Program & Schedule

Tuesday, September 24

ISNIE Summer school
18:30- Welcome Party

Wednesday, September 25 【DENIM XIII Day 1】

8:00-9:00	Registration
9:00-10:00	Session 1: Welcome
10:00-10:30	A.M. Coffee Break
10:30-12:00	Session 2: Instrument 1
12:00-13:00	Lunch
13:00-13:40	Session 3: Instrument 2
13:40-14:30	Sponsor short presentation
14:30-15:30	Poster Session
15:30-17:10	Session 4: Instrument 3
17:10-18:30	DENIM challenge

Thursday, September 26 【DENIM XIII Day 2】

8:40-10:00	Session 1: Instrument 4 & Sample
10:00-10:30	A.M. Coffee Break
10:30-12:10	Session 2: Sample & Others
12:10-13:10	Lunch
13:10-14:50	Session 3: Project 1
14:50-15:20	P.M. Coffee Break
15:20-16:20	Session 4: Project 2
18:30-	Banquet

Friday, September 27 【DENIM XIII Day 3】

8:40-10:00	Session 1: Project 3
10:00-10:30	A.M. Coffee Break
10:30-11:50	Session 2: Project 4
12:00-13:00	Lunch
13:00-14:00	AGM & Closing
14:00-16:30	Facility Tours

Monday, September 30

RANS Tour, 9:00- RIKEN, Wako

Program Overview

	Tuesday, September 24	Wednesday, September 25	Thursday, September 26	Friday, September 27	Sep. 28	Sep. 29	Monday, September 30
	venue: JAEA Tokai Mirai Base	venue: JAEA Tokai Mirai Base	venue: JAEA Tokai Mirai Base	venue: JAEA Tokai Mirai Base			venue: RIKEN Wako campus
AM	Registration 9:00 ISNIE Summer School	8:00 Registration DENIM-XIII 9:00 Welcome 10:00 A.M. Coffee Break 10:30 Instrument 1	DENIM-XIII 8:40 Instrument 4 & Sample 10:00 A.M. Coffee Break 10:30 Sample & Others	DENIM-XIII 8:40 Project 3 10:00 A.M. Coffee Break 10:30 Project 4	No Scheduled events	No Scheduled events	9:00- RIKEN RANS tour Meeting point: Wakoshi Station (Tōbu Railway and Tokyo Metro)
PM	12:00 Lunch	12:00 Lunch	12:10 Lunch	12:00 Lunch			
	13:00 ISNIE Summer School	13:00 DENIM-XIII 13:00 Instrument 2 13:40 Sponsors short presentation 14:30 Poster session 15:30 Instrument 3 17:10 DENIM challenge 18:30	13:10 DENIM-XIII 13:10 Project 1 14:50 P.M. Coffee Break 15:20 Project 2 16:20	13:00 DENIM-XIII 13:00 AGM & Closing Farewell 14:00 Tour of J-PARC&JRR-3 16:30			
	18:30 Welcome Party 3-minute walk from Mito Station		18:30 DENIM Banquet 5-minute walk from Mito Station				

🟦 Main DENIM sessions (Registered participants only)

🟧 Events that required pre-registration (Registration closed)

🟩 Social events open to all registered participants and registered accompanying persons

Oral presentations

Regarding the presentation time for oral sessions:

The welcome session: 25 minutes per presentation, including time for questions and answers.
The other sessions: 20 minutes per presentation, including time for questions and answers.
The Gold Sponsors presentation time: 10 minutes per presentation.

Wednesday, September 25, Day 1

Session 1: Welcome, 9:00-10:00

Session 2: Instrument 1, 10:30-12:00

Session 3: Instrument 2, 13:00-13:40

Session 4: Instrument 3, 15:30-17:15

Thursday, September 26, Day 2

Session 1: Instrument 4 & Sample, 8:40-10:00

Session 2: Sample & Others, 10:30-12:10

Session 3: Project 1, 13:10-14:50

Session 4: Project 2, 15:20-16:20

Friday, September 27, Day 3

Session 1: Project 3, 8:40-10:00

Session 2: Project 4, 10:30-11:50

Poster presentations

Wednesday, September 25, Day-1

Poster size: A0 portrait (width 841 mm × height 1189 mm)
Please ensure your poster fits within these dimensions.

WELCOME AND INTRODUCTION TO J-PARC MLF

T. Otomo[a,b] on behalf of J-PARC MLF
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[b] *Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), Tokai, Japan*

Materials and Life Science Experimental Facility (MLF) of Japan Proton Accelerator Research Complex (J-PARC) provides the world's most intense pulsed neutron and muon beams with the MW-class proton accelerator. User programs are implemented in 21 neutron beamlines and 4 muon beamlines. Approximately 10,000 cumulative users from Japan and abroad visit MLF annually to conduct a wide range of academic and industrial research. Our mission is not limited to providing the user program with existing state-of-the-art instruments, but also to explore the possibilities of neutrons and muons. Thus, the development of instruments, detectors, optical devices, analysis software and target systems for neutrons and muons is ongoing. This presentation will review the activities of MLF at J-PARC.

References

1. Takada, H. *et al.* Materials and Life Science Experimental Facility at the Japan Proton Accelerator Research Complex I: Pulsed Spallation Neutron Source. *Quantum Beam Science* **1**, 8 (2017). https://doi.org:10.3390/qubs1020008
2. Nakajima, K. *et al.* Materials and Life Science Experimental Facility (MLF) at the Japan Proton Accelerator Research Complex II: Neutron Scattering Instruments. *Quantum Beam Science* **1**, 9 (2017). https://doi.org:10.3390/qubs1030009
3. Sakasai, K. et al. Materials and Life Science Experimental Facility at the Japan Proton Accelerator Research Complex III: Neutron Devices and Computational and Sample Environments. Quantum Beam Science **1**, 10 (2017). https://doi.org:10.3390/qubs1020010
4. Higemoto, W. et al. Materials and Life Science Experimental Facility at the Japan Proton Accelerator Research Complex IV: The Muon Facility. Quantum Beam Science **1**, 11 (2017). https://doi.org:10.3390/qubs1010011

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RIKEN COMPACT ACCLERATOR-DRIVEN NEUTRON SYSTEMS
-FROM LABORATORY TO OUTDOORS-

T. Kobayashi[a], **S. Ikeda**[a,b], **Y. Ikeda**[a], **M. Mizuta**[a], **Y. Okuno**[a], **Y. Wakabayashi**[a],
T. Fukuchi[a], **T. Takanashi**[a], **S. Otsuka**[a] **N. Hayashizaki**[a,b] **and Y. Otake**[a]
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RIKEN has been developing compact neutron systems since 2011. RANS and RANS-II, two accelerator-based neutron systems and RANS-μ, an RI-based neutron salt meter, are already being used for daily neutron scattering measurement experiments. We have operated the RIKEN Accelerator-driven compact Neutron System (RANS) with a 7 MeV proton LINAC (RFQ+DTL coupled) and a beryllium target since 2013, and have analyzed mainly practical structural materials [1]. RANS is equipped with a room temperature polyethylene moderator and a helium-cooled mesitylene moderator. The following neutron scattering experiments can be performed at RANS, neutron transmission imaging, engineering diffraction experiment, small angle neutron scattering experiment, prompt gamma activation analysis, fast neutron scattering experiment. Examples of analyses include nondestructive observation of concrete interior (water penetration, void formation, rebar corrosion, and salinity), observation of water behavior in corroded areas of steel plates, and analysis of the behavior of textures under stress in steel plates. The RANS-II project to develop a mobile, installable accelerator neutron source was implemented in 2016 [3]. The energy was lowered to reduce the weight of the shielding, and a 2.5 MeV proton LINAC (RFQ) in combination with a lithium target was employed. At the same time, we have developed a method to make measurements with a smaller amount of neutrons produced. RANS-II is currently used as a stationary compact neutron source. Neutron scattering experiments as well as activation analysis and detector development (e.g. solar cell dosimeters) are being conducted at RANS and RANS-II. RANS-II has also been in operation as a hydrogen ion implanter. Based on the measurement technique, accelerator technology, and shielding parameters obtained from RANS-II, we are now developing RANS-III equipped with a 500 MHz RFQ accelerator [3] (Fig.1) and preparing it for field measurements on a trailer. RANS-III is currently being developed to irradiate neutrons downward and measure bridge deterioration through moisture and salinity measurements with neutron backscattering measurement and PGAA. Instruments loading and operational tests will be conducted in 2024, and neutron generation tests and actual sample measurements will be conducted in 2025 with the trailer stored in the newly constructed building.

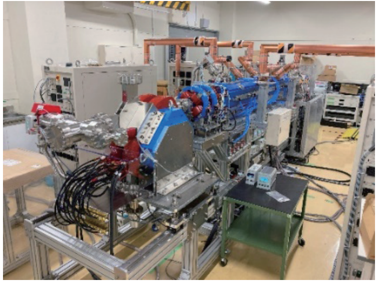

Figure 1: RANS-III Accelerator (RFQ) and bending magnet in the laboratory.

References

[1] Y. Otake, J. Neutron Research, vol. 23, 2-3, pp. 119-125, 2021.
[2] T. Kobayashi, S. Ikeda, Y. Otake, Y. Ikeda, N. Hayashizaki, Nucl. Instr. Meth. A 994, 165091, 2021.
[3] S. Ikeda, T. Kobayashi, Y. Otake, R. Matsui, M. Okamura, N. Hayashizaki, J. Neutron Research, vol. 24, 3-4,pp.249-259, 2022.

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CHOPPER POSITION DATA STREAMING: A CASE-STUDY OF REAL TIME DATA ACQUISITION AND STREAMING USING MATISSE

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The high-flux backscattering spectrometer at the National Institute of Standards and Technology Center for Neutron Research (NCNR) operates a phase-space transformation chopper in order to obtain a high neutron flux. There is a need to upgrade the current data acquisition electronics that integrate the chopper signals and neutron data as a single system.

We have designed a generic platform, the Multipurpose Absolute Time Synchronizer Scaler Enabler (MATiSSE), to capture timestamped data with sub-microsecond accuracy using absolute timestamps in the IEEE 1588 (Precision Time Protocol, or PTP) specification. We will present the accelerated design of a MATISSE based data acquisition board for the chopper signals.

MATiSSE is based on a field-programmable gate array (FPGA) system-on-module, the Kria K26 manufactured by Advanced Micro Devices, Inc. (AMD). The Kria K26 simplifies design complexity and offers a low-cost solution for a modular architecture. The K26 integrates a quad-core processor, onboard memory, an FPGA, and PTP hardware to facilitate many different application types.

Custom hardware and software processing can easily be implemented and enabled by design reuse. Internal design includes reusable firmware and software modules. A custom Linux operating system is implemented with custom drivers. Data is then pushed to Redpanda, an open-source centralized data streaming server that is Kafka compatible.

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DEVELOPMENT OF A DETECTOR HOUSING FOR THE SKADI INSTRUMENT AT ESS

Romuald Hanslik[1], S. Butterweck[1], S. Schoenen[1], M. Pap[1], G. Natour[1,2], R. Engels[3]

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A cutting-edge detector system has been developed for the SKADI instrument at the new ESS neutron source in Sweden. Utilizing a Li6 scintillator and area detectors with multi-anode photomultipliers, Forschungszentrum Juelich, in collaboration with IDEAS, has pioneered this innovative system. The design incorporates two movable detector housings within a vacuum tube, allowing for measurements at various positions. The readout electronics, housed within the detector housing, are actively cooled via external supply lines.

This talk gives some insights into development and design work concerning to the SKADI detector housing and cooling systems.

The main focus of that presentation will be on challenges and experiences during the development and design phase. First detailed designs and special solutions for the detector housing components and lessons learned from the manufacturing of the first critical components will also be presented.

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O-12-3

CHOPPERS AT THE SECOND TARGET STATION AT OAK RIDGE NATIONAL LABORATORY

W. McHargue
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The Second Target Station (STS) of the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) will be the brightest source of cold neutrons in the world when neutron production for instrument commissioning begins in 2034. To take full advantage of these cold neutrons, the facility will operate at 15 Hz. The 15 Hz operating frequency of the STS is 1/4th the operating frequency of our First Target Station (FTS), which operates at 60 Hz.

The use of slower speed choppers that are operating at the slower source frequency results in larger uncertainty of the neutron wavelengths at the edges of the desired neutron bandwidth selected by the choppers. To maintain optimized neutron bandwidth edges with the slower operating frequency of both the source and choppers, the choppers at the STS will be much larger in diameter than the choppers used in the FTS at SNS.

While designing the STS instruments, chopper concepts needed to be developed as placeholders in the instrument models until detailed design of the choppers could be completed in the future. The creation of chopper concepts was accomplished by first defining the requirements that the choppers needed to meet.

I will explain the requirements used to create the STS chopper compliant concepts (Figure 1), the two resulting standard chopper diameters which meet those requirements, the chopper concepts that were developed, and the status of the detailed design process of the STS choppers.

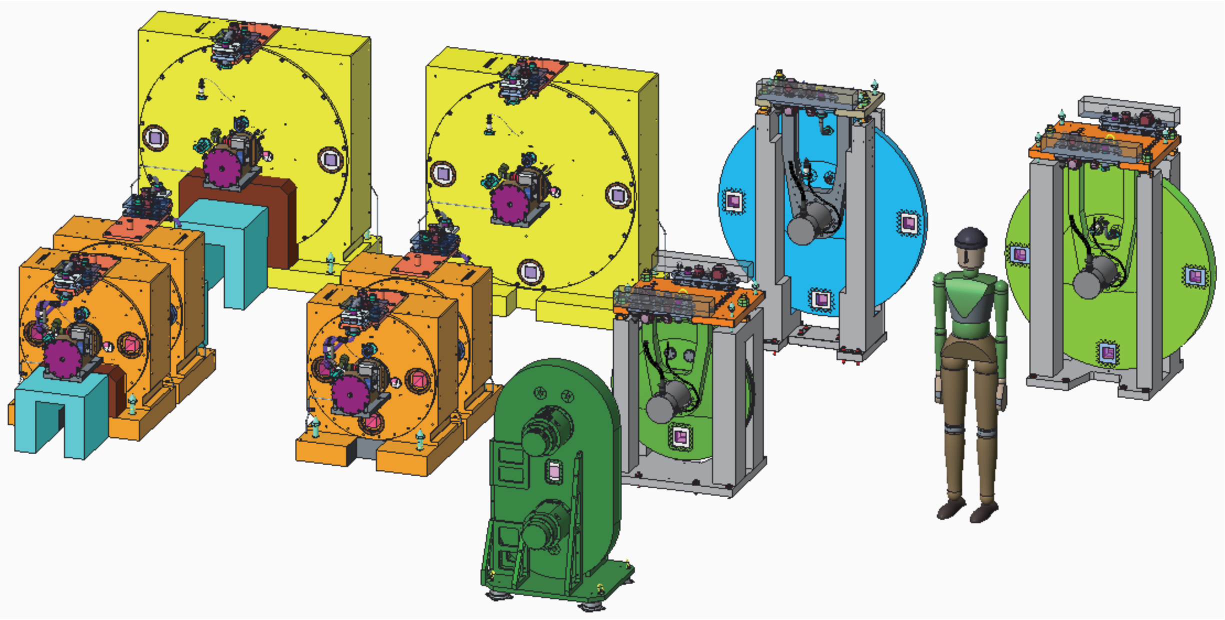

Figure 1: STS chopper specification compliant chopper concepts.

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MULTI LEAF COLLIMATOR 3 MEDAPP FRM2

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[a]*Heinz Maier-Leibnitz Zentrum (MLZ), Technical University of Munich, Garching, Germany*
[b]*Technical University of Munich, TUM School of Medicine and Klinikum rechts der Isar, Department of Radiation Oncology, Munich, Germany*
[c]*Physik Departement, School of Natural Sciences, Technical University of Munich, Garching, Germany*

The Multi-Leaf-Collimator 3 (MLC 3) is an upgraded collimator for external radiation therapy with fission neutrons. It has replaced a manually operated predecessor MLC 1A. The MLC 3 has thirty-eight leafs that can be moved electrically by stepper motors up and down. With these leafs can the treatment field be shaped according to the tumor geometry while sparing the surrounding healthy tissue. The leaf design also allows shaping divergent and convergent treatment fields, where the convergent field maximizes the effective area of the fission source used for treatment.

The talk will address the design and construction phases including the challenges and the boundary conditions met during the course of the project. How did the predecessor look like? What kind of solutions have been tried for the MLC_3? About problems that have appeared during the development of prototypes. Finally, the result of the construction.

O-13-1

MECHANICAL DESIGN AND CONSTRUCTION OF THE VERY SMALL ANGLE NEUTRON SCATTERING INSTRUMENT IN CSNS

Songwen.Xiao[a,b], Taisen.Zuo[a,b] , Xiong.Lin[a,b], Junsong.Zhang[a,b], Guangyuan.Wang[a,b], Yongcheng.He[a,b], Zhenqiang.He[a,b], and He.Cheng[a,b]
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[b] *Spallation Neutron Source Science Center (SNSSC), Dongguan 523803, China*

It took us four years, from January 2019 to January 2023, to complete the mechanical design and construction of the Very Small Angle Neutron Scattering Instrument (VSANS) at the China Spallation Neutron Source (CSNS). The acceptance test of VSANS has been completed, making it the first VSANS instrument based on a spallation neutron source [1].

the collimation system in front of the sample needs to be able to automatically switch four modes (VSANS mode, Traditional SANS mode, Polarized SANS mode, GSANS mode) according to the physical design. three sets of horizontal exchange chambers, five sets of rotary drums, five sets of rotary apertures and two sets of four-blade slits have been designed and manufactured in the collimation system, the multi-station switching of these device are realized by high-precision horizontal movement, rotation and vertical lifting, and all the devices are connected by front and rear bellows to maintain the overall vacuum environment in the collimation system (the total length is about 13m).

The vacuum scattering chamber with an inner diameter of 2.6m and a length of 12m is installed after the sample. A sapphire window with the diameter of 380mm and thickness of 10mm is installed in the front of the scattering chamber, and an aluminum window with the diameter of 400mm and thickness of 1mm is installed at the end of the scattering chamber. Three 3He detectors which can be moved forward and backward are installed inside the scattering chamber (normally arranged 1m, 4m and 11.5m away from the sample center). The GEM detector for VSANS mode is fixed behind the aluminum window (12.75m away from the sample).

