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Scatter Matters

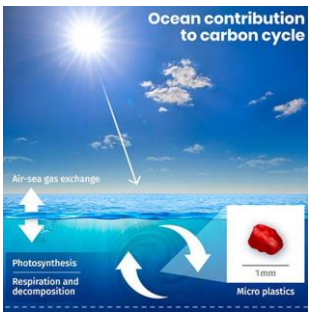
From the Director's desk

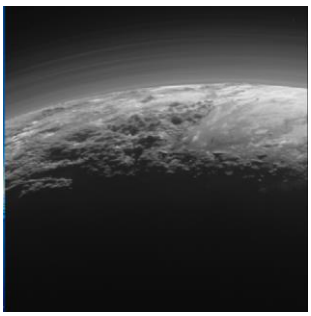
Operating in the 'new normal'

2020 continues to be a challenging year, and our thoughts are particularly with those of you in Melbourne and overseas, who are still under tight regulations due to COVID-19. We have been fortunate so far, here in New South Wales, and as a result welcomed users back to experiments on the 23rd June. However, rapidly evolving restrictions have brought disruption, and if restrictions do affect your upcoming scheduled experiments at the ACNS please keep your instrument scientist and the User Office up to date on the changes. We are particularly appreciative of the efforts of Deborah Wakeham who led the preparation of our detailed COVID-Safe work arrangements. Please note that the use of masks/face coverings (ANSTO provided) is now recommended in all ACNS areas.

As detailed in the last newsletter, the OPAL long shutdown has been rescheduled to June 2021. The primary reason for the OPAL long shutdown is to replace the TG123 primary shutter which feeds neutrons to the thermal-neutron-beam instruments in the Neutron Guide Hall. To enable this work to occur with minimal impact on the reactor operation, the neutron-guide-hall instruments will be shut down from 24th April to mid-July 2021, resulting in reduced numbers of days available for Neutron Guide Hall instruments in the 2021-1 round. The OPAL reactor schedule to the end of 2021 is available here and the ACNS instrument schedule can be viewed here.

A number of scientific highlights from ACNS have recently been promoted on the ANSTO website. Three of the science highlights are included in this issue of the newsletter. Two other recent highlights include work on methane and nitrogen under Pluto conditions and some surprising results on micro-plastics in our oceans.





We are looking forward to seeing you virtually at the ANBUG-AINSE Neutron Scattering Symposium (AANSS 2020) on 11th to 13th November 2020. The abstract deadline has just been extended to 7th September – so don't delay!

-Jamie Schulz

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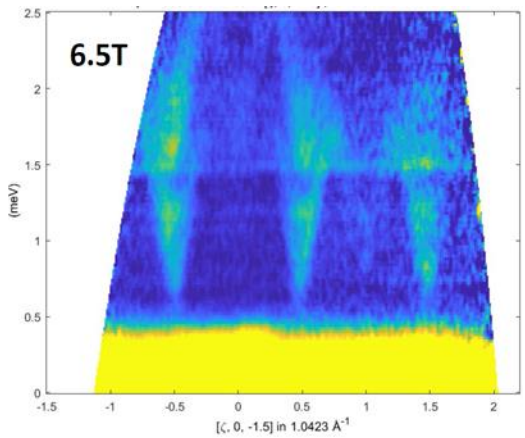
Around the instruments

Inelastic

Magnetic field measurements now available on Pelican. In October 2019, ANSTO took delivery of a new fully compensated 7T magnet (see the Sample Environment Update for full details on the magnet). This asymmetric magnet was designed with a very open geometry to allow the large detector on Pelican to be used and with a very low stray field to allow the Pelican Fermi choppers to operate. On returning to service in June 2020 the magnet was installed and thoroughly tested on Pelican. This included characterisation of the background resolution, as well as the performance of the instrument with an applied field and the integration of the control software. This was incredibly successful with the following achieved:

-Low background and no effect on the resolution.
-Pelican is fully operational at the maximum 7T.
-Full single-crystal data set.
-Studied powder samples and the effect of alignment in the field and quantified the background associated with restraining the sample.

