin, Atomic Energy 22, 124 (1967).
[2] F. Mezei, Commun. Phys. 1, 81 (1976); F. Mezei and P. A. Dagliesh, Commun. Phys. 2, 41 (1977).
[3] J. B. Hayter and H. A. Mook, J. Appl. Cryst. 22, 35 (1989).
[4] W. Wagner, G. S. Bauer, J. Duppich, S. Janssen, E. Lehmann, M. Lüthy, and H. Spitzer, J. Neutron Res. 6, 249 (1998).
[5] F. Mezei and M. Russina, Physica B 283, 318 (2000).
[6] C. Schanzer, P. Böni, U. Filges, and T. Hils, Nucl. Instr. and Meth. A 529, 63 (2004); P. Böni, Nucl. Instr. and Meth. A 586, 1 (2008).
[7] M. Hino, H. Sunohara, Y. Yoshimura, R. Maruyama, S. Tasaki, H. Yoshino, and Y. Kawabata, Nucl. Instr. and Meth. A 529, 54 (2004).
[8] C. Schanzer, P. Böni, and M. Schneider, J. Phys.: Conf. Series 251 012082 (2010).

Poster back-up

No

Author: Mr BÖNI, Peter (Technical University of Munich)

Presenter: Mr BÖNI, Peter (Technical University of Munich)

Session Classification: Talks

Track Classification: Neutron Guides

Contribution ID: **27** Type: **Talk**

On-target neutron production monitoring with Self Powered Neutron Detectors

Tuesday 3 September 2019 12:30 (20 minutes)

The DONES deuterium-lithium high-intensity stripping neutron source is part of the next generation of high-intensity, accelerator-driven neutron sources.
DONES will irradiate candidate material samples for fusion reactor structures with 10ˆ14 n/cmˆ2s, keeping the samples above 300 degrees C for 11 months consecutively, in which no access will be possible to the irradiation cell.
In these conditions, the necessary flux monitoring in the neutron beam will be challenging: dedicated R&D is ongoing to design the best detector for this environment.
One candidate are Self Powered Neutron Detectors (SPNDs) that exploit the neutron-induced activation of specific materials, which then decay through electron emission: in an SPND, the activated material acts as a first electrode (emitter). A second electrode (collector) placed at close distance from the emitter collects the beta electrons without any bias voltage. SPNDs are used for neutron flux measurements in fission reactors, and are tailored to exploit thermal neutron induced activation. Typical time response ranges from ms to s, construction is coaxial with an outer diameter of 3mm and few cm length. Due to the low current over neutron flux ratio, SPNDs are used for the measurement of neutron fluxes well above 10ˆ10 n/cmˆ2s, where other kind of detectors fail due to radiation effects (NIEL, SEE, DDD) when exposed for long periods of time.
In order to improve the sensitivity of SPNDs to MeV-range neutron flux measurement, a new set of emitter materials have been studied. A prototype with an aluminum alloy emitter has been realised, and tested together with a rhodium emitter in two experimental campaigns. The first one has been performed at GELINA photonuclear neutron source located in JRC Geel in January 2018: SPNDs have been placed at 3 cm from the photoproduction target, where a flux up to 6 x 10ˆ10 n/cmˆ2s is achieved with an energy spectrum up to 20 MeV. A detailed Monte Carlo simulation with MCNP code has been performed in order to better evaluate the neutron spectrum at the detector position, and also the gamma contribution to the signal. A second experimental campaign has been performed at CERN n_TOF facility, where the same set of SPNDs has been placed close to the spallation target for 50 days during fall 2018. There, a completely different time distribution of neutrons is present, with pulses of 10ˆ13 protons of 20 GeV, with a duration of 25 ns, hitting the lead target every 1.2 s or more. Data have been compared with a detailed FLUKA simulation of the target yield.
Results from the two experiments showed a good sensitivity of the rhodium SPND also in the MeV range, with the capability to resolve prompt and delayed spallation target emission, and a promising detection efficiency for the aluminium one. The new n_TOF target will host a set of SPNDs as a direct flux monitoring station that will stay in place for ten years operation. Effects due to the mixed field in accelerator driven sources will be taken into account in the next design of SPNDs for this purpose.