The mechanical structure of VSANS is very complicated with more than 54 axes of high precision motion control in vacuum environment, and we have completed this work well, and the repeated positioning accuracy of all equipment meets the experimental requirements.

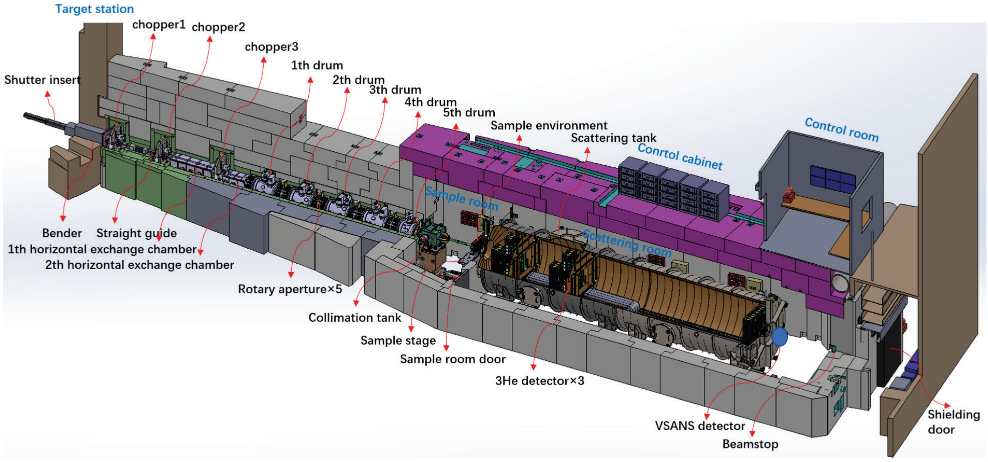

Figure 1.Overall layout of VSANS at CSNS

References

[1] Taisen Zuo. Zehua Han. Changli Ma. Songwen Xiao *et al*, J. Appl. Cryst. (2024). 57, 380–391.

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HIGH-SPEED CHOPPER TEMPERATURE, VACUUM AND HIGH MAGNETIC FIELD

Jonathan Garrett, **Chase Smith, Jerry Stockton, Rick Lee, and Jesse Souza**
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While commissioning the High-Speed Double Disk Chopper (HSDD) Chopper for the Cold Neutron Chopper Spectrometer (CNCS), multiple obstacles were encountered such as vacuum pressure, disk imbalance, disk shape changes, shielding obstructions and temperature issues. These issues required special attention to reach the performance requirements of the chopper.

Figure 1: Spindle Shield Rings.

High magnetic fields from the nearby 14T magnet imposed excessive forces on the magnetic bearings. The addition of special magnetic shielding (Figure 1) was added to reduce the forces effecting the operation of the electromagnetic bearings in the disk chopper spindles.

Vacuum pressure was amongst the most time limiting issues for reaching operational speeds (300Hz).

During initial testing, it took more than 24 hours to reach a relatively high base pressure of 3.1x10E-3 mTorr. To improve vacuum performance, about 40 feet (12m) of 1-inch (25mm) diameter vacuum tubing was replaced with 20feet (6m) of 1.5-inch (40mm) tubing and the turbo pump was relocated closer to the guide shielding. After changing the hardware and configuration, pump-down time was reduced to 10 hours and the pressure with both disk at operating speed (300Hz) is now maintaining 2x10E-4 mTorr.

Even after improving the vacuum performance, disk temperatures continued to be high, approaching the 125°F(52°C) maximum allowable temperature. This issue limited the speed of the chopper to 180Hz. To improve radiative heat transfer the chopper housing and disk were disassembled and all housing surfaces facing the disk were painted with KRYLON special purpose black high heat paint (Figure 2). This reduced the operating temperature and allowed the commissioning to continue and reach the full operating speed of 300Hz.

The CNCS Instrument is now operational with the spare HSDD at 300Hz, and the choppers were found to be operational at the full field of the 14 T Uncompensated Magnet.

Figure 2: HSDD painted

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IMAGINE-X UPGRADE TO ENABLE DYNAMIC NUCLEAR POLARIZATION

D. Myles[a], **J. Pierce**[a] **and D. Giuliano**[a]
[a]ORNL, HFIR/SNS, 1 Bethel Valley Road, Oak Ridge, TN, USA

The IMAGINE instrument, located within the High Flux Isotope Reactor (HFIR)'s cold guide hall at the Oak Ridge National Laboratory (ORNL), is receiving a major upgrade to enable the use of Dynamic Nuclear Polarization (DNP). The IMAGINE instrument is a Quasi Laue neutron diffractometer used primarily for the study of protein crystallography. Within the field of protein crystallography, neutrons play an important role by precisely locating the hydrogen atoms within the protein, which dictates how the protein will interact with other molecules. However useful in its current state, neutron diffraction in protein crystallography is significantly limited by the large incoherent scattering cross section of the hydrogen nucleus (79.9 barn) compared to its coherent scattering cross section (1.8 barn). This limitation requires large crystal sizes which are difficult to grow and difficult to prepare (freeze), as well as long beam times (weeks). Without the ability to increase the neutron flux on the sample, these limitations will be solved by physically manipulating the scattering cross sections with the use of DNP. DNP manipulates this nuclear property by taking advantage of the cross section's dependance on the spin alignment of the nucleus and the incident neutron. By aligning the spin of the incident neutron and hydrogen nucleus, the coherent scattering cross section can be increased by a factor of 8 while the incoherent cross section is reduced to 0 (Figure 1). This change produces a reduction in signal to noise ratio that enhances the instrument by a factor of 50.

Upgrades to the IMAGINE instrument (Figure 2) required to enable DNP are currently being designed and implemented. The incident neutron beam will be polarized using a double V cavity neutron polarizer, which will provide neutron beam polarization of greater than 90%. Neutron spin orientation will then be manipulated using a super conducting cryogenic spin flipper utilizing the Meisner effect with a flipping efficiency of over 98%. The neutron spin will be transported with a coil producing guide field (~20 gauss) and will be delivered to a protein crystal sample which will be polarized by a sample environment that will produce a magnetic field of 5 Tesla at a temperature of 1K. Next generation silicon photo multiplying (SiPM) Anger cameras will be utilized as detectors for this instrument.

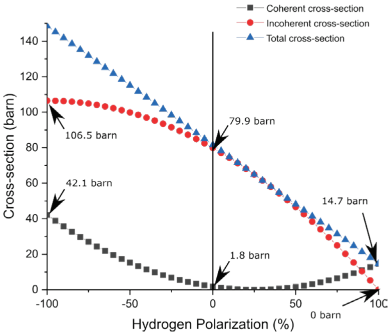

Figure 1: Polarization dependance of neutron cross section of hydrogen

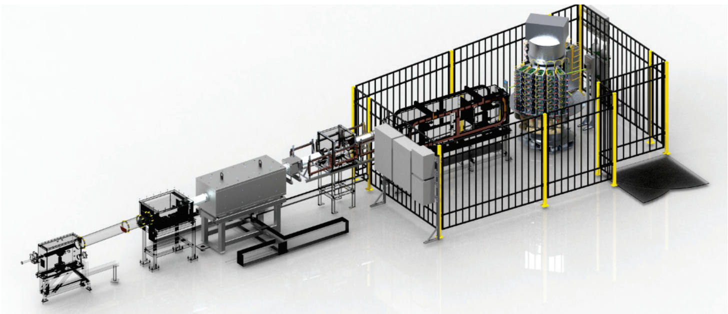

Figure 2: IMAGINE-X upgrade concept.

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THE STS STANDARDIZED T0 CHOPPER DESIGN

C. Hart[a]

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Many neutron scattering instruments at pulsed spallation sources utilize T_0 (time zero) choppers to filter very high energy neutrons and incident gammas out of the neutron beam. These neutrons reach the sample position almost instantaneously or with nearly zero-time increment. These neutrons are filtered from the beam by an Inconel block attached to a spinning rotor; accurate and repeatable angular positioning of the spinning rotor is critical to its successful operation.

The Spallation Neutron Source First Target Station (FTS) at the Oak Ridge National Laboratory employs T_0 choppers which are an in-house design. The FTS T_0 chopper utilizes a commercially available motor, motor drive, motor controller, resolver, and speed sensor. These components are integrated into an in-house design of the chopper rotor, housing, and support structure that are fabricated at domestic machine shops and then assembled on-site. The Second Target Station (STS) has adapted the T_0 chopper design, currently used on the FTS CORELLI beamline, by scaling it up to achieve the requirements for sweep speed, beam cross-sectional area, and operating frequency required by the initial suite of STS instruments. The STS T_0 rotor design is intended to be standardized across the instrument suite at STS and is 200% larger in diameter and 200% heavier but operates at 25% of the speed of SNS rotor due to the different source frequencies (60 Hz at FTS, 15 Hz at STS). These characteristics forced changes to the vacuum/containment housing and supporting structure. The new T_0 chopper design was developed using the existing FTS motor, resolver, and the latest generation of the control system due to familiarity and compatibility. There was a desire to utilize as many components as possible between the two chopper systems, but due to the significant changes in STS chopper size and weight, several supporting engineering calculations were needed to ensure a robust mechanical design. This presentation will describe many of the design changes that were implemented on the STS T_0 system along with their supporting calculations and analyses.

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AN IN-HIGH-VACUUM OSCILLATING RADIAL COLLIMATOR WITH EXTERNAL DRIVE SYSTEM.

R. Thermer, C. Boone, G. Sala, A. DeSantis
Oak Ridge National Laboratory, 1 Bethel Valley Road, Oak Ridge, TN 37830

Based on previous experience with existing, in-vacuum oscillating radial collimator motion systems from the Spallation Neutron Source, First Target Station (FTS), a new approach has been designed for some of the Second Target Station (STS) instruments. In this design, the collimator's motion system is installed outside a vacuum chamber and uses a proven, commercially available, electric cylinder which transmits a linear motion through a specially developed vacuum feedthrough into the vacuum chamber (see Figure 1). A mechanical linkage, which is connected via ball joints, then converts the linear motion into a rotary motion. This concept aims to increase reliability by removing the maintenance elements from the high vacuum environment and allowing direct access for maintenance purposes. Moreover, the linear drive system offers the flexibility to program different motion patterns. Careful feasibility assessments of important key components have paved the way for a different, hopefully more durable design. This presentation will give an overview of the design and its benefits.

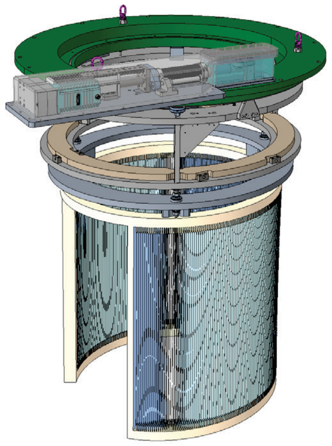

Figure 1: External collimator motion system

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FALCON – A NEW MULTI-PURPOSE BEAMLINE AT PSI

S. Thuersam and R. Mueller[a]
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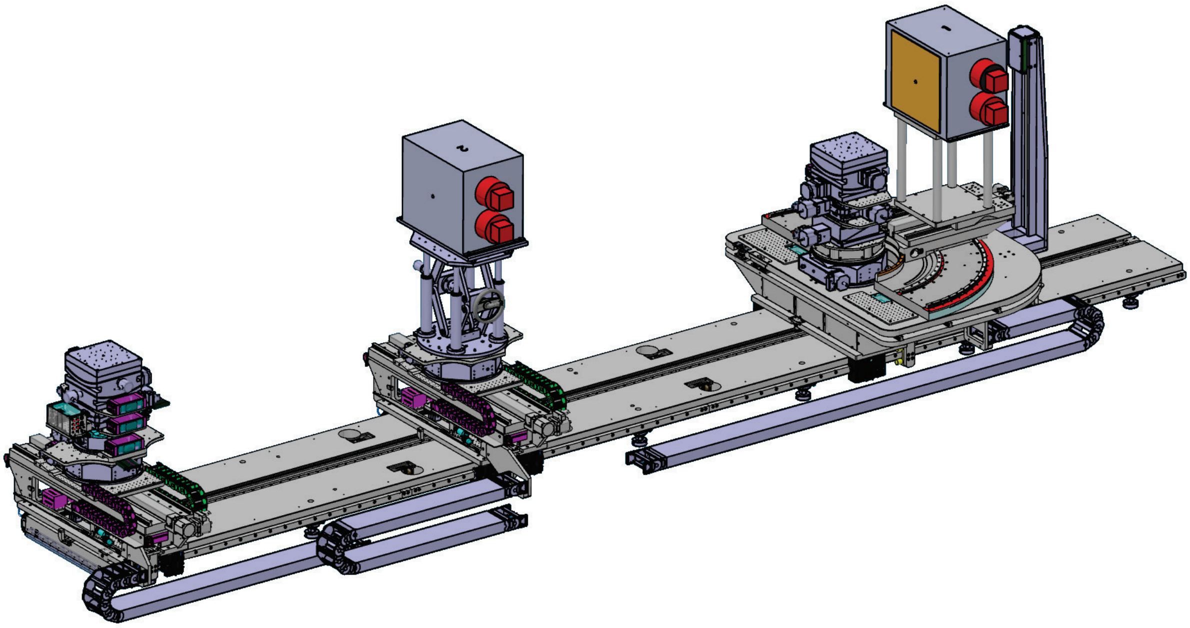
At the Paul-Scherrer-Institute there are currently several new beamlines as well as upgrades to existing ones being implemented.

One of which will be FALCON – a multi-purpose beamline which combines two major functions: Laue diffraction by use of CCD-camera setups in conjunction with neutron optics/aperture systems and TOF-setups with two chopper systems.
There are further applications such as 2-D-detectors, He3-counter tubes, vacuumized systems and many other mobile instrument components which are used less frequently for neutron optics studies or fundamental physics research but nevertheless need to be overhauled and implemented in a modular “plug-and-play”-style.
Therefore, all motorized axis’ as well as measuring components need to be quick-interchangeable – not only within FALCON itself but also the BOA-Beamline and in future other Beamlines such as NEUTRA and POLDI. This requires a multitude of mechanical, electrical, and computing considerations to make all these instruments & sub-systems work seamlessly.

Thus, our goal is to make the user experience as simple and intuitive as possible whilst keeping required maintenance in general and particularly the needed user support from our electronics department as low as possible.

In my talk I would like to present some of said considerations, challenges, and possible solutions.



View of the bare FALCON Instrument (work in progress)

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O-14-5

SYSTEMS BASED ELECTRONICS DESIGN

C. Scully Sabens[a]**, S. Wall**[a]**, R. Knudson**[a] **and B. Vacaliuc**[a]

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The Neutron Technologies Division (NTD) at Oak Ridge National Laboratory is working on creating standard electronics for detector systems. To manage the varying requirements for different beamlines, the team is taking a systems engineering approach. This methodology involves creating a project team of stakeholders from all areas of the neutron scattering instrument team. These stakeholders are involved in the development, installation, maintenance, and operations of the neutron scattering instrument. The Neutron Instrument Systems Engineer acts as a liaison between the different stakeholders to ensure the needs of all stakeholders are incorporated. When the Bio-SANS Instrument at HFIR received funding to add a new detector array, the NTD team took this opportunity to deploy new detector electronics. The team repackaged the new electronics to integrate into the existing detector module. The repackaging effort focused on space and thermal management. This presentation will focus on the methodology being developed for making standard electronics and how it is being implemented at beamlines at ORNL.

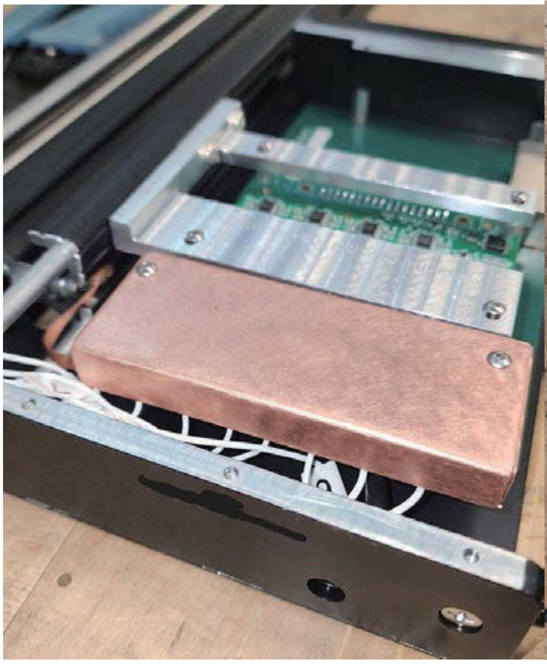

Figure 1: Legacy Design

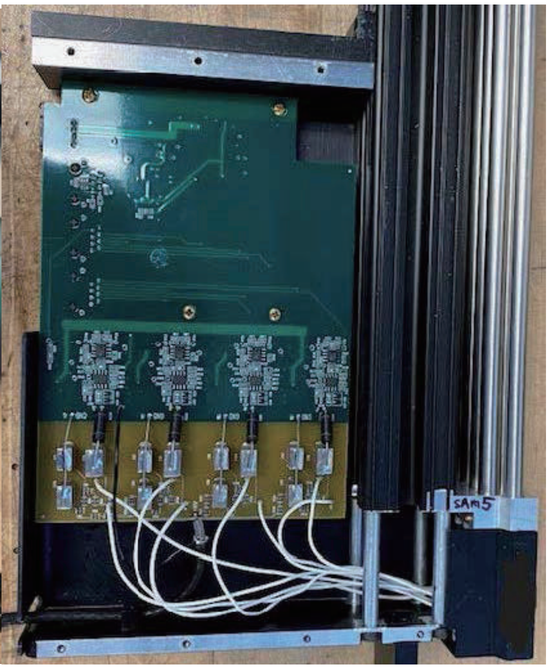

Figure 2: New Design

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LESSON LEARNED FROM AUTOMATION OF NEUTRON SCATTERING INSTRUMENTS

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The expertise acquired by our automation group is based on collaboration with a wide range of different scientific fields. This enables us to solve the special requirements of neutron scattering experiments efficiently by incorporating acquired know-how from other areas.
Few examples will briefly illustrate how the automation of the neutron scattering instruments benefits from this.