The 7T magnet is now fully available in the user program and Pelican will be accepting proposals with this equipment in the coming rounds.



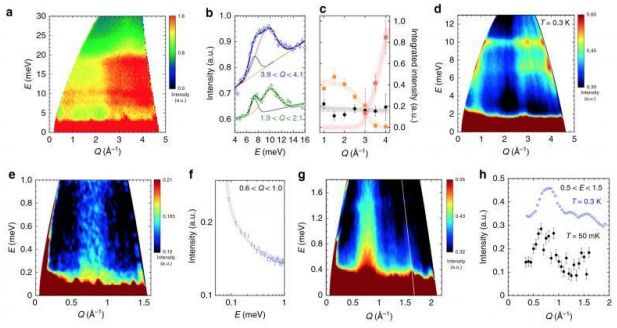
Inelastic neutron scattering from a copper oxide quantum magnet measured at 6.5 T. Figure courtesy of Kirrily Rule.

New results on quantum spin liquids. Work by Pelican users provided supporting evidence of a highly unusual quantum state, a quantum spin liquid, in a two-dimensional material, as reported by Prof Masayoshi Fujihala from Tokyo University of Science in Nature Communications.

Materials with quantum spin liquid states could be used in the development of spintronic devices, quantum computers, and other transformative quantum technologies.

In a quantum spin liquid, an elusive state of matter that is the subject of much investigation worldwide, the electron spins in a magnetic material never align but continue to fluctuate even at the lowest temperatures. This lack of ordered magnetic spin alignment in a solid structure has been described as a fluctuating liquid-like state.

The team from the Tokyo University of Science used Pelican, along with other inelastic neutron scattering instruments, to demonstrate the existence of a quantum spin liquid to very low temperatures. In particular the Pelican experiment was performed at 50 mK and this measurement demonstrated that the spin-liquid state persists to these very low temperatures.



*Inelastic neutron scattering data of $KCu_6AlBiO_4(SO_4)_5Cl$. Pelican measurements plotted in **h**.*

This is the first publication from Pelican using the Oxford instruments Kelvinox dilution insert. This sample environment is now in regular use on Pelican and has been adapted for the large samples required for inelastic scattering. It is also possible

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to rotate the dilution insert so single-crystal measurements are also possible.

See more on this work in an interview with Richard Mole, Dehong Yu and Shinichiro Yano.

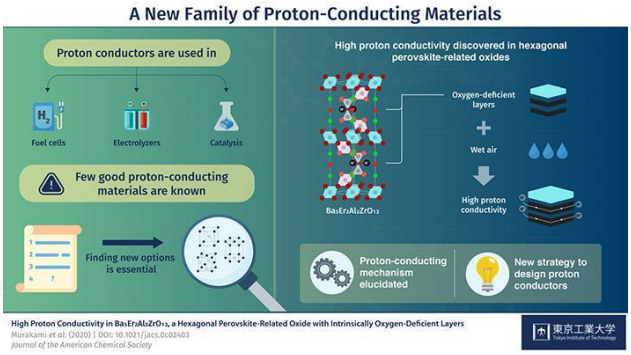
Diffraction

New robot available at Echidna. Our long-serving robot 'ROBBY' has had a hard-drive issue for the last few months and has been out of action. Luckily the new robot 'RALF' was onsite, and thanks to the hard work of sample environment specialist Norman Booth, RALF has filled in for ROBBY in the Echidna mail-in service over the last few months.

ROBBY and RALF on Echidna

Hopefully soon ROBBY will be back and running, but it is great to have more robots ready to work with our instruments. In the future it is hoped that as well as subbing in for ROBBY, RALF will also support ROSIE (Kowari's resident robot) with texture measurements. No prizes for guessing the growing convention for naming our ACNS robots!

New class of hydrogen conductors for industry. A science highlight from the Echidna instrument with users from Tokyo Institute of Technology in Japan, used the instrument to discover a new class of materials with the ability to conduct protons (hydrogen ions) that could potentially be used in next generation fuel cells, in electrolysers to break down water into hydrogen and oxygen, and in catalysis for industrial applications. Only a limited number of stable materials have been found that can conduct protons and only at the laboratory scale.