Poster back-up

No

Author: FIORE, Salvatore (ENEA)

Presenter: FIORE, Salvatore (ENEA)

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **28** Type: **Talk**

HIGH-INTENSITY PULSED NEUTRON SOURCE "NEPTUNE"(IBR-3)

Monday 2 September 2019 11:40 (30 minutes)

In the course of one third of centure (since 1984) the IBR-2 reactor has been and still is one of the most intense high-flux source of thermal neutrons in the world for the investigations on extracted beams, providing for the peak density of the neutron flux on the surface of moderators 6x10ˆ15 n/cmˆ2/s and for the time average neutron flux up to 10ˆ13 n/cmˆ2/s. However, service life of the IBR-2 is expected to end in 2034 ÷ 2037. Modern science requires neutron fluxes of one order of magnitude higher. Progress in the technics of spallation neutron sources gave opportunity where the peak fluxes of neutrons approximate to 10ˆ16 n/cmˆ2/s, and the average time ones –to 10ˆ14 n/cmˆ2/s.
In the research studies of FLNP JINR specialists it has been shown that pulsed sources of slow neutrons based on the fission reaction may be competitive with spallation neutron sources and even significantly (by an order of magnitude) exceed them in peak slow-neutron fluxes. Such facility considered to be in principally pulsed fast reactor as its predecessors IBR, IBR-30 and IBR-2 but higher power (10 MW) and with a reactor core based on fissionable isotope neptunium-237.
When being realized, NEPTUNE (IBR-3) will preserve leading position among world neutron facilities for research on extracted neutron beams such as high current linear proton accelerators. Peak neutron flux density expected to be near 10ˆ17 n/cmˆ2/s and time averaged thermal neutron flux 10ˆ14 n/cmˆ2/s. Duration of thermal neutron pulse 250 - 300 μs is consistent to high degree with experimental needs of neutron spectroscopy physics that use more and more cold moderators and long wave neutrons.

Poster back-up

No

Authors: Dr KULIKOV, Sergey (Joint Institute for Nuclear Research); AKSENOV, Viktor (Joint Institute for Nuclear Research); Dr SHABALIN, Eugeny (Joint Institute for Nuclear Research); Dr SHVECOV, Valery (Joint Institute for Nuclear Research)

Presenter: Dr KULIKOV, Sergey (Joint Institute for Nuclear Research)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **30** Type: **Talk**

Welcome Talk

Monday 2 September 2019 09:00 (10 minutes)

Poster back-up

Author: KENZELMANN, Michel (Paul Scherrer Institut)

Presenter: KENZELMANN, Michel (Paul Scherrer Institut)

Session Classification: Administrative

Contribution ID: **31** Type: **not specified**

Neutron scattering at SINQ

Author: KENZELMANN, Michel (Paul Scherrer Institut)

Presenter: KENZELMANN, Michel (Paul Scherrer Institut)

Contribution ID: **32** Type: **Talk**

Neutron scattering at SINQ

Monday 2 September 2019 09:30 (30 minutes)

Author: KENZELMANN, Michel (Paul Scherrer Institut)

Presenter: KENZELMANN, Michel (Paul Scherrer Institut)

Contribution ID: **33** Type: **Talk**

Neutron Production, &c.

Monday 2 September 2019 10:30 (1 hour)

Author: CARPENTER, John M.

Presenter: CARPENTER, John M.

Session Classification: Keynote lecture

Contribution ID: **34** Type: **Talk**

The solid-deuterium-moderator-based ultracold neutron source at PSI

Monday 2 September 2019 12:30 (20 minutes)

The ultracold neutron (UCN) source at the Paul Scherrer Institute (PSI) has been in regular operation for the last years for up to 8 months each year. It is serving UCN to three beam ports with a priority on maximizing the UCN intensity for the neutron electric dipole moment experiment (nEDM) at PSI which was data taking with world-record sensitivity.
The UCN output has been significantly increased since initial startup. We present an update on the status of the source and measurements to characterize the performance of the neutron optics and of the 4.5kg solid deuterium moderator.