Misjudgment of the commissioning effort quickly becomes a boomerang.
If deadline pressure results in the premature delivery of untested automation components, this can quickly lead to a doubling of times and costs.
It will be explained using examples.

The more complex the experiments, the more difficult the troubleshooting?
It doesn't have to be!
Here we have developed solutions that simplify this troubleshooting.

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FROM CONCEPT TO SCIENTIFIC OPERATIONS: NEUTRON CHOPPER SYSTEMS PROGRESS AT THE EUROPEAN SPALLATION SOURCE

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The entire neutron scattering community, alongside institutes and funding bodies across Europe, has been analysing, conceptualizing, testing and manufacturing to make ESS a success.

ESS is as technically and scientifically ambitious as the community that has dreamt and built it.

Critical to the success of the ESS is its suite of 100 neutron chopper systems, designed in varying speeds, shapes, and sizes to precisely morph the neutron beam in both time and space, thereby fulfilling the scientific needs of its users. The ESS will operate chopper discs of 20 cm diameter and just 1 kg to 3000 kg behemoth T0 choppers.

This presentation will provide latest updates from conceptualization, manufacturing, testing, installation and commissioning of neutron chopper systems at ESS by its partners, manufacturers and in-house.

As the ESS moves closer to operational readiness, with 15 neutron scattering instruments being prepared concurrently, we will share our challenges and successes into the ongoing work to mature these systems for the next generation of neutron science in Europe.

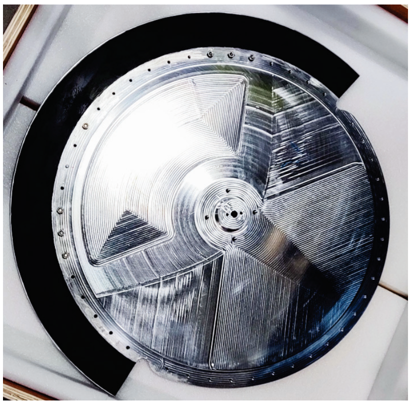

Figure 1: ESS BIFROST Chopper disc: Diameter 70 cm, Speed: 140 Hz, Opening: 180 deg

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40 YEARS OF ISIS INSTRUMENTS

J. Nightingale (Science and Technology Facilities Council)

ISIS Neutron and Muon source produced its first beam of neutrons in 1984 and this year celebrated its 40th birthday. Born from parts of an existing NIMROD accelerator, ISIS was constructed on a shoe-string budget and within 7 years. A second target station was constructed in 2009 and the facility now contains over 30 instruments. This talk will present 40 years of instrument design, how ISIS instrument technologies (and ISIS engineering in general) have evolved over the years from humble beginnings to complex endeavours.

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O-21-3

AN ULTRA-LOW TEMPERATURE SAMPLE CHANGER ECOSYSTEM

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As the investigation of magnetic materials with neutron scattering deepens, the demand for experiment time utilizing ultra-low temperature (ULT) devices increases. Set-up and cool-down times for traditional inserts (up to 8 hours) proportional to total experiment times strain experiment budgets and sample environment resources. The HB2A Powder Diffractometer and the HFIR Low Temperature and Magnetism Teams have developed a sample stage (Figure 1), environment, and container ecosystem that enables the reliable rapid changing of samples at ultra-low temperatures to help satisfy the demand for ULT experiment time and expand experimental capabilities.

The first constituent development of this ecosystem is the sample stage upgrade. From the ground up, the new stage consists of the following components: vertical translation (z), rotation, horizontal translation (x and y), and a second rotation stage above the x and y stages. The vertical stage travels 88 mm allowing for vertical sample changes. The top rotation stage enables revolving sample changes. The x, y, and bottom rotation axes are used for aligning the samples in the beam.

A series of sample environment developments constitute the second constituent of the ULT sample changing ecosystem. First is the use of an Oxford Instruments dry, bottom loading 3He refrigerator with a large bore that allows for multiple samples to be arranged about a vertical rotational axis (Figure 2). Initially, the principle was proven with three samples and was scaled up to five samples later. Stacking two sets atop one another allows for up to ten 3He samples to be cooled simultaneously with merely one set up. Next, two, 70 mm Oxford Instruments dilution refrigerator (DR) inserts that share the same gas handling cart have been used to set up and cool three samples simultaneously (Figure 3). The inserts can be swapped much like changing sample sticks for six DR samples for two cool down periods.

Finally, the cans and sealing device facilitate the rapid loading, and sealing of sample cans charged to 10 Bar of He exchange gas (Figure 4). The overpressure of He provides an excess of superfluid to thoroughly coat the powder for quick thermalization, and the tip-top cans seen in the aluminum version in Figure 2 allow for the vertically translating sample arrangement.


Figure 1: HB2A Stage

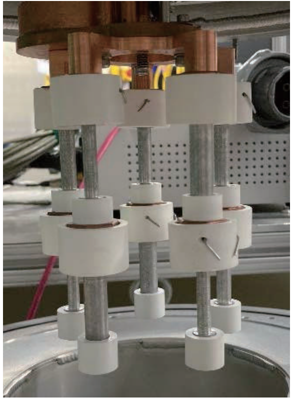
Figure 2: 10 3He Samples

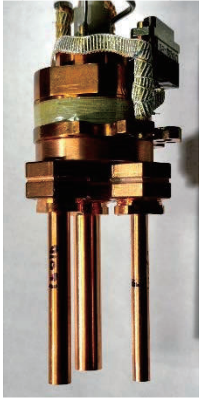
Figure 3: 3 DR Samples

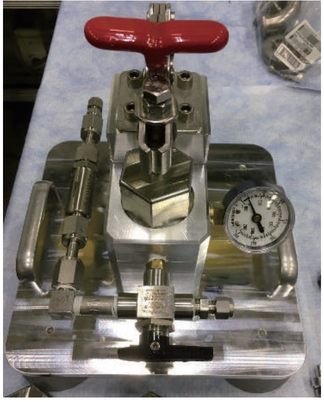
Figure 4: Sample Sealer

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DEVELOPMENT OF SAMPLES CELLS FOR THE STUDY OF SOLID-LIQUID INTERFACES USING NEUTRON REFLECTOMETRY

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The new design of sample cells for the investigation of solid-liquid interfaces by neutron reflection is currently under development for the ESTIA and FREIA reflectometers at the European Spallation Source (ESS), see Figure 1. The design has evolved from earlier work [1] to allow smaller sample volumes and faster flow rates. Use of standardized components and a modular design allows a wide range of experiments that include horizontal and vertical reflectometry geometries as well as grazing incidence scattering. Various flow arrangements to fill and replenish the liquid in the cell as well as continuous stirring are also possible. A seven cell sample changer is also under development for automation of measurements and precision control of solution mixing for contrast matching.

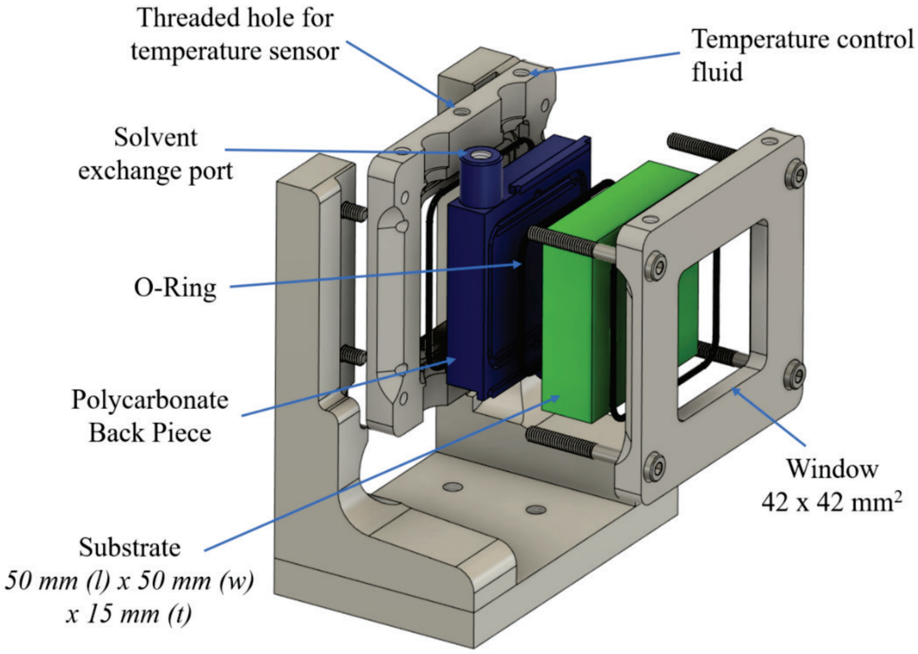

Figure 1: Model of solid-liquid sample cell showing the relationship and order of assembly of its various parts.

References

[1] A. R. Rennie, M. S. Hellsing, E. Lindholm, and A. Olsson, Review of Scientific Instruments 86, 016115 (2015).

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THE CHALLENGES WITH ELECTRICAL DESIGN OF AN INSTRUMENT UPGRADE

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Target station 1 at the ISIS Neutron and Muon Source is home to the SURF Neutron Reflectometer Instrument. In 2023 SURF received a large upgrade which consisted of the redevelopment of all electrical systems, various mechanical parts and installation of a new collimation vessel. This instrument is constrained by a small footprint and consequently had a complicated electrical design established over multiple years with various systems being installed on top of what was existing. The electrical design required stripping out the whole beamline, involving meticulous research and detailing exactly how everything functioned for a 30-year-old complex beamline. This demanded coordination of resources and being diligent with other engineering fields to enable a design solution to be found. This created various challenges and brought to the forefront the significance of the integration between electrical and mechanical engineering. It was imperative to record all findings and implementations. This was done through thorough documentation, design reviews and adding all electrical routes into the mechanical CAD model.

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O-22-3

ABSTRACT OF DENIM 2024: EVALUATION OF ELECTROMAGNETIC INTERFERENCE ON NEUTRON DETECTORS AT NEUTRON SCATTERING INSTRUMENTS

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The study investigated how to minimize electromagnetic interference (EMI) on position sensitive scintillation detectors, particularly from powered stepper motors. It was found that turning off stepper motors before measurements improves detection quality, indicating electromagnetic compatibility (EMC) issues. This assumption was confirmed by tests at the neutron scattering instrument KWS-3 at FRM II in Garching, Germany, where the unwanted interference could be avoided by powering off stepper motors prior to measurements. These findings are intended to inform the development of new instruments, such as those at the ESS in Sweden by the JCNS.

The study identified conductive interference emissions, transmitted via capacitive and inductive couplings, as the primary sources of interference. Improvement can be achieved by implementing proposed concepts, including selecting appropriate earthing and shielding strategies. This paper presents the application of these concepts, which enhance the interference immunity of the detectors, leading to a more efficient use of measurement time and resulting in potential cost savings during measurements.

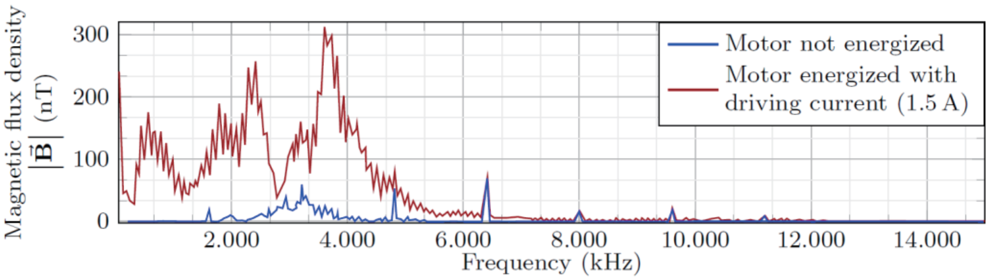

Figure 1: Measurement of the interference spectrum along the motor cable of the energized and not energized stepper motor at the KWS-3.

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CHALLENGES IN THE INSTALLATION OF A REUSABLE SHIELDING FOR NEUTRON AND GAMMA RADIATION

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E. Aulenbacher[a], **S. Seidl**[a], **A.Tartaglione**[a]
[a]Reserach Neutron Source Heinz Maier-Leibnitz (FRMII)
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Germany

After a year of work on the disassembly of a 500t radioactive instrument, the site is now available for a new shielding. This shielding will cover three new neutron guides on its way to a new instruments' building in our facility.

Considering the difficulties and costs associated with decommissioning of concrete shieldings in Germany, we at FRM II are using only reusable materials for every new instrument.

In this project, there are a number of challenges, such as: mounting multi-ton parts in areas without crane access, working with air cushions over channels in the ground, considering clashes with supports of neighboring structures, working in areas with 300µSv/h, organizing shared resources with other installations, coordinating just in time delivery of materials. We will present solutions how to meet the requirements for flammable shielding material and static requirements in case of earthquakes or aircraft collisions.

We will share issues and unpredicted challenges, 'the bad and the ugly', as well as the lessons learned during this project.

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RISK MITIGATION: BEHIND THE SCENES OF PROJECT SCHEDULE

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The NIST Center for Neutron Research (NCNR) is disassembling the vessel to clean the remaining debris (~1-3 g) from a damaged reactor fuel element. This will cause the NCNR to not conduct scientific operations for an extended period. The facility is taking advantage of this time to upgrade the oldest three neutron guide lines. Additionally, the NCNR is undertaking various upgrade and replacement projects. All these projects are part of the NCNR Integrated Project.

A multifaceted, multidisciplinary project like this one has the potential for a lot of things to go wrong. A risk register has been created to track, and to mitigate, risks to the project that could negatively affect the schedule, scope, and budget. Furthermore, hazard reviews are created to mitigate safety concerns for any activity. Those tools, along with a resource loaded project schedule, create a cohesive project plan with reduced error bars.

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ISIS ENDEAVOUR PROGRAMME UPDATE

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At the 2022 DENIM XI conference Dr Philip King, ISIS Science Division Head, gave a presentation on the then new ISIS Endeavour Programme, which included the delivery of 4 new instruments and the major upgrade of 5 existing instruments.

This presentation will show the progress over the past two years. Highlighting;

- Advancements made on the initial instruments.
- Technical advancements and challenges.
- Review of the risks and the proposed mitigating solutions.
- Reevaluation of the scope of the remaining instruments.
- Revised schedule and milestones.
- Restructuring of the Project Design Management team and their roles.

Plus, a broad overview of the other ISIS instrument projects outside the Endeavour Programme and the two ISIS in-kind contribution instruments for the ESS in Sweden.

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PROJECT UPDATE AND MANAGEMENT OF A MODERATOR TEST STATION AT SNS

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The Oak Ridge National Laboratory has plans to operate 3 world-class neutron facilities within the next 15 years. This includes the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR). The SNS currently operates the First Target Station (FTS) and is the future site of the Second Target Station (STS) which is under design. These facilities need continuous upgrades to keep them state-of-art and reliable to the neutron user community performing experiments at the facilities.

SNS is nearing completion a proton power upgrade project (PPU) to increase the power from 1.4 MW to 2.8 MW. New projects are underway to further enhance the capabilities of SNS including developing a purpose-built moderator test station (MTS) for the development of optimized moderators to be used at SNS and STS.

Moderators are critical components within the target system of SNS and other neutron facilities used to tune the neutrons to desired energies, pulse shapes, etc., optimized for specific instruments which they serve. By changing features of the moderator, such as para-ortho ratio, neutron poisons, or moderating mediums, significant performance gains at the instruments can be realized. Moderator designs are complex and the design cycle to develop, design, build, and test new moderators is long. Implementation into the operating facility is challenging and must be well tested and understood prior.

A moderator test station at the SNS will provide the needed test bench to perform optimization studies of new moderators in a focused manner without interruption to the operating user facility. The MTS will utilize an existing low energy beamline source to deliver beam to a new neutron producing target adjacent to the test moderators. The current beamline will be expanded while a second neutron beamline will be added equipped with diagnostic equipment such as detectors, beam monitors, and a data acquisition system that will be used to study and optimize the moderators under consideration.

The initial conceptual design was presented at DENIM last year. Since then, the conceptual design review was successfully completed, and the team is progressing through the preliminary design phase. A status update will be given with a focus on project management. The project has many challenges; project controls and planning are essential for future project success which is operating on a limited budget and schedule. Communication and planning are key elements driving current success with an experienced project team working together. A review of project controls implemented along with lessons learned will be discussed.

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HRPD: HIGHLY REFINED PROJECT DELIVERY – BUILDING NEW BEAMLINES AND THE ROLE OF INTEGRATION

Tim Maundrell

ISIS, RAL, Oxfordshire, UK

Often as engineers we work in isolation, boring into the detail of our own work, without necessary understanding the global picture. However, whole instrument projects are complex with a myriad of problems and tensions to be solved, across a spectra of skills and expertise. How do you manage sub-component interfacing and space restrictions across departments? When does engineering reality trump scientific need? How do you choose between staying in your comfort zone (“because we’ve always done it that way”) and experimenting with new, novel solutions?

To understand these compromises and to deliver whole beamlines successfully, ISIS have developed an Instrument Integration Team. With a top level view and standard working practises, their role is to understand the requirements of all stakeholders, hold these tensions together and deliver a complete solution which is, hopefully, greater than the sum of its parts. Sounds easy, right?

This talk will delve into some of these tensions and ways of working, specifically within the context of the HRPD-x Instrument Project.

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O-23-4

INSTRUMENT NEUTRON GUIDE UPGRADE PROJECT AT THE ACNS - ANSTO

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[c]*European Spallation Source, Lund Sweden.*

In March 2024 the OPAL 20MW light water reactor entered a planned shutdown to replace the cold neutron source. As part of this multi-month shutdown a range of upgrades was undertaken at the Australian Centre for Neutron Scattering (ACNS). This presentation focus' on the upgrade of the neutron guide on the SANS instrument (Quokka), the Reflectometer (Platypus), the Time of Flight Instrument (Pelican) and the Laue Diffractometer (Koala).