An infographic on the new family of Proton-Conducting materials

The investigators, Dr Taito Murakami and Prof Masatomo Yashima at the Tokyo Institute of Technology and Instrument Scientist James Hester, suspect that the protons move through a special oxygen-deficient layer in the compound. The team realised that intrinsic oxygen deficiencies in the new material gave it an advantage over other proton conductors—eliminating instabilities, the need for doping to improve conductivity, and difficulties in synthesising uniform samples.

Read the paper in the *Journal of the American Chemical Society*.

Watch more on this, in an interview with James Hester.

Small Angle

Mail-in service operational on Quokka. A reminder that in addition to standard proposals, we are also accepting mail-in proposals on Quokka. Mail-in proposals are accepted continuously and the proposal requirements are significantly abbreviated compared to the normal round. If there is enough interest from the community we will consider extending the service to other small-angle instruments. More information on the Quokka webpages.

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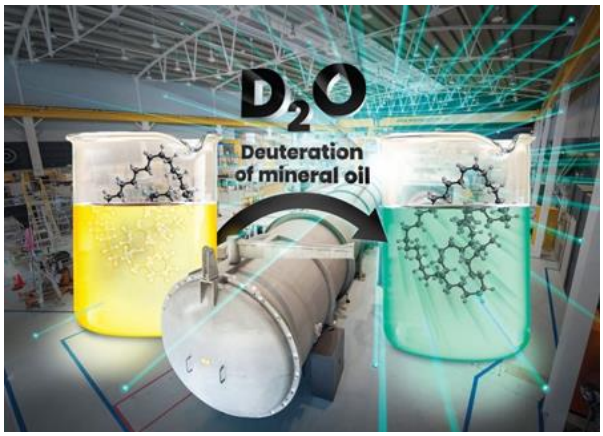
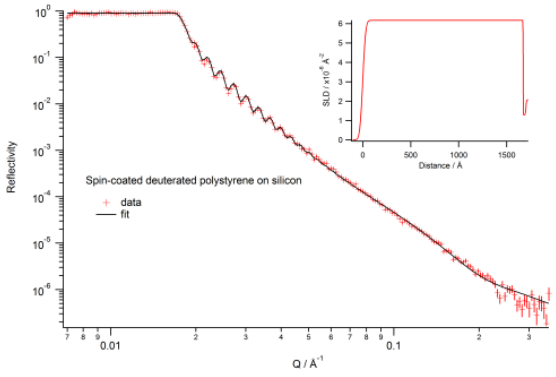
Industry collaboration with Mitsu Chemicals



Researchers from the Process Technology Laboratory, Mitsui Chemicals, Inc. in Japan have teamed up with the National Deuteration facility (NDF) to perform contrast-variation measurements with deuterated solvents on the Quokka instrument. The result is a recently co-published paper in Polymer Chemistry, which describes an easy one-pot deuteration method for large-scale production of deuterated mineral oil and poly(1-decene),typically used as solvents in their protonated form in polymer processing and manufacturing. This allowed Tamim Darwish from ANSTO's National Deuteration Facility in Australia , Dr Kazuki Mita from Mitsui Chemicals in Japan, Kathleen Wood from ACNS, and their co-workers to study polymer structures and oil-polymer solubility using neutron scattering on instruments at ANSTO.

Reflectometry

Hot commissioning of Spatz Since the resumption of operations after the COVID-19-induced shutdown, Spatz has powered ahead with hot commissioning. The instrument systems have been tested, calibrations completed, and the reduction software implemented. So far a range of different samples have been tested including the Bragg mirror, various different substrates (silicon, quartz, sapphire), spin-coated polymers, gold-coated silicon wafers, and more. A number of different sample environments have also been tested including solid-liquid cells, HPLC pump, and water baths. At the time of writing, the *in situ* ATR-FT-IR spectrometer for simultaneous reflectometry and IR spectrometry was being put through its paces. Spatz will welcome its first users in October (if COVID-19 restrictions allow!), and the instrument is currently open for applications in the proposal system.