Poster back-up

Author: LAUSS, Bernhard (Paul Scherrer Institut)

Presenter: LAUSS, Bernhard (Paul Scherrer Institut)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **35** Type: **Talk**

Target Development at PSI

Monday 2 September 2019 16:40 (20 minutes)

Poster back-up

Presenter: WOHLMUTHER, Michael (Paul Scherrer Institut)

Session Classification: Talks

Track Classification: Neutron Production

Contribution ID: **36** Type: **not specified**

Combined efficiency of moderation and beam delivery

Tuesday 3 September 2019 08:30 (1 hour)

Author: MEZEI, Ferenc

Presenter: MEZEI, Ferenc

Session Classification: Keynote lecture

Contribution ID: **37** Type: **not specified**

SINQ Neutron Guide Upgrade

Tuesday 3 September 2019 10:50 (20 minutes)

Poster back-up

Author: JANOSCHEK, Marc (PSI - Paul Scherrer Institut)

Presenter: JANOSCHEK, Marc (PSI - Paul Scherrer Institut)

Session Classification: Talks

Track Classification: Neutron Guides

Contribution ID: **38** Type: **Talk**

Ultrahigh precision machining of neutron focusing mirrors using metallic substrate

Tuesday 3 September 2019 11:10 (20 minutes)

Poster back-up

Author: YAMAGATA

Presenter: YAMAGATA

Session Classification: Talks

Track Classification: Neutron Guides

Contribution ID: **39**   Type: **Talk**

Neutron Optics inside sample environment

Tuesday 3 September 2019 11:30 (20 minutes)

Poster back-up

Author: BARTKOWIAK, Marek (Paul Scherrer Institut)

Presenter: BARTKOWIAK, Marek (Paul Scherrer Institut)

Session Classification: Talks

Track Classification: Neutron Guides

Contribution ID: **40** Type: **Talk**

The performance of ESS spectrometers in comparison with instruments at a short pulse source

Wednesday 4 September 2019 08:30 (30 minutes)

Poster back-up

Author: ARAI, Masa

Presenter: ARAI, Masa

Session Classification: Talks

Track Classification: Instruments & Detectors

Contribution ID: **41** Type: **Talk**

Neutronics performance measurement of CSNS moderators

Wednesday 4 September 2019 16:10 (20 minutes)

The China Spallation Neutron Source (CSNS) is an accelerator based multidiscipline user facility constructed in Dongguan, Guangdong, China. The CSNS consists of a linear accelerator, a rapid cycling proton synchrotron accelerating the beam to 1.6 GeV energy, a solid tungsten target station, and three instruments in phase one for neutron scattering applications [1]. The facility operates at 25 Hz repetition rate with an initial design beam power of 100 kW and is upgradeable to 500 kW. The first neutron of CSNS was produced on 28rd August 2017 after the construction of facility started on Oct. 2011 [2]. CSNS ramped the beam power to 50kW and consistently achieved an availability of more than 90%. The neutronic performance of the source (and moderators) provides evidence of strong coupling between the target and the moderators [3].
The neutron wavelength spectra (>0.286A) of three moderators, 20K Coupled Hydrogen Moderator(CHM), 20K Decoupled and Poisoned Hydrogen Moderator(DPHM) and room temperature Decoupled Water Moderator(DWM), were measured at beamline 1# 6# 9# and 20# by low efficiency He3 neutron detector and lithium glass neutron detector applying TOF method. The integral flux of cold and thermal neutron was verified by activation measurement of gold foil. The integral flux of three moderators is agree with the simulation results of engineering geometry model within 20%. The neutron pulse shape of DPHM was measured by time focusing technique and agree well with the simulation result. The detail of measurement methods and results will be introduced.

References

[1] H. Chen, X. Wang, Nature materials 15, 689 (2016),

[2] D. Cyranoski, Nature 551, 284 (2017).

[3] H. Chen, Y. Chen, F. Wang, T. Liang, X. Jia, Q. Ji, C. Hu, W. He, W. Yin, K. He, B. Zhang and L. Wang, Neutron News 29, 2-2 (2018).