In collaboration with the ESS guides specialist Dr P Bentley a design for a new focusing guide on the Laue Diffractometer Koala was developed. The expected flux should double for a sample size of 3x3mm. The guide will have translatable apertures on either end to select the appropriate conditions for the given sample. Installation is targeted for the 3rd quarter of 2024.

Also working with Dr P Bentley an optimized design for a parabolic tapered guide to focus the large beam down to 10x10mm for the Time of Flight instrument Pelican was developed. There was very little available space and this has resulted in 2 small guide pieces that translate in and out of the beam vertically. The expected flux improvement on is a factor of 10 on samples 10x10mm compared with the flux on large samples (up to 50x60mm). Installation took place from June 2024. Analysis of shielding performance was undertaken by Dr F Gruenau.

The SANS instrument Quokka guide replacement was undertaken primarily to optimize performance with a polarized neutron beam. A total of 15m of guide was installed in May 2024. The instrument was originally aligned with a theodolite in 2006, this process was repeated and a Faro laser tracker was also used to confirm alignment.

The Reflectometer Platypus guide replacement was relatively straight forward and a small improvement in flux of 25% is expected over the guide installed in 2006 by changing from a tapered for a straight guide. The 1m guide was installed and aligned in April 2024.

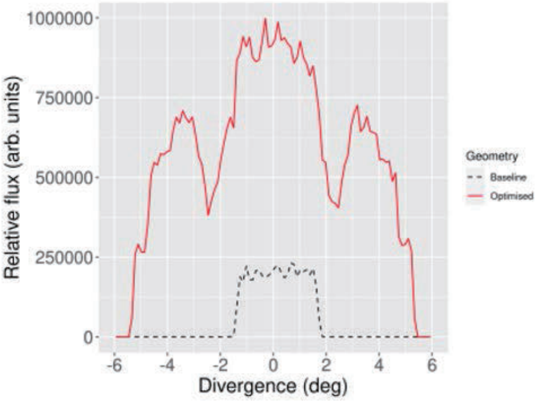

Figure 1. (Left) Expected flux gain on a 10x10mm sample on the TOF instrument Pelican.

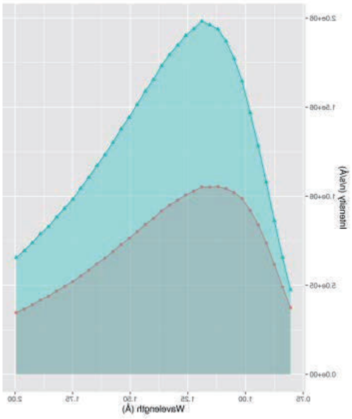

Figure 2. (Right) Expected flux gain on a 3x3mm sample on the Laue Diffractometer Koala.

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O-23-5

REACTOR RECOVERY AND GUIDELINE UPGRADE PROJECT AT NIST

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The NIST Center for Neutron Research (NCNR) has not conducted scientific operations since January 2021 due to a damaged reactor fuel element. Following an extensive cleanup effort, the reactor can be operated safely, and well within regulatory requirements. However, routine operations remain inhibited by a small quantity of damaged element debris (~1-3 g) still present in the reactor vessel. Thus, plans are underway to disassemble the vessel for further cleaning ahead of a return to scientific operations. In parallel with this reactor recovery project, the facility will upgrade the three oldest neutron guidelines and the associated guide support systems. This upgrade will improve data rates by a factor of 2-10 for the nine instruments served by these guidelines. The NCNR is pursuing these two projects as a single integrated project and is managing resources as such.

This presentation will provide an overview of the project scope and details on how the project plan was developed and is being coordinated between various teams and disciplines at the NCNR.

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KNOWLEDGE TRANSFER PHASE 1: IN-KIND CONTRIBUTIONS TO THE ESS

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Large-Scale Research Infrastructures (LSRIs) are vital for conducting advanced scientific research and fostering innovation. They represent significant investments in knowledge, technology, and international cooperation, driving progress across multiple scientific disciplines and contributing to societal advancements.

In-Kind contributions such as equipment, technology, and expertise are a fundamental aspect of the development and operation of LSRIs. They are motivated by a combination of strategic, economic, and collaborative benefits. These contributions enable countries to share costs, promote technological advancement, and enhance their international standing. It also enables LSRIs to leverage the strengths and specialties of diverse partners, fostering a collaborative approach to scientific and technological advancement. By participating in LSRIs, member countries not only contribute to global scientific progress but also reap significant domestic benefits in terms of capacity building, economic growth, and innovation.

The European Spallation Source (ESS) is a multi-disciplinary LSRI currently under construction in Lund, Sweden. It is designed to be the world's most powerful neutron sources, enabling groundbreaking research in a wide range of scientific fields. It is a pan-European project with contributions from 13 European countries, including Sweden, Denmark, Norway, Germany, and the UK. The collaborative nature ensures shared expertise, resources, and funding. The construction of the ESS are funded through contributions from the member countries. This includes both financial and In-Kind contributions.

Since the ESS is a "green-field" facility, the construction project benefits a lot from expertise coming from all over Europe. At the same time the In-Kind model caused and causes quite a few challenges and issues, ranging from legal and VAT topics to quality assurance, change management, warranties and liabilities.

In the current well-advanced phase of the construction-project it is timely to discuss possible In-Kind contributions to the Steady State Operation phase. This can only be achieved successfully if a thorough analysis of the issues and challenges for In-Kind contributions to the construction is conducted.

Therefore, the knowledge transfer proposed during the last DENIM XII has been divided into different phases and phase one focuses on lessons learned from In-Kind contributions to the ESS. This presentation will cover all aspects of knowledge transfer reported so far with focus on neutron instrumentation engineering challenges.

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SECOND TARGET STATION INSTRUMENT SYSTEMS PRELIMINARY DESIGN STATUS 2024

V. Graves
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The Second Target Station (STS) Project is well into its Preliminary Design phase after receiving Critical Decision 1 (CD-1) approval from the U.S. Department of Energy in November 2020. The initial suite of eight instruments provided with the project were selected in July 2021, and soon thereafter the preliminary designs of four instruments began; subsequent Preliminary Design Reviews for the optic systems of CHESS, PIONEER, and QIKR were held in August 2023. The STS Project has undergone some significant changes due to various value engineering choices made to reduce the overall Total Project Cost, and the Target & Instrument Building has also undergone significant changes. This presentation will provide a current status of STS Instrument Systems, progress on instrument development, and an overall project schedule.

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ABSTRACT OF DENIM 2024: HOW ISIS MANAGES CHANGE TO SAFETY SYSTEMS ON OPERATING BEAMLINES

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This talk will deliver an overview of how ISIS manages changes to safety systems on operational beamlines such as the shielding, and personal protections systems.

Safety systems are designed and installed to a high standard and at at the moment of intial operation, following commissioning, are considered to be at the operating peak with regard to keeping people safe.
However, thoughtout the operational life of a beamline numorous changes, upgrades, and modifications may occur. Some are carefully planned and some are as a result of operational needs. If not carefully managed this may lead to negitive performance of these safety systems and consequenses.

This talk will discuss the guidlines employed by ISIS Instrument Operations to maintain the integrity of safety systems during operational changes. I will illustrate these practices with real world examples, highlighting the logic behind our appraoch to preventing the degradation of our instrument safety systems.

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IN-SITU 3HE POLARIZATION AND ANALYSIS DEVICE AT THE FRM II

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[c]ISF, Faculty of Mechanical Engineering, RWTH Aachen University, 52062 Aachen, Germany

An in-situ SEOP polarizer (Spin-Exchange Optical Pumping) with polarization analysis has been designed for the POLI instrument (Polarized Hot Neutron Diffractometer) at FRM II in Garching, Germany. Figure 1 shows the entire setup at POLI.

The mechanical assembling of both components, the analyzer and the polarizer, is finished and currently the two devices are in Garching for electrical assembly. In the next steps they will be installed on the instrument and commissioned.

The presentation describes the design of the setup at POLI and the individual technical components of the polarizer and the analyzer and explains the function of both devices and how they work together.

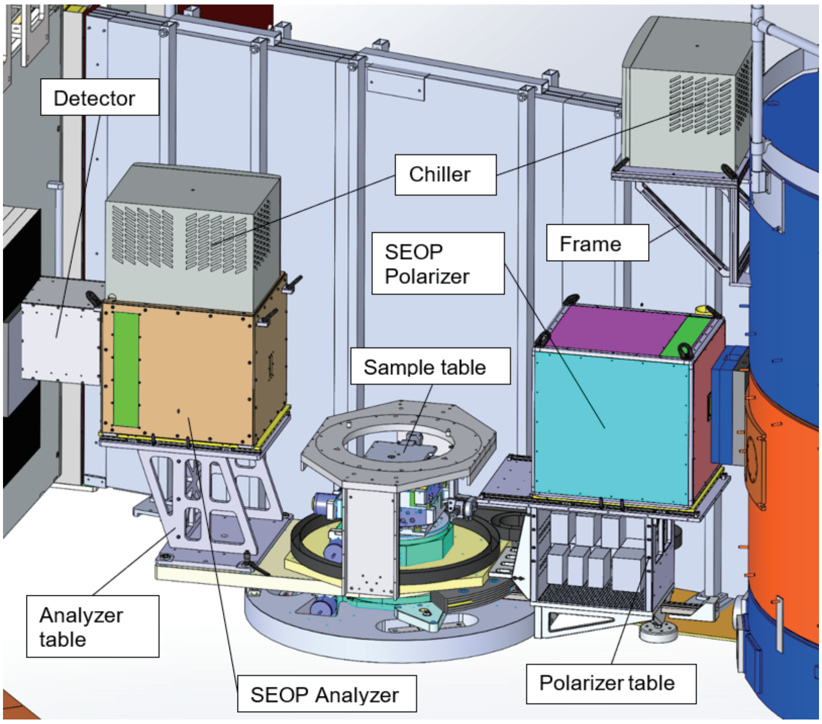

Figure 1: Setup @ POLI.

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[1] E. Babcock *et al* 2023 J. Phys.: Conf. Ser. 2481 012009

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ENGINEERING PRACTICES AT NSS

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In the presentation I´m going to provide an overview of the NSS (Neutron Scattering Systems) engineering workflow and review processes, focusing on instrument engineering aspects and experiences.

The lifecycle phases and the brief summary of the content is the following.

- Preparation for design.
  Instrument proposal, and considerations for the concept.
- Preliminary design
  Maturity level of design, and roles of stakeholders
- Detailed design
  Expected structure and content of the documentation. Design verification approach.
- Manufacturing and procurement.
  Definition and tracking of procurement scope.
- Installation and Integration.
  Tracking of installation and challenges of integration.
- Commissioning
  Cold and hot commissioning strategies.

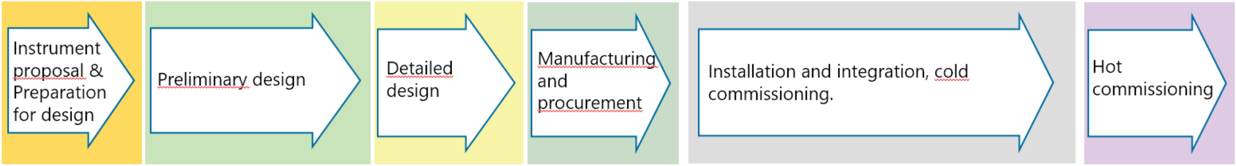

Figure 1: NSS design workflow.

References
[1] ESS-0092276 - ESS Handbook for Engineering Management
[2] ESS-0051706 - NSS Process for Neutron Instrument Design and Construction

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INFLUENCE OF A DECADE OF EUROPEAN COLLABORATIONS ON ESS AND THE ISNIE COMMUNITY OF PRACTICE: PERSONAL REFLECTIONS

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Europe stands proudly awaiting first neutrons at its newest user facility the ESS.

This goal which has brought together and motivated much of Europe’s neutron science and engineering community for more than a decade, will shortly be complete, and quietly dissolve the myriad of technical collaborations between facilities and universities across the continent which made it possible.

Less well recognised is that during this same period, from within much the same community, a second professional collaboration, that of the DENIM community soon ISNIE, spontaneously also came into being and evolved in parallel.

On the eve of the goals completion, under which both collaborations have prospered, I propose a personal reflection on how the vision and passion of each community has nourished the others success, how synergies have emerged between them driving further professionalisation within the industry and opening possible futures for the instrument engineering community in Europe and beyond.

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STS STANDARDIZED TRANSPORT TUNNEL SHIELDING DESIGN

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Standardization of designs can provide potential cost savings not only in design but also in procurement and in maintainability over time. To benefit from those savings, the Second Target Station (STS) Project has been pursuing standardized designs in many areas such as guide housings, shutters, choppers, and shielding. However, it can be challenging to find a single design that meets a given set of requirements across many beamlines, each of which may have different needs and constraints. The design of standardized beam transport tunnel shielding for STS has faced many challenges and has considered many possible solutions for those challenges. This presentation will give a description of the challenges faced along with a discussion of how the current proposed design solves them.

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O-32-1

AN OVERVIEW OF THE ORNL SECOND TARGET STATION PROJECT

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The Oak Ridge National Laboratory (ORNL) Second Target Station (STS) Project is a 10+ year, multi-billion (US) dollar project to build a second target station at ORNL's Spallation Neutron Source (SNS). The STS will deliver a 700 kW, 15 Hz proton beam to a solid tungsten rotating target, producing neutrons for 18 to 22 neutron scattering instrument end stations. The STS will provide the highest peak brightness cold neutrons in the world. The science capabilities provided by the instrument suite at the STS will complement those of the two existing neutron scattering user facilities at ORNL, the SNS First Target Station (FTS) and the High Flux Isotope Reactor (HFIR). This talk will give a technical overview of the project and its 5 major subsystems, Accelerator Systems, Target Systems, Instrument Systems, Conventional Facilities and Integrated Control Systems. The ORNL Second Target Station Project is funded by the US Department of Energy Office of Science Basic Energy Sciences program.

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DENIM XIII TOKIA Japan 2024

Continual Improvement of ISIS Instruments (old & new)

Presentaion by John Crawford – contributions form A.Eagles*, K.Mordecai*, T.Willoughby*, S.Cooper*,*
STFC ISIS RAL Harwell OX10 0QX UK

Topic areas
Instrument Projects, Operations and Maintenance

<u>*Abstract*</u>

Continual Improvement of ISIS Instruments (old & new)

This talk will deliver an update on our recent experience and lessons learned in the upgrade and operation of the Instrument suites in TS1 & TS2 at ISIS over the last year
Area's of focus will be;
The challenges faced and lessons learned keeping the older ISIS Instruments performing.
Updates on the following Instrument challenges faced over the last year will be ;

- TOSCA CCR's and Improving maintenance procedures
- MARI Mechanical shielding failure
- MAPS Jaws repairs
- IMAT Sample stack repairs
- INTER Secondary commissioning (also poster)

The challenges faced keeping the older ISIS Instruments performing.
The first part of the talk will focus on the technical difficulties we face when maintaining and managing legacy Instruments. I will demonstrate the importance of succession planning and knowledge transfer through examples like the maintenance of TOSCA, the failure of mechanical shielding in MARI and MAPS jaws failure. I will also focus on the importance of good maintenance practice and the benefits of Instrument performance tracking (lost time), the improvements we've made to our Operating procedures and Shutdown procedures.

Pre-building for Instrument Performance

The second part of the talk will demonstrate the value added to Instrument performance of pre-building Instrument upgrades. I will focus on the demonstrated improvements to INTER and the factors that contributed to the gains made. The importance of concentrating technical efforts early on pre-builds delivers increased performance during Operation.

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BACKEND REDESIGN OF THE HIGH-FLUX TRIPLE-AXIS SPECTROMETER TAX

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The current HB3 backend has low vertical and horizontal acceptance, antiquated shielding, and severe sample table weight limitations due to the cantilevered design. We redesign the HB-3 backend to increase the signal to noise ratio and to allow the use of larger and heavier sample environments. The new design will provide a greater horizontal and vertical acceptance of the scattered beam, will allow the use of horizontal focusing and Q-dispersive constant energy geometry. Specific items in the design include:

1. The cantilever supported monochromator arm will be replaced by a plate-on-rail outside circumference of the arm's travel to support the far end at constant elevation and provide smooth rotation.
2. The current fixed analyzer has vertical focusing only. It will be replaced by an analyzer with moveable and rotatable columns of pyrolytic graphite (PG) crystals, and the columns will retain the fixed vertically focusing element. The moveable and rotatable features will permit operation of the instrument in the 4 discrete modes including the conventional flat analyzer single detector mode, monochromatic point-to-point double focusing mode, diffraction with PSD mode, and the monochromatic q-dispersive mode in transmission geometry mode.
3. The analyzer drum will be enlarged to accommodate the new analyzer. Its moveable wedge shielding system will be redesigned to permit control of the horizontal opening size, with more resolution of the opening size (i.e., smaller wedges). The redesign will provide a more closely machined, tighter structure to reduce background. Accommodations will be made for incoming collimation.
4. The current single ^{3}He detector tube will be replaced by an array of linear position sensitive detector (LPSD) ^{3}He tubes in order to implement the 4 discrete operational modes referenced above.
5. The detector shielding will be redesigned to accommodate the new detector array and the associated wiring/electronics. Provision will be made for incoming collimation, with adjustable masks immediately upstream of the collimation.

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MODULAR INTERDIGITATED DETECTOR ARRAY SYSTEM (MIDAS) UPGRADE AT HFIR HB-2A

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The HB-2A POWDER instrument operating at the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) is undergoing an improvement project to upgrade the detector system and accompanying instrument components. This neutron diffractometer utilizes Debye-Scherrer scattering geometry to conduct magnetic and crystal structural studies of powder and ceramic samples in extreme conditions (Figure 1a). These sample environments can range in temperature from 0.03 – 1800 Kelvin, magnetic fields to 8 Tesla, and pressures up to 2 GPa. It is also the only powder diffractometer at ORNL with polarized beam capabilities. The current instrument has a 44-element detector with individual collimators that rotates radially through 30 steps around the sample center for the collection of a single data set. These scans can take significant experimental time, even with the high flux neutron beam, and time resolved studies are not possible. Due to this limitation, the MIDAS upgrade is currently in development to design a continual array detector and increase the throughput on the instrument by ~30 times (Figure 1b).