The reflectivity of a spin-coated deuterated polystyrene film on a silicon substrate taken on SPATZ. The inset shows the corresponding scattering length density profile

Operations

Sample Environment Update Over recent months we have been commissioning our new pieces of sample environment. These are all now ready and integrated into our user program, and here we outline some of their capabilities.

Our new 7T compensating asymmetric vertical-field magnet from Oxford Instruments has recently had a successful commissioning followed by user experiments on Pelican, which are described elsewhere in the newsletter. It can reach magnetic fields of up to 7T, with a maximum ramping rate of 0.3 T/min. The temperature range of 1.5 K to 300 K is available at all fields and ramp rates. Temperatures above 300K are possible using a high-temperature sample stick, but please note the maximum field decreases with higher sample temperature.

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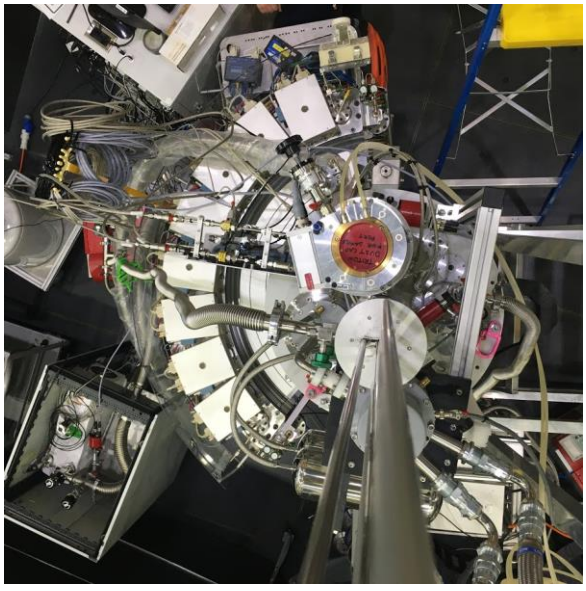
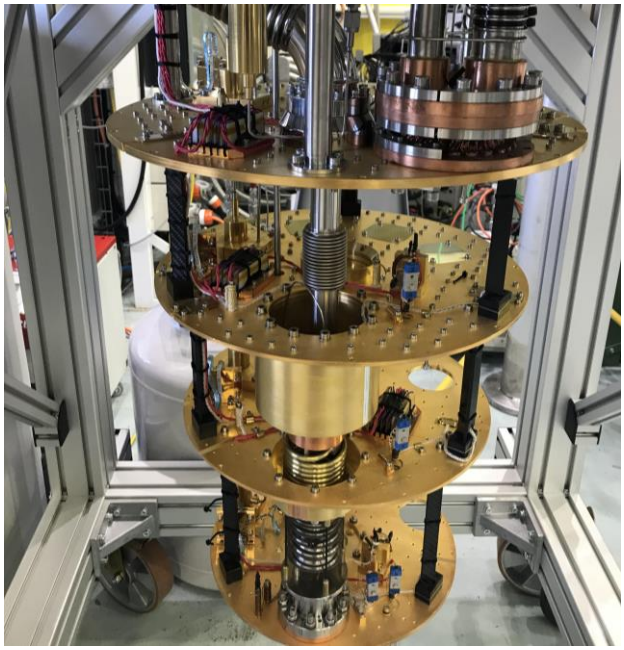
The 7T magnet from Oxford Instruments

A rotation stage allows the sample probe to be aligned *in situ*. Two tail configurations are available to suit either inelastic time-of-flight instruments or our SANS instruments. Changing between these tails requires warming the magnet up to room temperature. This change takes about two weeks and consumes significant amounts of liquid helium. Hence the magnet will be set up for blocks of experiments for each configuration to reduce the number of times this changeover occurs. At the time of writing the magnet is being prepared for commissioning on Quokka.



