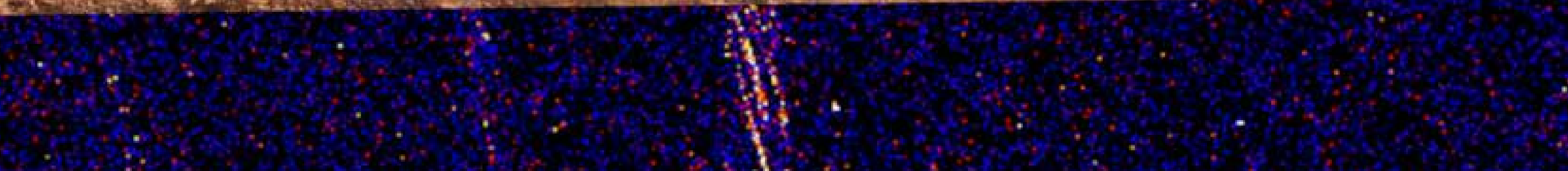


ANNUAL REPORT 2024

AINSE

THE AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

Playing a leading role in nuclear **Education** and training

Stimulating and **Supporting** students and early-career researchers in pursuing a career in nuclear science and engineering

Facilitating **Collaborations** with researchers at ANSTO's landmark infrastructure

Providing an effective **Network** between all stakeholders of nuclear science and engineering

Engaging with **Members** to enhance funding opportunities and ensure relevance of nuclear education and training

AINSE
THE AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING
New Illawarra Road, Lucas Heights NSW 2234 Australia
+61 2 9717 3376 | enquiries@ainse.edu.au | www.ainse.edu.au
ABN 18 133 225 331

Contents

AINSE 2024 Annual Report

From the President and the Managing Director

AINSE celebrated another productive year filled with student events and supporting high-quality research. A variety of funding opportunities were offered once again throughout the year, including the new Pathway Scholarship for Honours and Masters Students (replacing the former Honours Scholarships); Postgraduate Research Awards (PGRA); Residential Student Scholarships (RSS); Scholarship AINSE ANSTO French Embassies (SAAFE); Early Career Researcher Grants (ECRG); along with travel, conference, and professional and technical skills support. Most applications in 2024 were processed through the new AINSE portal, providing a more streamlined experience for applicants, approvers, reviewers and the AINSE secretariat.

In 2024, 30 Pathway Scholarships were awarded to students from 16 member institutions. The SAAFE program awarded 7 new scholarships in 2024 in which 4 different AINSE universities participated. The PGRA scholarships once again continued to be the most highly funded program in 2024 with support provided to 113 postgraduate students. This included a new AINSE postgraduate cohort of 34 PGRA scholars and 2 RSS Scholars from 20 different member institutions. In September AINSE announced its ECRG scholarships in which 17 scholars were successful from 12 different member institutions.

In May at AINSE's annual networking event, AINSE Scholar Gold Medals for excellence and impact in research were formally awarded to Dr. Oliver Paull (University of New South Wales), for his research on multiferroics, and to Dr. Yanxiang Meng (University of Melbourne), for his research on the molecular mechanisms of cell signalling during cell death.

Following the Award Ceremony, AINSE's annual Networking Dinner was held to bring together representatives from the Australian nuclear science and technology sector. AINSE member representatives from across Australia and New Zealand met with members of the AINSE and ANSTO Boards, representatives from ARWA, ARPANSA, the ANA, ATSE, and AusYGN, alongside AINSE alumni and ANSTO researchers, at the Sydney Masonic Centre. Gold Medal recipient Dr. Oliver Paull shared his AINSE-supported research into multiferroic materials with the assembled guests over dinner, in an extended conversation with AINSE President Prof. Ian Gentle. During the evening, AINSE staff member Nerissa Phillips received special acknowledgement for her 30 years of service to AINSE, over which time she has provided administration support to thousands of students and researchers.

AINSE held three schools in 2024: the AINSE Winter School; Postgraduate Orientation Week; and the Women in STEM and Entrepreneurship (WISE) School. The AINSE schools play a major role in connecting with students to help create a pipeline of students interested in further enhancing capacity in nuclear science, engineering, and related research fields.