The MIDAS upgrade will utilize Helium-3 linear position sensitive detector (LPSD) tubes at 20 atm with accompanying electronics to create 8 pack assemblies. These 8 packs will be stacked 2 high and then interweaved so that they overlap the dead zone areas on the tube ends. 7 of these stacks are then organized tangent to an optimized radius from the sample center and forms the continuous detector array. This design is a novel and low-cost addition to the existing instrument that will significantly increase the science capabilities. The electronics and data reduction software will be updated to increase the acquisition rate of the instrument and improve weak signals from smaller samples. A new oscillating radial collimator will be procured and installed to provide proper resolution. The current instrument shielding will be replaced with non-magnetic modular shielding that will allow greater maximum magnetic fields for the sample environment. The base will also be replaced with a non-magnetic stand and a mezzanine will be incorporated above the instrument for access to load/unload samples. A prototype of the interdigitated array was tested on the current POWDER instrument with success and detector tubes have been purchased from Reuter Stokes (Figure 2). Designs are in development for the MIDAS upgrade and this presentation highlights the unique science and engineering challenges/solutions to have this instrument upgrade installed and operational in the HFIR instrument beam room.

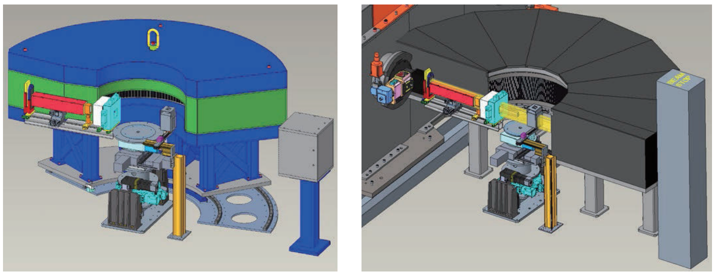
(a) (b)

Figure 1: Models of current (a) POWDER instrument and (b) MIDAS conceptual design

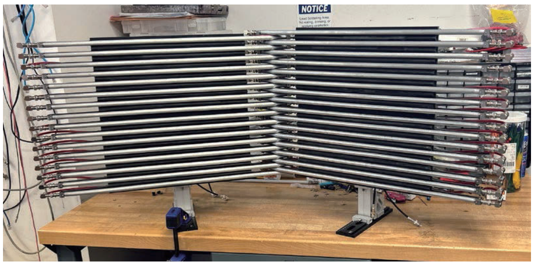
Figure 2: Prototype interdigitated 8 pack detector stacks

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Optimized sample environment for the 6-axis robot at the neutron diffractometer STRESS-SPEC

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Co-authors: Heims, D. [2] , Hofmann, M.[1], Wang, L.[1] , Gan, W.[2], Faulhaber, E. [1], Peters, J. [1],
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Keywords: neutron diffraction; sample environment; laser furnace; tensile/compression rig

Components and materials from new production processes, i.e. additive manufacturing (AM), require highly flexible sample positioning systems for residual stress diffraction experiments. Therefore, the STRESS-SPEC group has pioneered the use of industrial robots for sample handling and positioning at neutron diffractometers [1, 2]. In this respect, a dedicated sample environment is essential to fully exploit the capabilities of the robotic positioning system. In this presentation, we will give a brief overview of this robotic sample positioner project (funded by the BMBF Germany) with the primary focus on the adapted sample environment and here a recently developed lightweight laser furnace with a large neutron acceptance angle. This furnace allows investigation of samples at elevated temperatures up to 1200 °C, while benefiting from the positioning flexibility of a 6-axis industrial robot. Some features and example use cases of the laser furnace are presented. The furnace control rack was built with interoperability in mind, allowing control of various other sample environment devices as well. Furthermore, an outlook will be given on our current development of a mechanical tensile testing machine which can be mounted on the 6-axis robot of STRESS-SPEC. This test rig has an innovative piston and drive arrangement which lets the measuring volume stay stationary while testing. The crosshead topology of the rig is optimized with respect to the weight limits of the robot and in combination with high strength Titanium as building material results in a total mass of less than 30 kg, while providing a large neutron acceptance angle and a load capacity up to 50 kN.

[1] H.-G. Brokmeier et al., Mater. Sci. For. **652** (2010) pp. 197–201. DOI: 10.4028/www.scientific.net/MSF.652.197
[2] C. Randau et al., Nucl. Instr. Meth. A 794 (2015) pp. 67–75. DOI: 10.1016/j.nima.2015.05.014

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HIGH TEMPERATURE FURNACE SAFETY AND REMOTE CONTROL, AS WELL AS TEMPERATURE STUDIES

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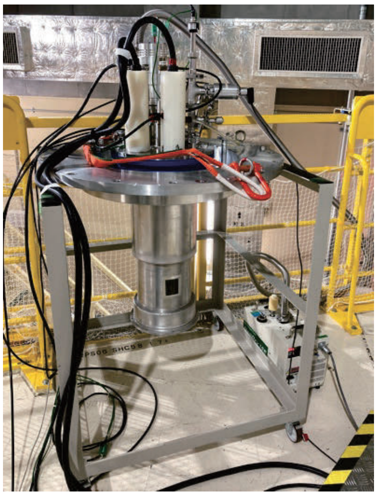

Figure 1: Vanadium high-temperature furnace

BL08 Super High Resolution Powder Diffractometer, SuperHRPD [1] at MLF, J-PARC has the vanadium high-temperature furnace as one of the sample environment instruments (Figure 1). It reaches a maximum temperature of 950 °C in 4 hours from room temperature. It is high-demand sample environment equipment, with 1/4 of the proposals requesting their use. Meanwhile, it was only operated when a person was near the furnace to avoid fire and other hazards. This report describes the measures taken to permit remote operation of the furnace at MLF. In conjunction with this safety measure, sample temperature calibration was also examined. The poster will also introduce issues in temperature calibration.

The furnace uses a control panel to monitor vacuum, temperature and cooling water, etc., and if abnormal values are detected, the heater is automatically turned off and informed of the problem by alarms and patrol lamps. To enable experimentation with remote control in MLF, certain safety requirements need to be met as well as these interlocks. In particular, systems that can be monitored remotely, that check the well-being of equipment, and that provide an environment where anyone can respond to emergencies are required.

Firstly, as part of the development of the remote monitoring system, an alert panel was installed to read signals from the control panel. The alert panel enables the real-time viewing of alerts and notifications from any machine in the network via the web UI. Furthermore, software was developed for the purpose of recording the data used in the experiments and scheduling the temperature settings. The next point is the soundness of the equipment. Heaters change their current and voltage values over time, so temperature rise tests are performed periodically, and regular maintenance and inspections of the furnace are also carried out to check the condition of the heating elements, etc. The user should check the sample's reaction at high temperatures and the sample holder's reaction before use. For remote operation during the experiments, the communication flow goes to the person in charge of the equipment in the event of an emergency. And manuals are posted on site so that if an alarm goes off, anyone can go to the side of the device to find out what to do.

The above steps have resulted in the safety of the equipment and measures being recognized by the MLF, allowing remote operation of the furnace at BL08.

References

[1] S. Torii *et al*, J. Phys. Soc. Jpn. 80 (2011) SB020.

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P-3

NOMAD Secondary Collimation Project Update

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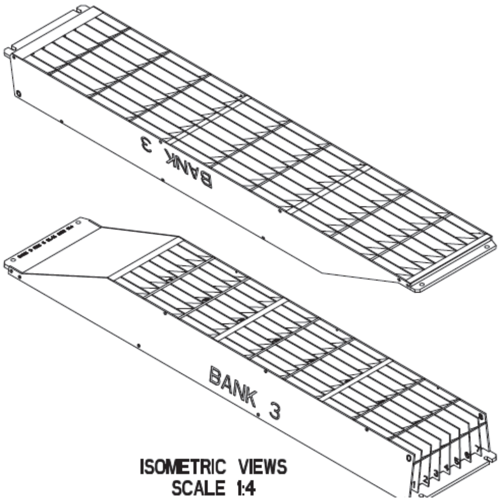
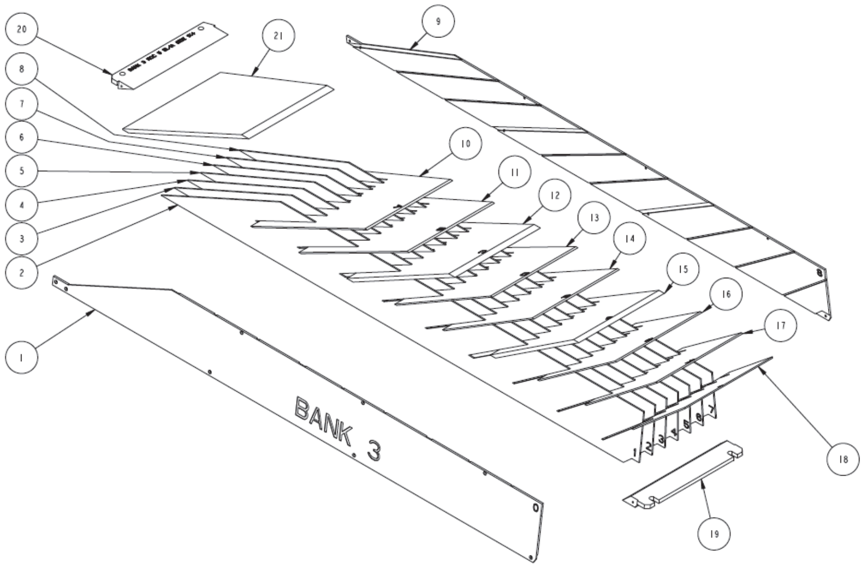
The NOMAD instrument team at the spallation neutron source has been exploring different methodologies for secondary colimitation of helium 3 LPSD 8-packs. After the previous DENIM the team received suggestions and made new connections. After exploring these suggestions, the team has focused on developing a borated aluminum sheet metal collimator with Alumeco. This poster will focus on the lessons learned and new concept for the secondary collimators.





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COMPACT ANALYSER TOWER ASSEMBLY FOR POLARIZED COLD NEUTRON TRIPLE-AXIS SPECTROMETER KOMPASS AT THE MLZ.

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The common trend towards the study of small samples of few mm³ only in combination with an advanced sample environment, has given rise to the implementation of sophisticated focusing conditions in modern neutron spectroscopy. The detection of small inelastic signals in a variety of environmental conditions such as low temperature, pressure, magnetic and electric fields requires a well thought-out instrument design.

This contribution provides an overview of the analyser tower assembly of the new cold neutron triple axis spectrometer KOMPASS [1, 2] recently built at the MLZ, Germany. The KOMPASS instrument has been developed to operate exclusively with polarised neutrons, which imposes restrictions on the use of non-magmatic materials only and requires a careful design of the guide-fields along the entire neutron path. The precise combination of diverse mechanical, pneumatic and electronic components within a restricted volume supplemented, complemented by the modern neutron shielding provides a state-of-the art component that is characterised by experimental flexibility due to several analyser options, low background level and compliance with high neutron polarisation.

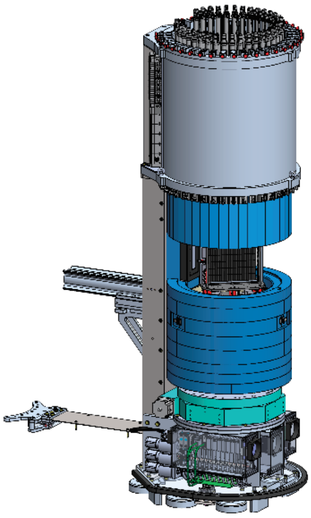

Figure 1: CAD Modell of the analyser tower at KOMPASS

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[2] https://mlz-garching.de/kompass
[3] D.Gorkov et al., in preparation, Nucl. Instr. and Meth. A (2024).

The construction of KOMPASS is funded by the BMBF through the Verbundforschungsprojekt 05K19PK1.

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P-7

DIFFRACTOMETER FOR RESIDUAL STRESS ANALYSIS INSTRUMENT UPGRADE -DENIM 2024

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The NCNR has upgraded and added new capabilities to the Diffractometer for Texture and Residual Stress (DARTS) shown in Figure 1. The purpose of the instrument is to non-destructively measure tri-axial residual stresses in industrial parts and structural materials at spatial resolutions ≥ 1 mm^3. Stresses are determined from the measurement of elastic changes in the interatomic lattice spacing at depths up to several centimeters. Another important application is the measurement of sheet metal yield functions using specialized straining devices. Here, the neutron measurement of applied multi-axial stresses is combined with simultaneous strain measurements based on digital image correlation (DIC).

The upgraded instrument now features a large, high-pressure 10 bar 3He area detector (25 cm × 38 cm) for high-efficiency neutron detection. Optimized neutron flux on the sample is provided by single and multi-wavelength Si-Crystal monochromators with variable curvature. Sample environment equipment consists of two multi-axial high-capacity straining devices (shear device and Octo-strain), a uni-axial load frame, separate sample stages for small and large samples, and a digital image correlation system for the measurement of plastic strain during multiaxial loading.

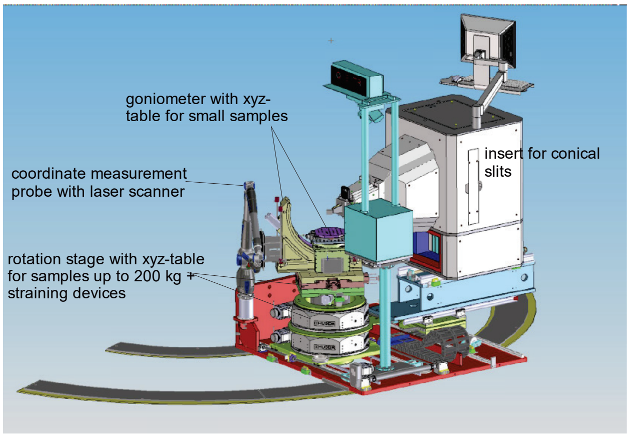

Figure 1: New Diffractometer for Residual Stress

Octo-Strain has eight individually controlled actuators (40 kN each) that can produce strain paths and straining modes common in sheet metal forming. Compressive stresses are possible but may need anti-buckling measures. The shear device has two actuators for producing a variety of shear deformation modes. Both devices can be rotated (Octo-strain: 190°; shear device: 135°) to allow different measurement directions necessary for determining the stress tensor and the principal directions of deformation.

References

Justin L. Milner, Thomas Gnäupel-Herold, Design of an Octo-Strain Specimen for Biaxial Tension Testing, Proceedings of the ASME 2018 13th International Manufacturing Science and Engineering Conference, https://doi.org/10.1115/MSEC2018-6612

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P-8

POLARIZATION ANALYSIS METHOD FOR REMOVING INCOHERENT SCATTERING COMPONENT AT BL15 TAIKAN AND SANS-J

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In small-angle neutron scattering (SANS) measurement, incoherent scattering components from samples are observed as background that does not have structural information. Precise estimation of incoherent scattering component and separation of it from the coherent scattering component is important for the correct evaluation of the sample structure especially with hydrogen-rich soft matter samples that have large incoherent scattering cross-sections. In the spin-incoherent scattering process, spin flipping of neutrons occurs with a probability of 2/3 in a single scattering event whereas no spin flipping occurs in the coherent scattering. Therefore, by separately observing spin-flip and non-spin-flip scattering components using polarization analysis, the incoherent scattering component can be experimentally estimated and separated from the coherent scattering one.

There are some SANS instruments that have such polarization analysis option in Japan, BL15 TAIKAN [1] at Material and Life science Experimental Facility (MLF) of J-PARC and SANS-J [2] of JRR-3. At TAIKAN, incident neutrons are polarized by magnetic supermirrors. We have prepared polarization analysis setup that consists of ^{3}He spin-filter type analyzer and an automatic sample changer [3]. Using this setup, we can obtain coherent and incoherent SANS profiles whose scattering angle $2\theta < 24°$ ($q < 10$ nm^{-1}) separately and mount six samples simultaneously.

At SANS-J, the incident neutron beam is polarized by a permanent-magnet type sextupole magnetic lens to obtain intense polarized neutron beam. Using this lens optics, intensity of incident neutron flux becomes 30 times higher than that of pinhole collimation beam polarized by supermirror type polarizer. Neutrons scattered by the sample are analyzed by magnetic-supermirror type analyzer that placed in front of the high-angle detector of SANS-J and measurable q-range of this setup is $q < 2$ nm^{-1}.

In this presentation, we will introduce polarization analysis setups of TAIKAN and SANS-J and show recent experimental results.

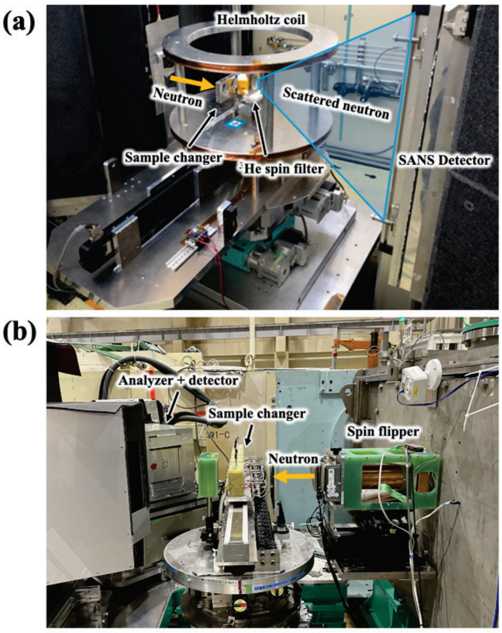

Figure 1: Polarization analysis setup of (a) BL15 TAIKAN and (b) SANS-J.

References

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[2] T. Kumada *et al*, J. Appl. Cryst. **56** (2023) 1776–1783.
[3] T. Okudaira *et al*, J. Appl. Cryst. **54** (2021) 548–556.

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POLDI Upgrade

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POLDI: a neutron time-of-flight diffractometer for materials science. It was put into operation in 2002. In contrast to other experiments at the neutron source SINQ at PSI Switzerland, the realization was not carried out by the usual instrumentation team.