Top-down view of the Triton dilution cryostat

The Triton is a dilution cryostat from Oxford Instruments, with a temperature range of 20mK to 30K, and has been commissioned on Pelican and Wombat. Echidna and Sika commissioning is to follow and users may be interested to consider this cryostat for their dilution experiments. Samples may be bottom or top loaded. Bottom loading a sample is best for single-sample experiments or for samples that need additional space.



Detail of the inside of the Triton cryostat

Top loading allows sample changes during an experiment. Powder samples should be loaded under a helium atmosphere or a suitable deuterated solvent added (e.g. d-propanol) to optimise thermal conductivity between the sample can and the sample.

CF-13 and CF-14, new equipment from ICE Oxford, join our suite of cryofurnaces. They have two temperature ranges, cold probe: 1.5 K to 450 K and hot probe: 50 K to 800 K. They can be mounted on goniometer stages to allow up to 10° of tilt (at reduced cooling efficiency) and have 360° rotation stages for the sample sticks. Sample sticks have ±25 mm of height adjustment.

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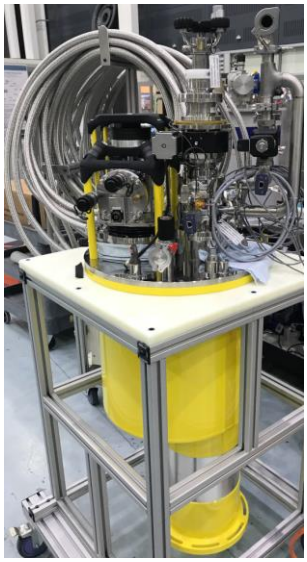

CF-13, one of our new 'Lemon' cryofurnaces from ICE Oxford.

As discussed in the Diffraction section, RALF is our new 6 axis robot, able to be used on Kowari for texture and to substitute for ROBBY on Echidna.

Also, keep an eye out for the upcoming sample environment handbook. We hope this helps you choose the right bit of sample environment for planning your experiments. If you have any sample-environment questions for your upcoming experiment or proposal please get into contact with our Sample Environment Manager, Rachel White (Rachel.White@ansto.gov.au) or any of the sample-environment team.

Beamtime Applications

For submission advice see the website or contact the ANSTO NSW User Office team on:
T: +612 9717 9111
E: user.office.nsw@ansto.gov.au

Powder Diffraction & Small-Angle Neutron Scattering Mail-in Rounds

Applications for mail-in powder diffraction measurements on Echidna and small-angle neutron scattering measurements on Quokka are continuously open.

COVID-19 Proposal Round

Applications for rapid-access beam time in support of COVID-19 research are continuously open.

2021-1 Proposal Round

Applications for beam time for the first half of 2021 are now open. The call for proposal will close on Tuesday 15th September 2020 at 11:59pm (AEST).

Event Reports

AINSE Winter School 2020

Report by Jitendra Mata

Every year in the mild winter of Sydney, the Australian Institute of Nuclear Science and Engineering (AINSE) holds its Winter School. The Winter School provides an opportunity for mainly undergraduate science students to explore the possibility of future research in nuclear science and technology mostly at ANSTO. This year due to the COVID-19 situation, AINSE decided to organise the school completely online as a virtual meeting. This was a risky move, as Winter Schools have always provided a medium to bring students onsite for deeper engagement. The general aims of this event are for students to meet ANSTO staff and explore the possibility of future research collaborations especially for their Honours and PhD degrees, and to gain deep insight into ANSTO's landmark research facilities including the Australian Centre for Neutron scattering (ACNS) and the Australian Synchrotron (AS). The AINSE winter school attracts students from both Australia and New Zealand, and also provides a great social environment, which most students remember for a very long time.

Despite all the concerns, the AINSE Winter School which ran from 6th to 9th July 2020 was a huge success. It attracted 80 students with a good gender balance (44M/35F). The school's program was designed in such a way that students get an overview of ANSTO's division of Nuclear Science and Technology & Landmark Infrastructure (NSTLI), the Research Themes, and various

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Infrastructure Platforms at ANSTO. Also there were five dedicated facility sessions (Radiation Damage and Nuclear Materials, Natural Radioactivity in Environmental Studies, ACNS, Centre for Accelerator Science, and AS). Students were divided in four groups that rotated around these five facility sessions over the last two days of the school. There were also presentations from AusYGN, WiN Aus, and a virtual tour of the Discovery Centre. A total of four (repeated) ACNS facility sessions were run over two days.