The Winter School attendance was 74 students from 25 member institutions attending the school online in July as a 6-day event. The online School was expanded into a second week of activities, welcoming the Heavy Ion Accelerator Facility (HIAF) from the Australian National University (ANU) into the suite of AINSE-supported facilities showcased during the event. Following the online component, 42 students from 20 institutions then visited in small groups in September to experience selected areas of Nuclear Science and Technology (NST) at ANSTO's Lucas Heights campus.

In October, AINSE held its annual online Postgraduate Orientation week with 30 students attending. Postgraduate scholars undertaking research at ANSTO or any AINSE member postgraduate students interested in ANSTO were eligible to attend. On the final day, a masterclass for new students was held to provide information on how to write competitive funding applications. The program coincided with Nuclear Science Week, an international celebration of nuclear science. AINSE again collaborated with the Australian Young Generation in Nuclear (AusYGN), the Women in Nuclear (WiN) Australia chapter, the Australian-American Fulbright Commission, and the National Museum of Nuclear Science and History in Albuquerque for the 2024 event.

In early November, the ANBUG-AINSE Neutron Scattering Symposium (AANSS) for 2024, hosted at ANSTO's Lucas Heights Campus was held. At the event the 2024 Australian Neutron Beam Users Group (ANBUG) presented awards for excellence across the neutron sector. Most of the recipients were AINSE alumni and colleagues including Dr Joseph Bevitt – Neutron Award and Dr Rezwanul Haque – Young Scientist Award, who were given recognition for their outstanding work in neutron-based research. In addition, former AINSE President Prof. Brendan Kennedy was presented with the career award for his significant contribution to neutron science. Dr Hayden Robertson received the award of Outstanding PhD and Dr Liliana de Campo the Technical Award due to contribution to instrumentation for neutron science.

The final event of the year was the Women in STEM and Entrepreneurship School (WISE), where 70 first-year female students attended either online or in-person from 21 member institutions. On the final two days of the program, 43 of the WISE students were able to visit ANSTO's Sydney campus in Lucas Heights, with the remaining students continuing in an online attendance mode. The cornerstone of the AINSE WISE program is a year-long mentorship program that runs for 12 months after the school attendance. During the final days of the program the students were able to attend a 'Meet the Mentors' networking event.

We would like to thank and congratulate the AINSE secretariat: Michael Rose, Kim Shields, Nerissa Phillips, Laura Owen, Rebecca Duncan, Elijah Penzo, Denali Hutt and Amanda Lisser, Sarah Cooper and Georgia Barrington-Smith for their work in 2024. The efforts of the AINSE staff in continuing to maintain the online, face-to-face and hybrid formats for events whilst also offering excellent support to the research community with enhanced member benefit opportunities are much appreciated.

We extend our thanks to Mr. Shaun Jenkinson, Chief Executive Officer of ANSTO, for allowing us to utilise the facilities and collaborate with the ANSTO staff maximising benefits for our members. We also thank the ANSTO staff involved with AINSE from many areas, and in particular NST staff, for ensuring that the students and researchers were well supported in 2024. This strong support allows AINSE to meet strategic objectives to enhance opportunities in nuclear science and engineering and related areas and build a strong pipeline of scholars. We also extend thanks to AINSE member representatives for promoting AINSE opportunities and connecting as many potential scholars as possible.

AINSE remains strong financially with a large membership base and support from ANSTO and the university sector. AINSE finished 2024 with a deficit of $22,035, which was lower than the budgeted deficit. This was largely due to an underspend in secretariat due to a vacant position and some gains in interest revenue.

2024 was the first year under AINSE's new strategic plan and AINSE is tracking well with its goals, which have involved further enhancing benefit to members where possible. We look forward to continuing the diverse range of AINSE programs in 2025 and utilising the skills and experience of the Secretariat and Board in working further towards our strategy.