The realized solutions still left plenty of room for improvement, both conceptually and in terms of implementation. Especially in the areas of detector, neutron flux and background reduction.

The ongoing upgrade is intended to optimize the existing weak points and make the instrument fit for future applications. In addition, the operation and maintenance of the instrument will also be simplified. However, the instrument will not be completely renewed!

Some of the work has already been completed. Many others are still in the realization or even planning phase.

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90% BACKGROUND REDUCTION USING >99.999% ALMINIUM WINDOWS AND 30 TIMES ENHANCEMENT OF POLARIZED NEUTRON FLUX USING EXTENDED SHORT-FOCAL-LENGTH MAGNETIC LENSES IN SANS-J AT JRR-3

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Al alloys are widely used for neutron windows in diffractometers and their sample environmental apparatuses, because they do not only have high transmission and low scattering power, but also have high fracture toughness, processability, and affinity with other metallic materials. However, scattering from nano-particles of additives and impurities in the alloys have interfered SANS measurements in many cases. Recently, we found that SANS intensity from >99.999% aluminium (5N-Al) is much smaller than that from the alloys (Figure 1), and then developed a 500 mm-diameter 5N-Al window for a vacuum tube of SANS-J at JRR-3 [1]. Although the center thickness of 5N-Al window (3 mm, Figure 2) was made larger than that of the alloy window used so far (1 mm) to compensate smaller fracture strength, the scattering from the window was reduced by 10 in maximum. Figure 3 compares the scattering from 1 mm-thick H_2O using the Al alloy and 5N-Al windows. Thanks to the decrease of background intensity, the SANS-J with the 5N-Al window can measure the scattering at Q down to 0.03 nm^{-1}.

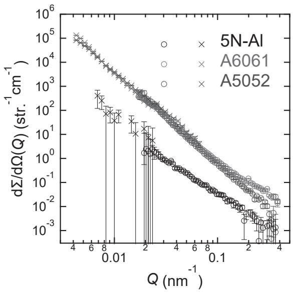

Figure 1: SANS of 5N-Al and Al alloys.

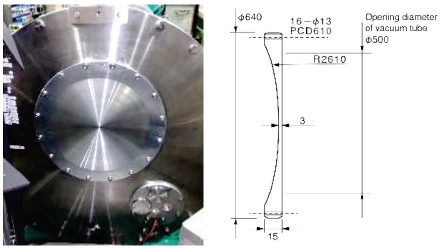

Figure 2: 500 mm-diameter 5N-Al window.

Unlike material lenses such as MgF_2, the magnetic lenses focus the neutron with positive spin polarity without transmission loss or diffuse scattering. However, since the magnetic lenses defocus neutrons with negative spin polarity that interfere structure analysis, 1.2 m-long magnetic lenses (f = 4.8 m) have been used in combination with small-diameter quadrupole magnet polarizer only to measure the scattering at $Q < 0.07\ \mathrm{nm}^{-1}$. Here, we propose a novel use of the magnetic lenses without polarizer for the scattering measurements at $0.2\ \mathrm{nm}^{-1} \leq Q \leq 6\ \mathrm{nm}^{-1}$ by focusing the incident neutron beam with positive spin polarity on the sample position using totally 3.6 m-long magnetic lenses (f = 2.4 m), whereas the defocused beam with negative spin polarity was blocked by a slit at the sample position to achieve polarization higher than 83%. The flux of the polarized neutron beam became higher than that with non-focused conventional layout by a factor of 30.

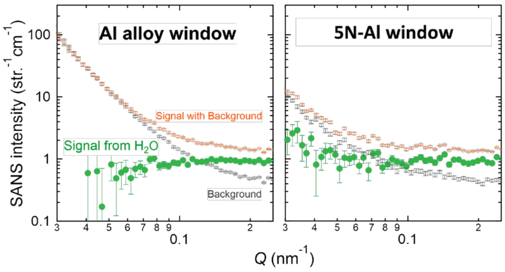

Figure 3: SANS curves of 1 mm-thick H_2O. Orange: signal with background, Gray: background only, Green: after subtraction.

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Physical design and neutron optics tuning for the engineering materials neutron diffractometer "EMD" at the China Spallation Neutron Source

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Neutron diffraction is a key method for detecting microstructures and residual strains in large engineering components. This study presents the physical design and neutron optics tuning of a new diffractometer at the China Spallation Neutron Source. Our goal is to minimize the experimental time for accurate diffraction peak determination. The design includes a neutron transport system, wavelength selection system, optical system, and resolution and intensity regulation system. We optimized the wavelength bandwidth for scientific experiments and adjusted neutron flux and peak intensity through neutron transport considerations.

During debugging, we use signal delay to achieve neutron bandwidths with different starting wavelengths. Neutron flux is measured through spectrum integration or gold foil activation, and resolution and peak intensity are optimized. Scattering center is ensured by aligning the neutron beamline, sample stage, and radial collimators with the scattering center using a high-precision laser tracker and validated with the neutron beam. Software calibration aligns ±90° detectors with the scattering center.

After tuning, the diffractometer achieved a neutron flux of 6×10^6 n/s/cm^2 and a resolution of 0.3-0.38% at d-spacing: 0.5-2.6 Å. The peak position deviation in LaB6 diffraction patterns is just 6 microstrains. After a year of debugging and trials, the EMD instrument shows excellent performance, accurately measuring residual stresses and conducting in-situ neutron diffraction experiments for both uniaxial and biaxial tension.

Keywords: Engineering Materials Diffractometer, strain mapping, microstructure, in-situ tensile experiments, Calibration of the neutron path, the center of the gauge volume, the China Spallation Neutron Source

P-13

ESTIA: THE SMALL SAMPLE FOCUSING REFLECTOMETER AT EUROPEAN SPALLATION SOURCE (ESS)

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Neutron reflectometry is a powerful tool for investigating thin films and interfaces, with a host of industrially relevant applications from model cell membranes to next generation hard drive materials and everything in between. The technique, currently, is severely limited by neutron flux. After users have made unusually large samples, we still often have to cut the incident beam from ~cm down to <100um to keep the beam footprint solely on the sample.

This has been the standard modus operandi since the first reflectometry experiments ~40 years ago. However, since the realization of the Selene guide system (on AMOR at PSI) [1], another option has existed – to focus the neutrons onto the sample, in ESS case directly from the moderator face. This approach gains orders of magnitude more flux than collimating but comes at a significant technical cost and a challenging installation and commissioning stage.

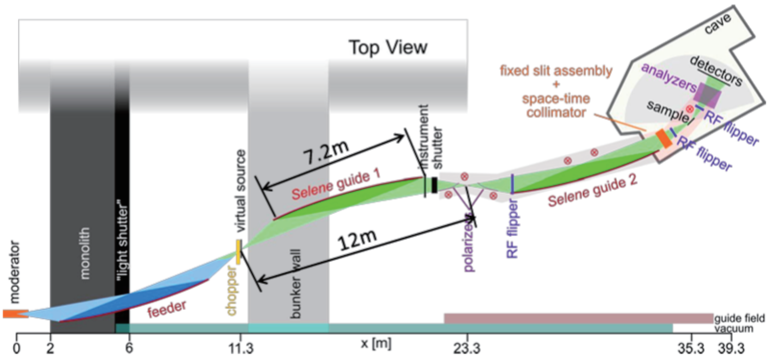

Figure 1 - ESTIA design Concept

The ESTIA instrument on the European Spallation Source (figure 1) was designed with the full Selene guide concept in mind: A virtual source created by a 3D slit system to transport the desired footprint, while maintaining the same divergence profile of ±1.5° onto the sample. Two sets of elliptical mirrors, consisting of 15 mirror segments for both horizontal and vertical focusing, to transport the beam defined by the virtual source directly onto the sample. Beam size at sample down to 1x1 mm, with no need for collimating slits. Absolute interferometer and robot carriage to position the mirror segments to ~100's nm precision (180 degrees of freedom). A polarizer consisting of two transmission supermirrors that are bend in the shape of equiangular spirals. The method allows polarizations above 95% and good transmission, without negative impact on other beam characteristics [2]. We would like to present the instrument concept and its innovative technical solutions but also the expected challenges on installation and commissioning of such a complex instrument.

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P-14

TOWARDS THE DEVELOPMENT OF A COMPACT VERY COLD NEUTRON SOURCE FOR THE HIGH BRILLIANCE NEUTRON SOURCE

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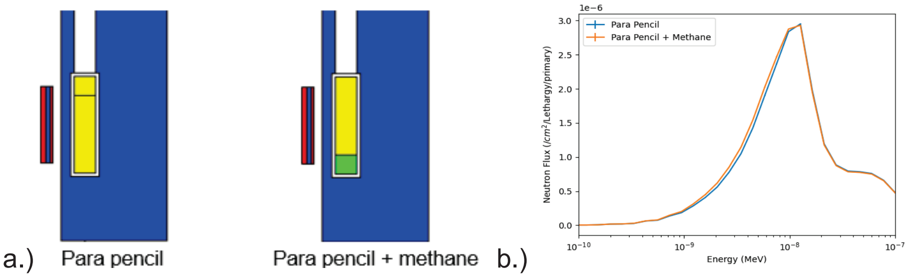
Very cold neutron (VCN) sources present an exciting opportunity for scientists to access unprecedented length and time scales, and achieve improved sensitivity in neutron experiments [1]. VCNs are defined over a wide spectral range, from 1 meV (9 Å) down to a few hundred neV (> several 100 Å). Wavelengths of up to several tens of Å are of particular interest to many research communities. Recently, thermal scattering kernels were developed for candidate VCN moderator and reflector materials under the HighNESS project [2]. These advances present an opportunity for the conceptual design of VCN sources at newly emerging high-current compact accelerator-driven neutron sources (Hi-CANS). The High Brilliance neutron Source (HBS) is a Hi-CANS project which hosts a linear accelerator delivering a pulsed proton beam of energy, 70 MeV, and peak current, 100 mA, to a novel high-power tantalum target and compact target-moderator-reflector (TMR) [3]. A low-dimensional parahydrogen cold moderator has already been designed for the HBS and tested at the JULIC Neutron Platform. Starting from this concept, a Monte Carlo study is underway to develop a target moderator reflector (TMR) to realise a very cold neutron source for the HBS. The low dimensional parahydrogen moderator will serve as an efficient cold neutron converter, and within it, an appropriate secondary moderator is implemented to shift the neutron spectrum generated by the parahydrogen to lower energies, or equivalently longer wavelengths. As methane is known to generate a colder neutron spectrum than parahydrogen, it is currently being investigated to shift the cold spectrum of parahydrogen to lower energies. Figure 1 a.) shows a geometry with parahydrogen only and that with methane embedded in parahydrogen. Figure 1 b.) clearly shows that methane shifts the spectrum to lower energies. Results from a full optimization of this moderator-reflector geometry conducted in PHITS shall be presented.



a.) Para pencil Para pencil + methane b.)

Fig. 1 a.) The geometries of the cold neutron moderator and very cold neutron moderators are illustrated. b.) A comparison of neutron spectra obtained from the geometries are presented.

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THE NU-NSE NEUTRON SPIN ECHO SPECTROMETER AT NIST

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The νNSE spectrometer is an instrument used to investigate slow dynamical processes and molecular motions at nanoscopic and mesoscopic length scales. It uses magnetic fields to encode polarized neutron velocities via Larmor precession and to decode scattered neutron velocities by un-precessing those same neutrons.

The NIST Center for Neutron Research has massively upgraded its neutron spin echo spectrometer with the acquisition of superconducting main coils capable of fields exceeding two tesla. Correction of those fields is accomplished using pairs of high current “Pythagoras” coils embedded in the bore of the main coils. With these features the instrument is capable of measuring Fourier times up to 700 ns, more than double the performance of the CHRNS-NSE it replaces and enabling the exploration of critical biological motions.

Addition features of the instrument include the online selection of two different neutron velocity selectors, two different incident polarizers, new high precision ultra stable switching power supplies, and high rate capable 3He detectors.

Installation work on the instrument has concluded and the spectrometer is currently in offline commissioning pending the restart of the NBSR reactor. This presentation is an overview of the instrument and the project.

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ICONE : A PROJECT OF A FENCH HICANS

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The French neutron scattering user community has a strength of more than a thousand users. After the final shutdown end of 2019 of the Orphée research reactor in Saclay that was equipped with more than 20 neutron scattering instruments, the number of beam days available for our community has drastically decreased. In a context of cost limitations, the LLB has presented the project of an ambitious new neutron source based on the innovative HiCANS concept. This project follows various international reports [1] presenting compact source as a way to provide high neutron scattering capacity at decent cost. Called ICONE for Innovative Compact NEtron source, our project has the aim to provide France with neutron scattering instruments with performances higher than the one that were available on Orphée but at a lower cost. Presented on Figure 1, this source will provide French community with the capacity to do all necessary experiments to be able to gather sufficient neutron scattering knowledge and knowhow to access to the top ranked neutron sources like ESS, SNS or J-Parc with the best chances of success.

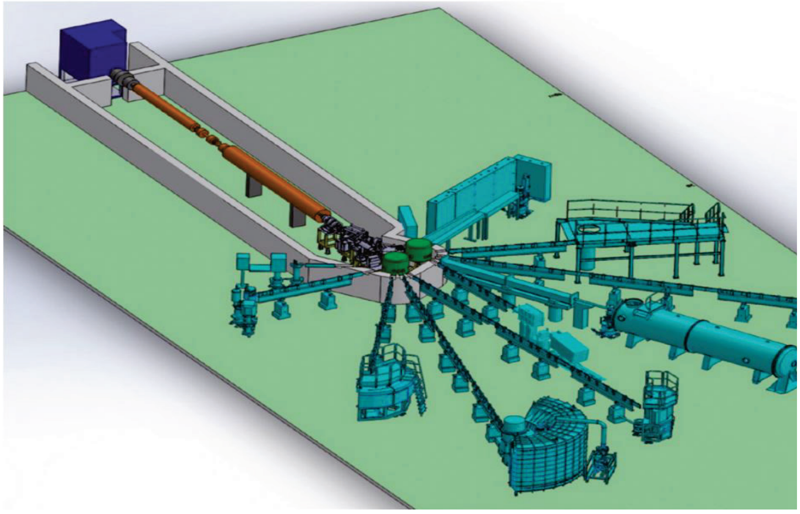

Figure 1: A view of the ICONE project with two targets and its 10 neutron scattering instruments

We will give a detailed presentation of our project and will focus on technical choices that have been made to reduce cost and risks without too much loss of performances. Tests that have been made to bring to maturity the necessary key technologies for the ion source, the accelerator, the target and the instruments will also be presented.

Reference

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DEVELOPMENT OF A PROTON POLARIZED APPARATUS

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Nanoscale connections at the interface between organic and inorganic layers buried in the material are important in the development of hybrid materials. Neutron scattering techniques with high material penetrating power specialize in observing buried interfaces, however, the analysis of a single scattering curve cannot uniquely determine the structure due to the many degrees of freedom of the parameters consisting of the thickness and composition of the interface. A spin-contrast variation (SCV) method has been developed [1,2], which utilizes the fact that the neutron scattering length of a proton in a sample strongly depends on their spin orientation with respect to each other. The SCV method can reveal the thickness of the coupling agent monolayer formed at the interface and even its entanglement with the neighboring layers, based on the change in the polarized neutron scattering curve depending on the proton polarization.

Cold neutrons are easily polarized simply by passing through a polarizer, however, the proton cannot be polarized enough to be distinguished by neutron scattering under thermal equilibrium conditions of high magnetic field and low temperature. Then, the dynamic nuclear polarization (DNP) method is essential to significantly amplify nuclear polarization by transferring polarization from the electron spin to the nuclear spin by magnetic resonance. On the other hand, the DNP method consumes large amounts of liquid helium by the application of tens of mW microwaves in a cryogenic environment. This is a bottleneck in the practical use of the SCV method to measure multiple samples. Therefore, we have been developing a cryogen-free DNP system for the SCV method. In our previous cryogen-free tests, the proton polarization was only about 8% under the sample environment of 3.3 T and 3.1 K [3], which is insufficient to reach a practical level of polarization. We planned to improve the polarization to 50%, which is a sufficiently practical level, by increasing the magnetic field to 6.3 T and improving the sample cooling efficiency. The sample cooling efficiency can be improved by the insert design by circulating cryogenic helium gas from the bottom of the sample cell through the top side of the insert, the temperature rise due to microwave application will be reduced.

This presentation will report on the test results of the newly introduced superconducting magnet in June this year and the progress of the cooling test using the improved insert.

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P-18

IMPLEMENTATION OF AN EPICS-BASED CONTROL SYSTEM FOR A NEUTRON SPIN-ECHO SPECTROMETER

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Neutron scattering experiment require a combined control of motors for positioning stage, the sample environment and the neutron data acquisition by detectors. Especially for neutron spin echo (NSE) spectrometers, the electric current of spin flippers and precession coils are also subject to systematic control.

For the neutron spin echo spectrometer at Japan Research Reactor-3, iNSE [1, 2] (Fig.1 left), we have developed an EPICS-based control system because of its function extensibility and open development environment. EPICS: Experimental Physics and Industrial Control System [3] is used in large facilities such as accelerators, but it is also useful for neutron scattering instruments. Most recent experimental devices (for example, motor controller and power supply) are capable of being controlled via the TCI/IP protocol over a network and therefore can be easily incorporated to EPICS.

So far, we have built a system that controls and monitors (Fig.1 right) the following devices such as motor controller, DC current supply (100W-class power for Mezei-type spin flippers and 10kW-class power for the main precession coil), function generator (RF spin flipper), temperature controller, data logger for temperature and monitoring sensors.

The presentation will introduce our EPICS-based control system for a neutron spin-echo spectrometer, iNSE.