Poster back-up

Author: LIANG, Tianjiao (CSNS)

Presenter: LIANG, Tianjiao (CSNS)

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **42** Type: **not specified**

ESS Moderators: Current Status and Upgrade Options

Wednesday 4 September 2019 16:50 (20 minutes)

Poster back-up

Author: TAKIBAYEV, Alan

Presenter: TAKIBAYEV, Alan

Session Classification: Talks

Track Classification: Moderators & Reflectors

Contribution ID: **44** Type: **Talk**

Workshop Goals and Details

Monday 2 September 2019 09:10 (20 minutes)

Poster back-up

No

Authors: Dr CHARLES, Yoann (Paul Scherrer Institut); ZANINI, luca (European Spallation Source)

Presenters: Dr CHARLES, Yoann (Paul Scherrer Institut); ZANINI, luca (European Spallation Source)

Session Classification: Administrative

Contribution ID: **45** Type: **Talk**

Cold Neutron Moderators and Reflectors: Some recent problems and results

Wednesday 4 September 2019 11:50 (1 hour)

Poster back-up

Authors: Prof. GRANADA, Rolando (Argentine Atomic Energy Commission); GRANADA, Rolando (Argentine Atomic Energy Commission)

Presenters: Prof. GRANADA, Rolando (Argentine Atomic Energy Commission); GRANADA, Rolando (Argentine Atomic Energy Commission)

Session Classification: Keynote lecture

Contribution ID: **46** Type: **not specified**

Overview over Fast Neutron Lab Activities

Wednesday 4 September 2019 17:10 (20 minutes)

Author: WOLFERTZ, Alexander (Paul Scherrer Institut)

Presenter: WOLFERTZ, Alexander (Paul Scherrer Institut)

Session Classification: Talks

Contribution ID: **47** Type: **not specified**

Neutron Production Session Summary

Thursday 5 September 2019 10:30 (15 minutes)

Author: LILLEY, Steven (STFC)

Session Classification: Talks

Contribution ID: **48** Type: **not specified**

Instruments, Guides & Detectors Session Summary

Thursday 5 September 2019 10:45 (15 minutes)

Authors: NIEDERMAYER, Christof (Paul Scherrer Institut); WOHLMUTHER, Michael (Paul Scherrer Institut)

Presenter: NIEDERMAYER, Christof (Paul Scherrer Institut)

Session Classification: Talks

Contribution ID: **49** Type: **not specified**

Moderators and Reflectors Session Summary

Thursday 5 September 2019 11:00 (15 minutes)

Author: Dr GALLMEIER, Franz (Oak Ridge National Laboratory)

Session Classification: Talks

Contribution ID: **50** Type: **not specified**

Workshop Closeout part 1

Thursday 5 September 2019 11:15 (15 minutes)

Author: Dr ZANINI, Luca (b. European Spallation Source (ESS), Lund, Sweden)

Presenter: Dr ZANINI, Luca (b. European Spallation Source (ESS), Lund, Sweden)

Session Classification: Talks

Contribution ID: **51** Type: **not specified**

Workshop Closeout part 2

Thursday 5 September 2019 11:30 (15 minutes)

Author: WOHLMUTHER, Michael (Paul Scherrer Institut)

Session Classification: Talks

Contribution ID: **52** Type: **not specified**

Workshop Closeout part 3

Thursday 5 September 2019 11:45 (15 minutes)

Author: Dr CHARLES, Yoann (Paul Scherrer Institut)

Session Classification: Talks

Contribution ID: **53** Type: **not specified**

Discussion

Monday 2 September 2019 17:10 (1h 30m)

Author: LILLEY, Steven (STFC)

Session Classification: Discussion

Contribution ID: **54** Type: **not specified**

Discussion

Wednesday 4 September 2019 10:10 (1h 30m)

Authors: JANOSCHEK, Marc (PSI - Paul Scherrer Institut); HARADA, Masahide (JAEA)

Session Classification: Discussion

Contribution ID: **55** Type: **not specified**

Discussion

Thursday 5 September 2019 08:30 (1h 30m)

Author: Dr GALLMEIER, Franz (Oak Ridge National Laboratory)

Session Classification: Discussion