Prof. Ian Gentle
AINSE President

Ms. Michelle Durant
AINSE Managing Director

AINSE Board 2024

Prof. Ian Gentle
President
University Representative

Ms. Michelle Durant
Managing Director

Dr. Diana Day
Independent Director
Commenced 01/01/2024

Dr. Leonie Walsh
Independent Director

Prof. John Bell
University Representative

Prof. Janice Aldrich-Wright
University Representative

Mr. David Filipetto
ANSTO Representative

Prof. Andrew Peele
ANSTO Representative

Ms. Roslyn Hatton
ANSTO Representative

AINSE Staff 2024

Managing Director

Michelle Durant
BSc, BFinAdmin, GradDipAppCorpGov, FGIA, FCG, GAICD

Secretariat

Business Manager:
Kim Shields
GradCertMgt, AdvDipAcc, CertGovNFP

Communications and STEM Manager:
Dr. Michael Rose
BSc, BMath(Hons), PhD, MScom, AssocDegAvn

Marketing and STEM Officer:
Georgia Barrington-Smith
BSc(Hons)

Administration and Accounts Officer:
Nerissa Phillips (part-time)

Administration and Events Assistant:
Dr. Rebecca Duncan (casual)
BSc, BA, GradDipEnEnv, MEnvSc(Res), PhD

Administration and Events Assistant:
Denali Hutt (casual)
BSc, MMark

IT and Administration Assistant:
Sarah Cooper (casual)
BSc(IT), DipSoftDev

Staff who concluded in 2024:

Administration and Events Officer:
Laura Owen BCom(Mktg), AdvDipEvents

Administration Officer:
Elijah Penzo (casual)

Administration Assistant:
Amanda Lisser (casual)

Pictured left to right, top to bottom










Strategic Directions

Vision

To enhance the capability of Australia and New Zealand in nuclear science, engineering and related research fields by facilitating world-class research and education.

Mission

AINSE provides pathways and networks for collaboration within nuclear science, engineering and related industry, and research nationally and internationally and builds capability and diversity through training and education.

Strategic Priorities

1. Be the vital link between universities and knowledge in the nuclear industry by exploring targeted opportunities for the next generation of students and researchers with an interest in nuclear science and engineering.

- Support the next generation of students and researchers by exploring new opportunities for collaboration and knowledge transfer nationally and internationally.
- Work with AINSE members for continued improvement of existing programs aligned with current trends in the tertiary sector.
- Expand the reach and accessibility of existing programs to AINSE member students and researchers.

2. Be a visible and respected brand with strong connections that reaches a wider audience beyond nuclear scientists and engineers.

- Promote AINSE's value proposition and align it with the priorities of Government, ANSTO, Universities, Industry, and other interested parties.
- Effectively communicate AINSE's vision and mission to a wide range of different stakeholders through outreach and marketing campaigns.

3. Facilitate research collaboration through networking and expanding opportunities nationally and internationally.

- Play a key role in supporting research collaboration and networking opportunities between ANSTO, Universities, Industry, and other experts in nuclear science and engineering.
- Explore targeted national and international opportunities to support the expansion of the nuclear industry.

4. Be appropriately resourced to remain responsive to opportunities within a changing environment.

- Liaise through networking and targeted meetings with local, national and international policy makers to influence and communicate future priorities that relate to emerging trends and opportunities as identified by members.
- Seek new collaborative opportunities to expand member benefits in nuclear science and engineering and other related research areas in line with member priorities.
- Efficiently manage and protect AINSE's information assets.

5. Provide a sustainable and growing business that increases the value of AINSE membership.

- Diversify AINSE's revenue streams, while recognising the importance of existing members and maintaining/increasing membership value.
- Identify gaps in the AINSE pipeline to address emerging trends through member consultation to develop targeted programs when required.

Harrison Stevens, AINSE PGRA Scholar and Ph.D. student at the University of Tasmania, Australia, collecting sediment cores using a Uwitec hammer corer. Please see p22 for further details. Image credit: Harrison Stevens.

Research Highlights

Using geochemical indicators to assess the vulnerability of springs to mining impacts Doongmabulla springs and the Carmichael Coal Mine (Queensland)

Angus Campbell[1], Matthew Currell[2], Ian Cartwright[3], Dioni Cendón[4], John Webb[5].

[1] RMIT University, Melbourne, VIC, Australia.
[2] Griffith University, Nathan, QLD, Australia.
[3] Monash University, Melbourne, VIC, Australia.
[4] Nuclear Science & Technology (NST), ANSTO, Lucas Heights, NSW, Australia.
[5] La Trobe University, Melbourne, VIC, Australia.