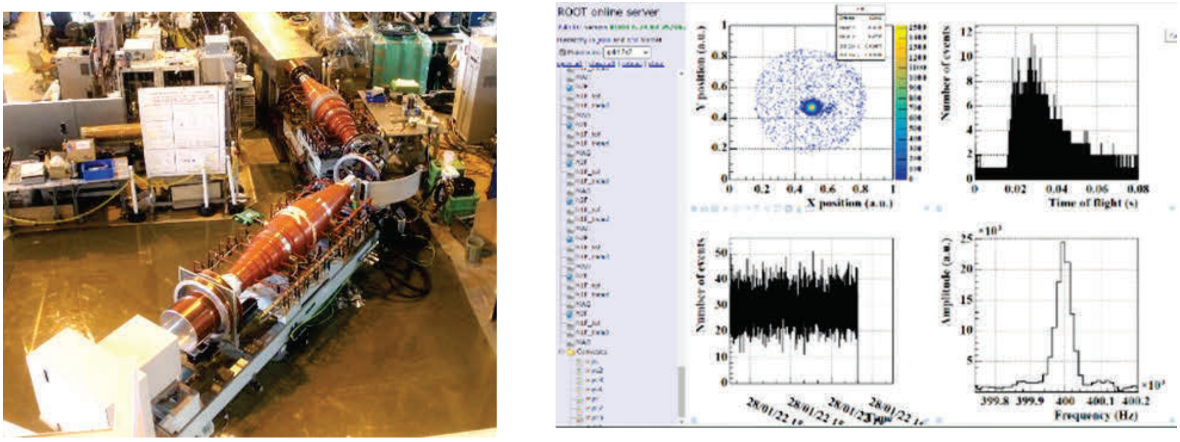

Figure1. Left: Photograph of iNSE. Right: Online data monitor generated by CERN JS ROOT [4].

Acknowledgements: The EPICS-based control system presented here was originally developed for the neutron resonance spin echo spectrometers at MLF BL06 at J-PARC by Dr. Yasu, formerly of KEK.

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STATUS OF NEUTRON IMAGING INSTRUMENT “RADEN” AT J-PARC MLF

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The Energy-resolved neutron imaging system, RADEN, has been constructed in J-PARC MLF in 2014 and started the user operation in 2015. This instrument was designed to enable the energy-resolved neutron imaging experiments, such as Bragg edge imaging and neutron resonance imaging to visualize spatial distributions of crystallographic information and elemental information respectively. To realize excellent performance for these experiments, it was installed at the beamline of BL22, which viewed the decoupled moderator providing a fine wavelength resolution of about 0.2% and a neutron flux of 10^8 n/sec/cm^2 from keV to meV neutron energy region. In addition, as the results of continuous developments on energy-resolved neutron imaging techniques using time-of-flight (TOF) analysis and on the related devices, the polarimetric neutron imaging and the neutron imaging with the grating interferometry became available in combination with wavelength/energy analysis. Accordingly, RADEN becomes a quite unique instrument in the world that can offer opportunities of conducting almost all energy-resolved neutron imaging experiments. In addition, since the ample space inside the RADEN beamline and flexibility of sample arrangement allows experiments in combination with various sample environment and peripheral equipment, neutron imaging experiments during in-situ processing and in-operando experiments using practical devices have been conducted intensively.

In the presentation, we will explain the current status of the RADEN instrument in detail and our on-going technical development.

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P-20

COLD NEUTRON SOURCE REPLACEMENT AT THE ANSTO OPAL REACTOR

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ANSTO is currently undertaking a significant project to replace the cold neutron source (CNS) within its OPAL reactor pool. The CNS was originally designed with 10 (nuclear reactor) power year's life as per manufacturer's recommendations due to irradiation effects on the in-pile material of construction (Aluminium grade AlMg5). Thermal neutron bombardment leaves the material susceptible to transmutation of aluminium to silicon which effectively solution hardens the metal, increasing the likelihood of cracking and crack propagation.

The CNS in-pile assembly is the assembly installed within the CNS vacuum containment, consisting of a moderator vessel, thermosiphon heat exchanger, reflector plug and ancillary items. The proposed replacement CNS in-pile assembly (or CNS MkII) has been designed by HNF Technologies, which was also subcontracted for the design and manufacture of the original CNS.

The CNS MkII in-pile assembly essentially functions the same as the original design but has a 70mm taller moderator chamber and is expected to produce in the order of 5-10% more flux at the 5 angstrom wavelength (Figure 1). The increased volume of the moderator chamber will create additional heat load which must be removed via a higher capacity thermosiphon heat exchanger. Other design changes to the CNS in-pool pipework are also presented.

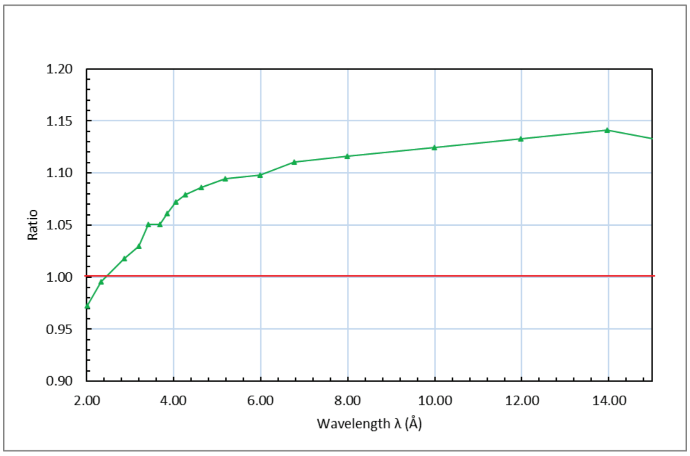

Figure 1: Expected performance improvement of CNS MkII (green line) compared to original CNS (red line)

Replacing the CNS in-pile assembly is a complex manoeuvre involving radiation, work at heights, confined space and manual handling. The project considered robotics, automation, manual work, shielding, shielding, distance, time, dose, skill levels, tools and other factors and decided on a combination of ideas.

Training and rehearsing the installation manoeuvre were deemed to be critical factors. To minimise the likelihood of issues to both staff and the reactor, a mock-up of the reactor was built to develop the replacement manoeuvre and to train the installation technicians.

Since the OPAL reactor also provides other services across health and industry, the shutdown is to be kept as short as reasonably achievable, with schedule optimisation another major consideration.

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THE JÜLICH HIGH-BRILLIANCE NEUTRON SOURCE PROJECT

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Accelerator driven neutron sources provide a cost-efficient and attractive alternative to classical neutron sources like fission reactors and spallation sources. With the advent of high current proton accelerator systems, a novel class of such neutron facilities can be established termed High-Current Accelerator-driven Neutron Sources (HiCANS). Due to performances similar to medium flux research reactors, these sources are going to be an integral part of the European neutron landscape.

The High Brilliance neutron Source project (HBS) at the Forschungszentrum Jülich develops such a HiCANS facility. It utilizes a 70 MeV and 100 mA pulsed proton linear accelerator providing tailored proton pulses with frequencies of 24 Hz or 96 Hz up to three optimized target stations. Due to the low energy nuclear reactions releasing neutrons from a high-power tantalum target, the target stations are compact in comparison to spallation neutron sources. It allows for an efficient neutron production, moderation and extraction and thus allowing competitive neutron instrument performances.

A detailed technical design report describing all relevant components ranging from accelerator, target, moderators up to the instruments was published recently. It shows a potential national neutron source facility with up to 24 instruments for all kinds of applications.

I will present the current status of the High-Brilliance Neutron Source (HBS) HiCANS project as well as the next steps.

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NOVEL 3D PRINTED COMPONENTS FOR IMPROVED MANAGEMENT OF WAVELENGTH SHIFTING FIBRES IN NEUTRON DETECTORS

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Effective and precise management of wavelength shifting fibres is crucial for the optimal performance of WLSF detectors. Initial prototypes tested in our on-site detector manufacturing facility were 3D printed using stereolithography in clear rigid resin. They faced significant challenges during assembly because the clearance required for fibre routing led to fibres being too loose, complicating tensioning and alignment, and increasing the risk of deviation from straightness. To address these issues, we designed a novel 3D printed component utilizing the advanced capabilities of PolyJet 3D printing technology.

This innovative component incorporates different materials within the same print to enhance functionality. By using a flexible rubber-like material in the fibre routing holes, we leverage the friction to hold the fibres securely in place without causing damage, thereby simplifying the assembly process and ensuring the fibres remain straight.

Moreover, the integration of identification numbers directly into the 3D print eliminates the need for a labor-intensive and error-prone manual ink-filling process. This advancement not only streamlines the assembly but also enhances the reliability and accuracy of fibre identification.

The implementation of this PolyJet-printed component demonstrates significant improvements in assembly efficiency, fibre alignment, and overall detector performance. This approach sets a new standard for the integration of multi-material 3D printing in the precise and reliable management of wavelength shifting fibres for WLSF detectors.

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P-23

TITLE: POLYCHROMATIC MULTIPLEXING STRESS-STRAIN DIFFRACTOMETER USING FOCUSING ANALYZERS

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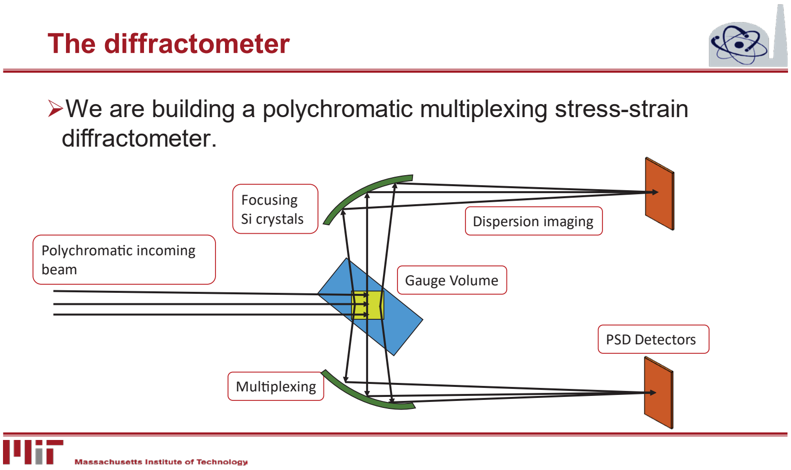
Engineering beamlines are essential tools that characterize internal stresses within materials which guide the development of advanced manufacturing techniques for new technologies. Measurements at these beamlines usually require scanning a small gauge volume over a large sample and the procedure is repeated for different sample directions or lattice planes; all these compounding factors lead to prohibitive measurement times and oversubscribed instruments.

To improve the efficiency of these diffractometers at steady-state sources, we are designing and evaluating a prototype polychromatic multiplexing stress-strain diffractometer using focusing analyzers. A polychromatic incoming beam enables multiplexing by placing multiple analyzers after the sample. See **Figure 1**.

The analyzers are placed one-after-another to measure multiple lattice planes as well as on opposite sides of the sample to measure strain in two directions. The analyzers are made from bent-perfect silicon crystals that use reciprocal-space focusing.

In this poster, we show the instrument design, show the instrument construction at the Massachusetts Institute of Technology (MIT) Reactor, and compare the instrument capabilities with traditional designs.

We measured a round-robin sample (aluminum shrink-fit ring and plug) that was used to benchmark stress-strain diffractometers around the world at the HIDRA beamline at HFIR to compare the performance of this new diffractometer design.



The diffractometer

➢We are building a polychromatic multiplexing stress-strain diffractometer.

Figure 1 Adelphi – MIT polychromatic multiplexing stress-strain diffractometer

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P-24

WORLD'S FIRST STUDIES IN INFLUENCES OF A NEUTRON-DOMINANT MIXED RAY ON RADIATION RESISTANT LUBRICANTS AND THEIR DETERIORATION MECHANISMS

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Although the only indicator for determining radiation resistance of lubricants is conventionally irradiation-outcomes with a γ-ray, in many actual equipment there is also a neutron-dominant mixed ray. If a mixed ray further would deteriorated lubricants, it would be questionable in radiation installations worldwide that selections of lubricants and setting of their maintenance cycles based on γ-ray indicators only. To verify this, it was conducted by MORESCO, CERN, ESS and Brescia Univ. that the world's first evaluation of irradiation of lubricants with a mixed ray and analysis of deterioration mechanisms. [1] [2]

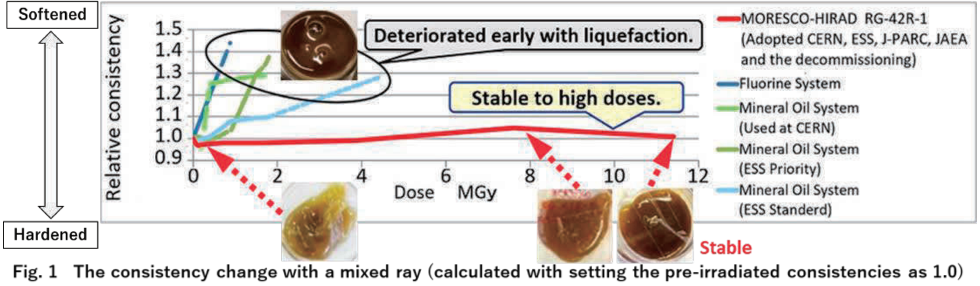

Fig. 1 The consistency change with a mixed ray (calculated with setting the pre-irradiated consistencies as 1.0)

Fig. 1 shows the rate of consistency change (post / pre irradiation) of the existing ones given priority according to a standard with a γ ray by the European Accelerator Facilities, and MORESCO's Polyphenylether (PPE)-based grease.

It was verified that existing greases rapidly deteriorated with liquefaction, and that a mixed ray had higher energy than a γ ray and deteriorates lubricants more easily, also that the only judging a radiation resistance with a γ ray was inadequate for a sufficient safety. While MORESCO's PPE grease exhibited overwhelming stability up to the high dose and high radiation resistance to even a neutron-dominant mixed ray identified to be more severe deteriorating factor.

Additionally, in evaluations of PPE base oil alone with a mixed ray conducted to identify the mechanism of radiation resistance of the PPE grease, it was also verified that its main molecular structure of PPE oil was generally maintained after irradiation, that mainly a change in its side chain part was limited to partial and polymerisation and maintaining properties, and it did not accompany oxidation. My poster presents in detail that the aforementioned studies on PPE lubricants, contributing to improve safety and stable operation in advanced high radiation fronts, including accelerators, by its outstanding radiation resistance.

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NEW POSSIBILITIES WITH 3D PRINTING AND INNOVATIVE FILAMENTS

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Building neutron optics devices, including neutron guides, necessitates effective shielding of construction materials against neutron radiation (thermal and cold neutrons) to prevent material damage such as embrittlement. Additionally, neutron radiation escaping from these devices is disturbing the neutron science experiment as so-called background.

Common shielding materials in neutron science include boron, cadmium, and gadolinium. Boron-based materials are preferred because they produce only low-energy gamma radiation, which can be easily shielded. However, boron carbide (B_4C) materials are very hard and rather expensive to process. The present standard shielding material, BORAL, consists of a matrix of B_4C in aluminum, with B_4C enrichment ranging from 20 to 35 wt%.

To replace BORAL, we have developed boron-enriched filaments for 3D printing applications using FFF printing technology. These filaments incorporate boron carbide (B_4C) at concentrations of 25-40 wt%. The B_4C is embedded within a plastic matrix containing approximately 10 wt% hydrogen, thereby enhancing the shielding properties of the material. A disadvantage of B_4C is its carbon content, which is highly abrasive, leading to frequent replacement of 3D printer components. To mitigate this, we developed a novel filament containing 25 wt% of boron 10 isotope, which is less abrasive and offers better shielding performance.

In addition, we have manufactured filaments containing up to 20 wt% gadolinium oxide. To counteract the secondary gamma radiation emitted, we created composite filaments that contain both B_4C and tungsten, with enrichment levels reaching up to 70 wt%.

With these filaments we are aiming to produce various types of collimators and flight tubes. Initial prototypes have been manufactured and tested.

We will present the current state of our developments, including the limiting factors and challenges associated with the 3D printing technology.

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3D-PRINTED NUTATOR FOR SPHERICAL NEUTRON POLARIMETRY

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An important area of basic research with neutrons is the investigation of the magnetic properties of various materials [1]. Spherical neutron polarimetry (SPN) can be used. For this, a polarized neutron beam is used, which hits the sample and the scattered beam is then measured with detectors [2]. In order to adiabatically rotate the polarity of the neutron beam, a rotatable magnetic field is required, one possibility being a so-called nutator.

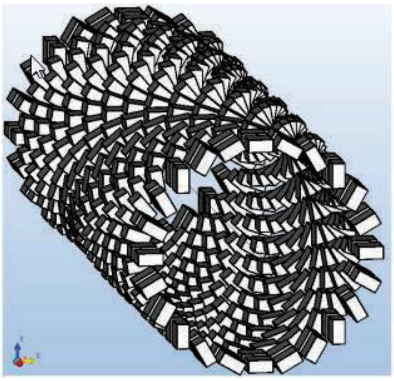

Figure 1: simulated *order of halbach*-rings

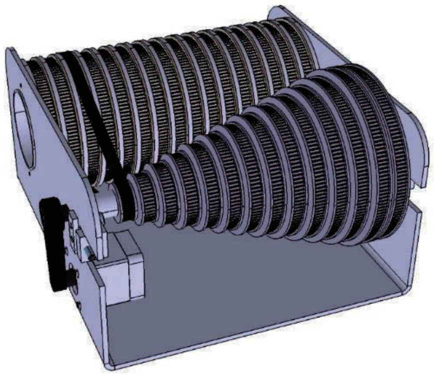

Figure 2: Nutator-Protoyp with 3D-printed Parts

For POLI (Polarized Hot Neutron Diffractometer), an instrument of Forschungszentrum Jülich, a simple and inexpensive prototype has to be developed. The concept of the prototype is based on so-called halbach-rings consisting of several neodymium magnets. The arrangement and selection of the permanent magnets is based on magnetic simulations carried out by the research center's computing department. The arrangement of the rings is shown in figure 1.
The unfinished prototype is shown in the figure 2. The number of rings is reduced to 16, with two rings at the outlet being twisted at an identical angle and two rings at the inlet being rigidly mounted. These rigid rings stabilize the polarized beam at the entrance and exit. To rotate the polarized beam, the individual rings must be rotated by a gearbox. The rings have teeth on the outer edge and are rotated by the gearbox with belts. A stepper motor is used as the drive, which can be integrated into the SPS of POLI. In order to implement the prototype quickly and cost-effectively, the magnetic ring and the drive pinions are manufactured using the FFF (Fused Filament Fabrication) process. The use of this additive process enables flexible production and rapid adaptation of the geometry if this becomes necessary during the test phase. The printed magnetic rings are supported as plain bearings by an aluminum tube, through which the neutron beam is guided and manipulated by the resulting magnetic field. To adjust the tension of the belts, both the drive axle and the stepper motor can be moved radially.