In the past I have helped with the Winter School from the Small Angle Scattering (SAS) group side, which only required a couple of hours of commitment (mostly showing students practical aspects of SAS instruments). However this year the game was completely different. I not only had to design the whole facility session but also to make sure students got the maximum out of that session. Being completely online, I needed to think of ways to make sessions more interesting, useful, engaging, yet not overly technical. Also being the only presenter, I needed to make sure I was not physically talking all the time; this would have been boring and certainly would have killed me :). One of the major disappointments was not being able to show students our wonderful instruments. From the beginning I was determined to overcome this challenge. I contacted Susan Bogle from the ANSTO Communications team to help me to make a video presentation of Quokka. Susan was great; we filmed around 1 hour which gave us 10 min of great video. This video proved to be an excellent investment. Not only did the students love it, but ACNS was the only facility with such a practical demonstration video. This video is now being used for my teaching at The University of Auckland.

Overall it was a great experience to be involved in the AINSE Winter School. I feel the program was packed and it was also echoed by students who submitted feedback saying they would like to see the same content of the whole school spread out over a week (instead of just three days). The school was closed by the wonderful speech from Adi Paterson, whose speeches I always find very inspiring. The ACNS participation also included shorter contributions about the other instrument groups and sample environment by Joseph Bevitt, Guochu Deng, Alison Edwards, Stephen Holt, and Rachel White, and a facility overview by Garry McIntyre.

Behind the Scenes of Big Science

One of the slightly frustrating things about working at ACNS is not being able to show off what we do all that easily to the public. Unlike our colleagues at the synchrotron, we cannot have an open day of the neutron guide hall. But with Australia's National Science of 2020 week going completely online, we had an opportunity to rectify this.

So the idea of our 'Behind the Scenes of Big Science' event was born. We decided to highlight five of our instruments, covering small angle scattering (Quokka), inelastic scattering (Sika), diffraction (Echidna), engineering (Kowari), and reflectometry (Spatz). We recorded segments on each of these instruments, with the aim of describing them and some of the science impacts they have.

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Behind the scenes of the 'Behind the Scenes' event!

Then, on the evening of the 19th of August the plan came together. Hosted by Rachel White, we used the videos to showcase the instruments over Zoom, and then had a really fun Q&A after. With over 300 people signing in (but probably a bigger audience as many families were watching) the questions poured in. A big thanks to the ANSTO Communications team, the videographers at Film Mafia and the Discovery Centre team for pulling this whole event together.

You can view the tour of ACNS put together for the event on ANSTO's YouTube channel.

SASSY 2020

Report by Anton LeBrun. The COVID-19 isolation did not stop the Sydney Soft Matter community getting SASSY this year (Surfaces and Soft stuff in SYdney) with the annual meeting being held online. As with previous years, the one-day meeting was expertly organised by Stuart Prescott at UNSW. There were many ACNS staff and users present in the audience as well as a plethora of talks that featured data gathered on the neutron beam instruments. There was a joint talk from Isaac Gresham (UNSW) and Ed Johnson (Newcastle) on responsive polymer brushes which featured soft matter bingo (reflectometry, QCM-D, ellipsometry, polymer, surfactant, BINGO!), and there was even a Melbourne interloper with Josh Marlow (Monash) presenting work from his PhD on liquid crystals and nanoparticles. The plenary talk this year was given by Anna Wang from UNSW, who gave an inspiring talk on forming primitive model cells using soap. The end of the day finished on a high note with the virtual posters. Let's hope we can get SASSY in person in 2021.

Awards

Australian Neutron Beam Users Group

ANBUG are currently seeking nominations for their five annual awards, these are:

ANBUG Career Award – for sustained contribution throughout the recipient's career to a scientific subfield, or subfields, using neutron scattering techniques.