In arid and semi-arid environments, springs, permanent waterholes and groundwater-fed streams are vital sources of water that often sustain groundwater dependent ecosystems (GDEs) of ecological (Fensham et al. 2004; Bonada et al. 2020; Doody et al. 2015) and cultural significance for Indigenous Peoples (Ah Chee 2002; Moggrirdge 2020).

Currently, many GDEs are in decline due to groundwater extraction for irrigation, mining and other purposes (Post et al. 2020; Habermehl 2020). Sustainable management of GDEs relies on a clear understanding of the hydrogeological system and groundwater processes that sustain them.

In Central Queensland, contention has surrounded the development of Australia's largest coal mine, the Carmichael Coal Mine (Fig. 1), and whether groundwater extraction associated with the mine will impact groundwater flows to the ecologically and culturally significant Doongmabulla Springs Complex and the Carmichael River (Fig. 2) (Currell et al. 2020). Uncertainty regarding the source(s) of water that sustain the Doongmabulla springs, the exchanges between the Carmichael River and groundwater, and the extent of inter-aquifer connectivity have prevented clear assessments of how mining will impact the GDEs (CSIRO & Geoscience Australia 2019).

This study focused on resolving these three key conceptual uncertainties and re-assessing the vulnerability of the Doongmabulla springs and Carmichael River to mining impacts. A range of spring, river and groundwater samples collected across four field campaigns between 2021-2023 were analysed for a suite of environmental isotope tracers (including Hydrogen-3 (^{3}H), Carbon-14 (^{14}C) and Chlorine-36 (^{36}Cl) at ANSTO's Isotope Tracing in Natural Systems (ITNS) and Centre for

Sustainable management of groundwater dependent ecosystems relies on a clear understanding of the hydrogeological system and groundwater processes that sustain them.