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[1] P. Brown, Neutron Scattering from Magnetic Materials, Grenoble cedex, France: Elsevier, 2006.
[2] „sni-portal.de,“ 26 Juni 2024. [Online].

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THE DESIGN DEVELOPMENT OF THE STS PIONEER DETECTOR STRUCTURE

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PIONEER is a one of the eight instrument concepts under development for the Second Target Station Project at the Spallation Neutron Source. It is a time-of-flight, single crystal diffractometer designed to study small volume samples and will utilize 160 Silicon Photo-Multiplier (SiPM) Anger Camera detectors arranged in a 240-degree arc about the sample position. The arc is made up of 10 vertical towers housing 16 cameras each (2 columns of 8 cameras) as well as the necessary electronics and their air cooling system. The towers move radially outward from their installed positions to allow access and maintenance. Repeatably positioning the cameras, and by extension, the towers, is critical (within 0.3 mm in any direction). Due to these requirements, the design of the detector structure has come to include a lower frame and upper cage. The lower frame's main purpose is to support the camera towers, while the upper cage is meant to provide the registration alignment for each tower relative to each other. The poster will describe the detector structure's design details and structural analyses.

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THE μNID EVENT-TYPE NEUTRON IMAGING DETECTOR AT J-PARC

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The μNID (Micro-pixel-chamber-based Neutron Imaging Detector) [1], an event-type neutron imaging detector based on the Micro-Pixel Chamber (μPIC) micropattern strip readout, has been developed in Japan for energy-resolved neutron imaging. Micropattern readouts such as the μPIC can provide both high rate and good spatial resolution, making them attractive options to tackle the challenges of energy-resolved neutron imaging at J-PARC and other intense, pulsed neutron sources. The development of the μNID began at Kyoto University in 2008 and has continued at the RADEN instrument [2] in J-PARC since 2014.

The μNID consists of a gaseous time-projection-chamber (TPC) and a μPIC two-dimensional, 400-μm pitch micropattern strip readout with an area of 10 cm × 10 cm, coupled to fast, FPGA-based front-end readout electronics. The μNID uses the TPC and fine-pitch readout to perform detailed, three-dimensional tracking and analysis of the charged secondaries from each neutron interaction, leading to improved spatial resolution and strong background rejection. The μNID uses ^{3}He gas as the neutron converter, providing 26% efficiency for thermal neutrons, and achieves 0.1-mm spatial resolution and a peak count rate of 44 kcps/cm^2 (global rate 4.6 Mcps). More recently, we have introduced the BμNID, a μNID with ^{10}B thin-film converter. Owing to a smaller event size, the BμNID achieves an increased count rate of 100 kcps/cm^2 (global rate 10 Mcps), although with a reduced spatial resolution of 0.3 mm. The commissioning of the BμNID was carried out in 2021, and it was deployed for user experiments at RADEN in February 2022. Images of a test pattern taken at RADEN are shown in Fig. 1 for each detector.

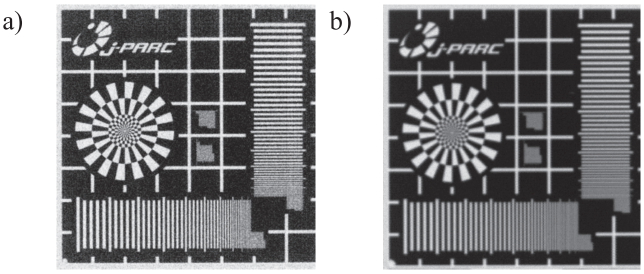

Figure 1: Images of a Gd test chart obtained by the (a) μNID and (b) BμNID detectors at RADEN.

In this presentation, we will discuss the ongoing development of the μNID system, including improvements to the analysis software and our recent efforts to improve the stability of the detectors under high neutron rates. We will also describe the development of new μPIC readout elements for improved spatial resolution and increased count-rate performance.

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IMPERFECT RIGGING METHODS: THE ENDLESS CYCLE OF NON-STANDARD LIFTS

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At the NCNR most lifts involving forklifts or cranes necessitate careful examination. This examination involves detailing the hardware involved, the configurations necessary for performing the lift, and the calculations ensuring safety is guaranteed. These documents are submitted by the engineer to a committee called the non-standard lift committee.

Recently I have been involved with submitting many of these documents to the committee. Most of these documents have pertained to lifting the neutron shields that will be moved to upgrade some of the neutron guidelines. While essential, these lifts have at times become a roadblock hampering progress of our main project.

Throughout my submissions, we have continuously revised the methods in which we analyze these lifts. I would want my presentation to be a semi comical look at the engineering process, and how it both helps us and holds us up at times. I will also go over how the NSL committee works, and why it is important for safety culture moving forward.

The biggest example of hardware that we have looked at the most is the swivel hoist rings. When using swivel hoist rings, the WLL is only allowed when the swivel hoist ring is fully threaded and seated properly. Since most of the neutron shields in our facility have a 3/8" gap between the top plate and the thread engagement, we decided we cannot lift to the swivel hoist ring WLL and instead we have had to calculate the safety factors in different manners. I will go over this process and go over how the ways we have decided to analyze the SF changed over time.

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P-30

DEVELOPMENT OF THE FUEL CELL OPERATION SYSTEM FOR OPERANDO NEUTRON IMAGING EXPERIMENT

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The fuel cell is regarded as one of the key devices for reducing greenhouse gas emissions and achieving carbon neutrality. Therefore, it has been vigorously investigated to improve the performance by various techniques. Neutron imaging is anticipated to contribute to fuel cell study especially on its water management by non-destructive observation of generated water inside the cell during the operation. Furthermore, it is important to study using the full-sized cell to understand the properties of a practical automotive fuel cell. Then, the operando imaging using the neutron beam is a unique technique to provide direct information about this requirement because of its high transmission ability and the large field of view.

Accordingly, we have developed an operation system to drive full-sized fuel cell for automotive which can be used inside the neutron imaging beamline RADEN in J-PARC MLF. The schematic illustration of the system is shown in Figure 1. It consists of gas supply units for the anode and the cathode lines, which control temperature, humidity, flow rate of each gas independently, back pressure units to control gas pressure in each line, and a load unit to control the power generation. The control of overall system can be made from outside remotely. In addition, due to the policy of MLF, it is prohibited to release gases irradiated by the neutron beam in the experimental hall, we have equipped a gas dilution system which can dilute H_2 gas by N_2 gas below the explosion threshold concentration of 4vol%. The H_2 concentration is continuously monitored by H_2 sensors, and it is included in the inter-lock system.

In the presentation, we will explain the system structure and its specification in detail.

This work was supported by the NEDO organization project, JPNP20003.

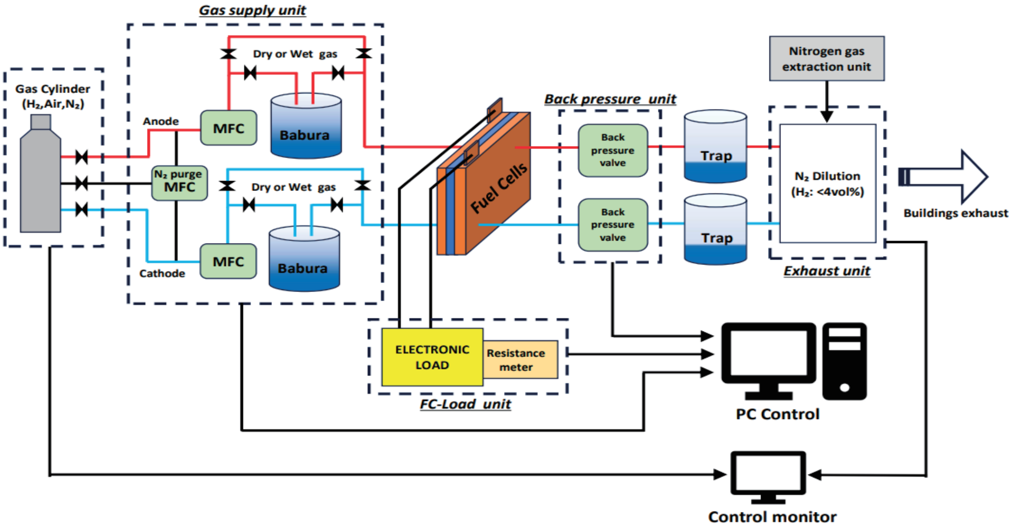

Figure 1: Schematic illustration of the fuel cell operation system for neutron imaging experiment.

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ABSTRACT OF DENIM 2024: ACHIEVING INCREASINGLY TIGHT TOLERANCES FOR MOTION EQUIPMENT

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This talk will deliver an overview of lessons learned in the pre-build and installation of two motion positioned detector systems at ISIS STFC.

There is an increasing number of motion control systems being installed for beamline equipment on Neutron instruments. These systems utilise several different designs, from linear rail/carriage combinations, rotational axes, kinematics and more, but all require precise alignment.
Recently I have worked on ISIS detector upgrade for INTER, as well as the detector pre-build for FREIA ESS, which both required a motion system to operate around a sphere of confusion at the sample point. This sphere ranged from Ø1.5mm for INTER to Ø0.15mm for FREIA.

With both projects, we encountered trouble achieving the desired specification due to design errors, manufacturing faults, and time pressures.
I will talk about the design features implemented to aid alignment and how these could have been improved, as well as the issues and resolutions found during the build regarding alignment and motion control.
This includes input from mechanical technicians, design engineers and our survey technicians.

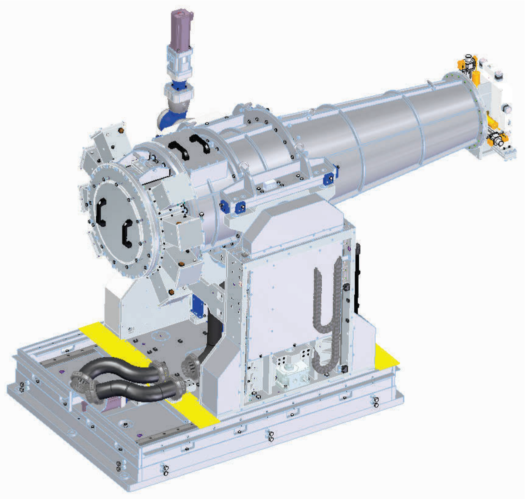

Figure 1 INTER System Assembly CAD

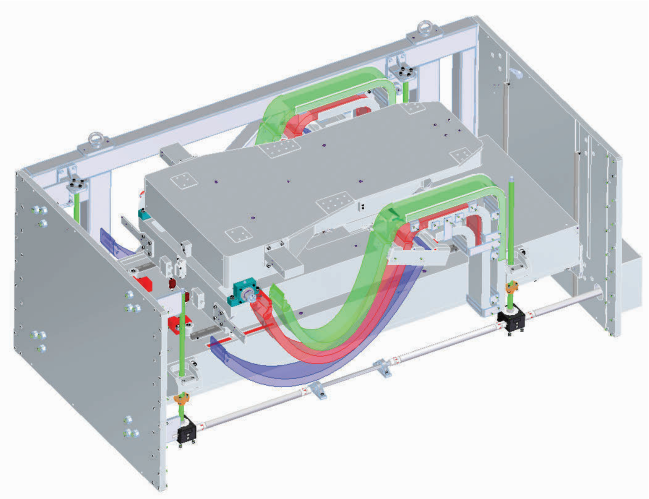

Figure 2 FREIA System Assembly CAD

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BRIEF INTRODUCTION OF NEUTRON OPTICS DEVICE

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Neutron Optics and Fine Machine system(NOFM) belongs to CSNS,it services the project construction of CSNS-II.All the devices that this system developed are used in the neutron instrument.The slits and neutron guides are two key devices in this system.

Two kinds of slits are developed during the project construction.one is normal slit, it is drived by step motor and controlled by encode system. The accuracy of full scale is better than 20μm.The thickness of this kind of slit can be limited to less than 50mm in the beam direction. This kind of slit is used in scattering room.

The other one is nonmagnetic slit. Its performance is the same with normal slit. It is designed very carefully and all the components are nonmagnetic material or the magnetic conductivity is less than 1.05. So it can be used in high magnetic environment. For example, in the 9T or even 14 T magnetic environment. Of course, the distance is also should be considered.

Figure 1: normal slit.

Figure 2: nonmagnetic slit.

Neutron guide is also a key optics device. In order to have the capacity of guide production by CSNS itself, many researches are done. In the flow scheme of guide production, one key step is to install 4 pieces of glass substrates to straight guide by using special tooling system. This tooling system has been designed and 0.5 meter straight guide and 2m straight guide are both made by this tooling system. The accuracy of cross section size in the entrance and exit are both less than 20μm while the form and location tolerance is also better than 20μm.It is the same with commercial production and can meet the requirement of project construction.

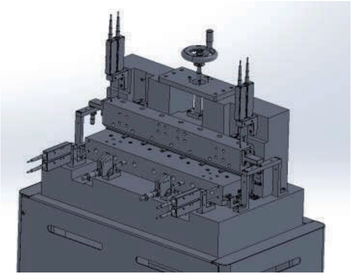

Figure 3: special tooling system for 0.5m straight guide.

Figure 4: 0.5m straight guide without supemirror.

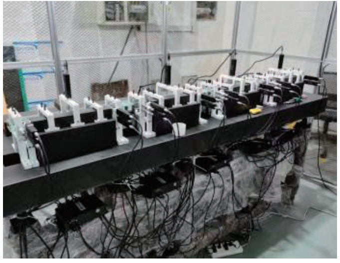

Figure 5: special tooling system for 2m straight guide.

Figure 6: 2m straight guide without supemirror.

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MAGNETIC LEVITATION BEARING SYSTEM AND HIGH-SPEED NEUTRON CHOPPER: ZHAOSONG KONG

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The development of neutron choppers has gone through about 80 years, but Santroll only started researching and producing disc type neutron choppers in recent years, as a new member. For motor and electronic control, Santroll have experience for over 20 years, and because of market trends, we continued to research and produce bearing support systems (ball bearings, oil bearings, magnetic levitation bearings), and composite material technology. How about preparing for a neutron chopper? So we started. Santroll's first generation disc type neutron chopper was supported by ball bearings, and the chopper disc was made of aluminum alloy; then we have continued to develop high-speed neutron chopper, which supported by magnetic bearings, and the disc is made of carbon fiber composite material. And the second and second plus generation has achieved. Now we have a new method, drive the chopper disk with an axial flux motor (Figure 1).

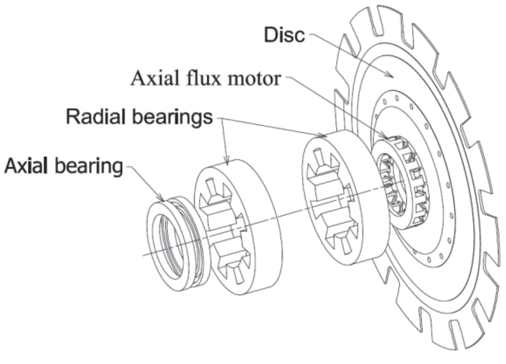

Figure 1: Axial flux motor for the chopper

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P-34

OSCILLATORY MAGNETIC FIELDS FOR NEUTRON RESONANCE SPIN-ECHO SPECTROSCOPY
(CAPACITY BOX)

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The generation of high frequency oscillatory magnetic fields represents a fundamental component underlying the successful implementation of neutron resonant spin-echo spectrometers, a class of instrumentation critical for the high-resolution extraction of dynamical excitations (structural and magnetic) in materials.

The poster shows the setup of the resonant circuits at the longitudinal resonant spin-echo spectrometer RESEDA at the FRMII in comprehensive technical detail [1, 2]. We demonstrate that these circuits are capable of functioning at frequencies up to 3.6MHz and over a broad bandwidth down to 35KHz using a combination of signal generators, amplifiers, impedance matching transformers and a carefully designed cascade of tunable capacitors and customized coils (c-boxes).

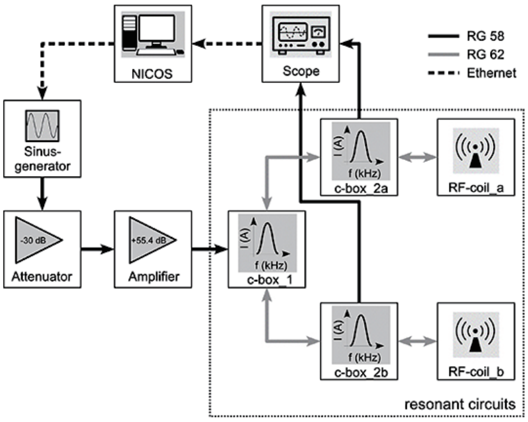

Figure 1: Schematic circuit diagram of the resonating circuit with two coils per circuit (NRSE configuration)

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NTDS — NEUTRON TECHNOLOGY DEVELOPMENT STATION

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Neutron Technology Development Station (NTDS) is a beamline in the second phase of the China Spallation Neutron Source project. It is positioned as an internationally advanced neutron beam research and testing platform, serving as an incubator for promoting the development of neutron technology at the spallation neutron source, and providing strong support for the construction and operation of neutron spectrometers. This beamline is scheduled to be completed in early 2026.

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DEVELOPMENT PROGRESS OF FERMI CHOPPER IN CSNS

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A Fermi chopper has been independently engineered for deployment in the high energy direct geometry time-of-flight spectrometer at the China Spallation Neutron Source, with the purpose of selecting monochromatic neutrons. Equipped with mechanical bearings, this chopper is designed to function at an optimal speed of up to 600 Hz. The slit package is meticulously crafted from laminated layers of single-crystal silicon and a composite of gadolinium-zirconium alloy. The installation of the Fermi chopper on the non-elastic spectrometer has been successfully completed, and it is currently operational. Moving forward, we are committed to the ongoing enhancement and refinement of the boron-coated absorber plates and the structural design of the collimator package.

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