ANBUG Neutron Award – for outstanding research in neutron science and leadership promoting the Australian neutron scattering community (>10 years post PhD).

ANBUG Young Scientist Award – for outstanding research utilising neutron scattering by scientists within 10 years of PhD conferral when accounting for significant career breaks.

ANBUG Outstanding PhD Prize – for a PhD thesis on research using neutron scattering techniques submitted to a university in Australia or New Zealand after 1st January the year prior to the award year (i.e., 1st January 2019 for the 2020 award).

Nominations for the 2020 awards are open and the nomination form can be downloaded from the ANBUG website. The deadline for nominations is the 18th September 2020.

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American Oil Chemist society

ACNS wishes to congratulate one of our long-time users Dr Andrew Clulow on his New Investigator research award from the American Oil Chemists' Society – congratulations Andrew!

Henry Marion Howe Medal

Anna Paradowska is among the authors who contributed to a 2019 paper that was recently awarded the ASM International ASM Henry Marion Howe Medal in Metallurgical and Materials Transactions A. The research led by the University of Manchester in the UK and Institut Laue-Langevin (ILL) in France, examined repair treatments on two nickel-based superalloys that are widely used in aeronautical engines and the energy sector.

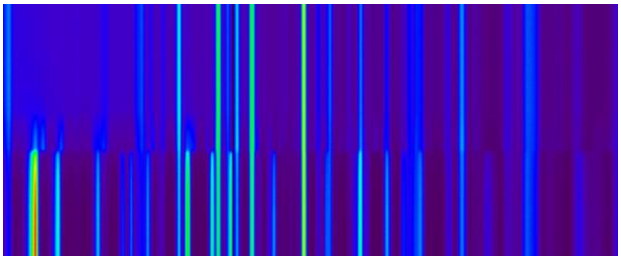
Upcoming Events

Continuing on the theme from the last issue of the newsletter – here we have events that you can enjoy in a socially distant manner.

ACNS Short talks

ACNS's regular Tuesday 10 am talks have now taken to Zoom, and are now available for our research community to join too. Covering topics that focus on technique development and research applications with neutron scattering, see the seminar schedule for the list of upcoming talks and do get in contact with Anton Stampfl (anton.stampfl@ansto.gov.au) if you would like to be on the mailing list for the zoom link, or indeed would like to give a talk.

ANSTO Powder diffraction School 2020



In the theme of 2020, the school will now be virtual, and will make access to lectures available (and free) to all who register. We hope also to run the practical elements of the course virtually, but will be restricting the numbers to these sessions, and prioritising those who already have data, or planning future experiments, with our facilities.

The dates of the course is set for 6th-8th October 2020, the deadline for applications is the 22nd September (unless our 450 people zoom limit is reached before then!).

This course would be ideal for Honours and PhD students, as well as early-career researchers, who have powder-diffraction data from ANSTO facilities. Also it is hoped that the lectures would be of use to all who are exploring powder-diffraction analysis.

See the school website for registration details.

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Magnetic structure determination from neutron diffraction data

The school, organised by Oak Ridge National Labs, US will provide hands-on training on how to determine magnetic structures from powder and single-crystal neutron data. The techniques of representational analysis and magnetic space groups will be introduced and used in a series of examples.

Lectures and hands-on tutorial sessions will cover:

-Symmetry analysis using representation theory and the SARAh program and ISOTROPY Suite
-Magnetic space groups using the Bilbao Crystallographic Server
-Refinement strategies using the FullProf Suite, Gsas2 and Jana
-Magnetic-structure determination from powder and single-crystal data (constant wavelength)

The school is intended for graduate students, postdocs, and research scientists who have a working knowledge of crystallographic refinement and will benefit from incorporating the techniques of magnetic structure determination from neutron diffraction into their research.

Deadline for applications is 11th September, please head to their website for more details.

AANSS 2020

The ANBUG-AINSE neutron scattering symposium will be a virtual event this year. Abstract submission is now open with the deadline for submissions of 7th September 2020. The thematic areas for the symposium this year are as follows:

- Advanced Materials
- Biological Systems
- Biomedicine & Food Science
- Chemistry & Crystallography
- Cultural Heritage
- Earth & Environment
- Magnetism & Condensed Matter
- Manufacturing & Engineering
- Neutron Instruments & Techniques

Keep up-to-date with ANBUG and AINSE activities on their respective twitter accounts @ANBUGneutron and @AINSE_ltd

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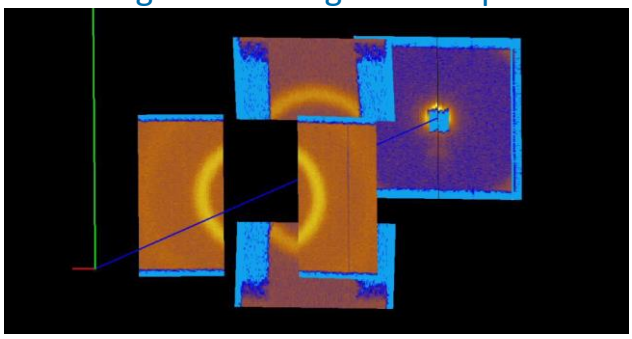
Small-angle-scattering workshop 2020



Keep an eye on the ANSTO what's on webpage, as a virtual small angle scattering workshop will be held 8th-10th December 2020.

The small-angle-scattering groups at the Australian Centre for Neutron Scattering and the Australian Synchrotron are hosting a workshop aimed at those new to small-angle scattering. The course will cover data collection, data analysis, data interpretation, and the application of scattering to a wide range of research fields.

The workshop will include hands-on tutorials to familiarise attendees with different approaches to data modelling and interpretation.

The course will be virtual, and registration and access to the lecture material will free. Practical sessions will also be run, but numbers for these sessions will be capped.

ICNS 2021

The ICNS 2021 is planned to be being held 4-8th July 2021 in Buenos Aires, Argentina. Organised by Asociación de Técnicas Neutrónicas de Argentina (ATENA) / Argentine Neutron Techniques Association it will be the largest international platform for sharing and exchanging the latest exciting advances in neutron scattering science, including a broad range of topics. Keep an eye out for future announcements once the website is up.

Meet the team

With all of the projects going on at ACNS there are always new faces joining the team. Here we keep you to up to date with team arrivals.

Jenny Bridge

Technical writer

Jenny has been contracting at ANSTO in various roles since March 2019. She has a good eye for detail and is a human spellcheck and typo detector. For many years she has enjoyed writing code in the underutilised VBA environment and surprising clients with simple but powerful shortcuts to enhance the useability of Word and Excel. She lives at Menai and is loving the shortest work commute she has ever experienced.

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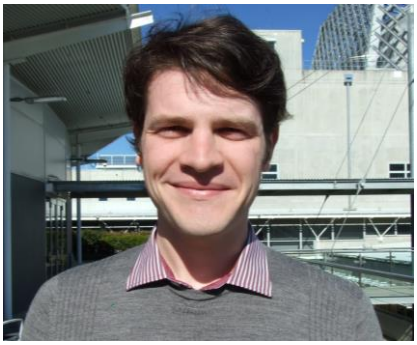
Ben Storer
Graduate

Ben provides support for the mail-in user program for small angle scattering and contributes to soft-matter research at ACNS. Part of ANSTO's Graduate Program, Ben has previously worked in the Human Health and Culture and Change teams. Prior to joining ANSTO, he studied neuroscience and psychology at the University of New South Wales.

Tim D'Adam
Sample environment professional officer



Tim has recently re-joined the ACNS after an 18-month stint working primarily with ultra-low temperature systems and superconducting magnets as a member of the Sample Environment group at the Institut Laue-Langevin in Grenoble, France. Tim has a range of experience which spans across a variety of cryogenic, magnetic and polarisation equipment employed in neutron scattering research.

Contact us

Do you have a story you would like to share with the ACNS user community? Contact the ACNS outreach team via:
E: helen.maynard-casely@ansto.gov.au