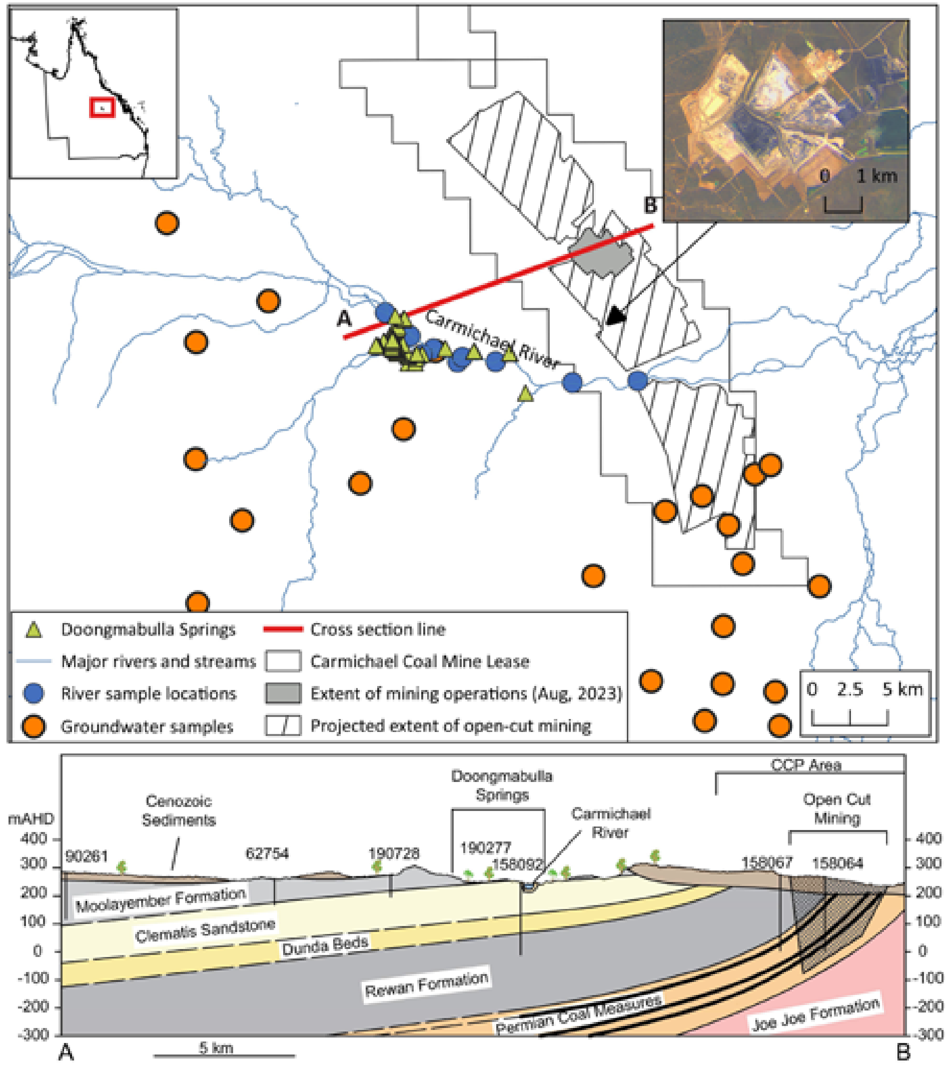


Figure 1: Site map and geological cross section of the study area (adapted from Campbell et al., 2024a). Shown is the location of the Doongmabulla springs, Carmichael River and water samples collected in this study. Also depicted is the Carmichael mine lease (CCP area) and the current (as of August 2023) and projected extent of the open-cut mine.

Accelerator Science (CAS) facilities (Fig. 1). This isotope tracer data was used alongside multiple other geochemical and geophysical datasets to develop a robust conceptual understanding of the GDEs and their associated hydrogeological system.

The findings of this study have significant management implications for the Carmichael mine and can be used to ensure the protection of the Doongmabulla springs and Carmichael River. This study also demonstrates the value of environmental isotope tracers for developing accurate conceptual hydrogeological models, and presents a widely applicable methodology that can be used across industry and the research community to better understand and protect GDEs in other contexts.

Isotope tracers indicate that an array of different groundwater sources with different residence times sustain the various springs within the Doongmabulla complex (Campbell et al. 2024a). ^{36}Cl activities suggest that springs in the west of the complex are predominantly sustained by very old groundwater from the Early-Mid Pleistocene (residence time >500ka), while groundwater recharged during the Holocene (residence time <4ka) and Late Pleistocene (residence time 50k – 150ka) is the main water source of the eastern springs (based on ^{3}H and ^{14}C activities) (Fig. 3). These data suggest that groundwater from Clematis Sandstone aquifer (Fig. 1) is the predominant source of the springs. However, Holocene groundwater critical to the eastern springs also transitions through the (younger) Cenozoic sediments and (older) Dunda Beds (Fig. 1), in areas near the mine which are likely to experience significant drawdown (Fig. 3). Deeper units (e.g. the Dunda Beds) also cannot be ruled out as the source of very old groundwater in the western springs (Fig. 3).

Archaeology, Geosciences and Environmental Sciences AGES

Figure 2: (A) the Doongmabulla springs. Photo credit: Matthew Currell. (B) the Carmichael River. Photo Credit: Angus Campbell. (C) Angus Campbell (right) and Matthew Currell (left) collecting groundwater samples. Photo credit: Matthew Currell. (D) Sunset over the Doongmabulla springs. Photo credit: Matthew Currell.

This revised conceptualisation contradicts the conceptual model of the springs that was used to predict the impacts of the Carmichael mine, that assumed that all springs are sustained solely by the Clematis Sandstone. It has major implications for the ecosystems' vulnerability to drawdown (Campbell et al. 2024a).

Isotope tracers indicate...different groundwater sources with different residence times sustain the various springs within the Doongmabulla complex

^{36}Cl and major ion concentrations in the Carmichael River (Fig. 2) indicate that influx of very old (residence time >500ka) and intermediate (residence time >50ka) groundwater sustains baseflow to the river near to the Doongmabulla springs. Further upstream, ^{3}H activities suggest surface runoff and shallow groundwater are the main water sources, while no regional groundwater influx to the river appears to occur downstream of the springs within the mine lease.

During major flood events, groundwater levels and chloride concentrations adjacent to the stream indicate river losses to groundwater occur near the Doongmabulla springs. However, downstream near the Carmichael mine, river leakage after heavy rainfall is much less significant. These conclusions indicate that the numerical models used to predict the Carmichael mine's groundwater impacts have overestimated baseflow in the Carmichael River, and the potential for river leakage to buffer drawdown in shallow aquifers below and adjacent to the stream channel.

Within the mining lease, aerial electromagnetic

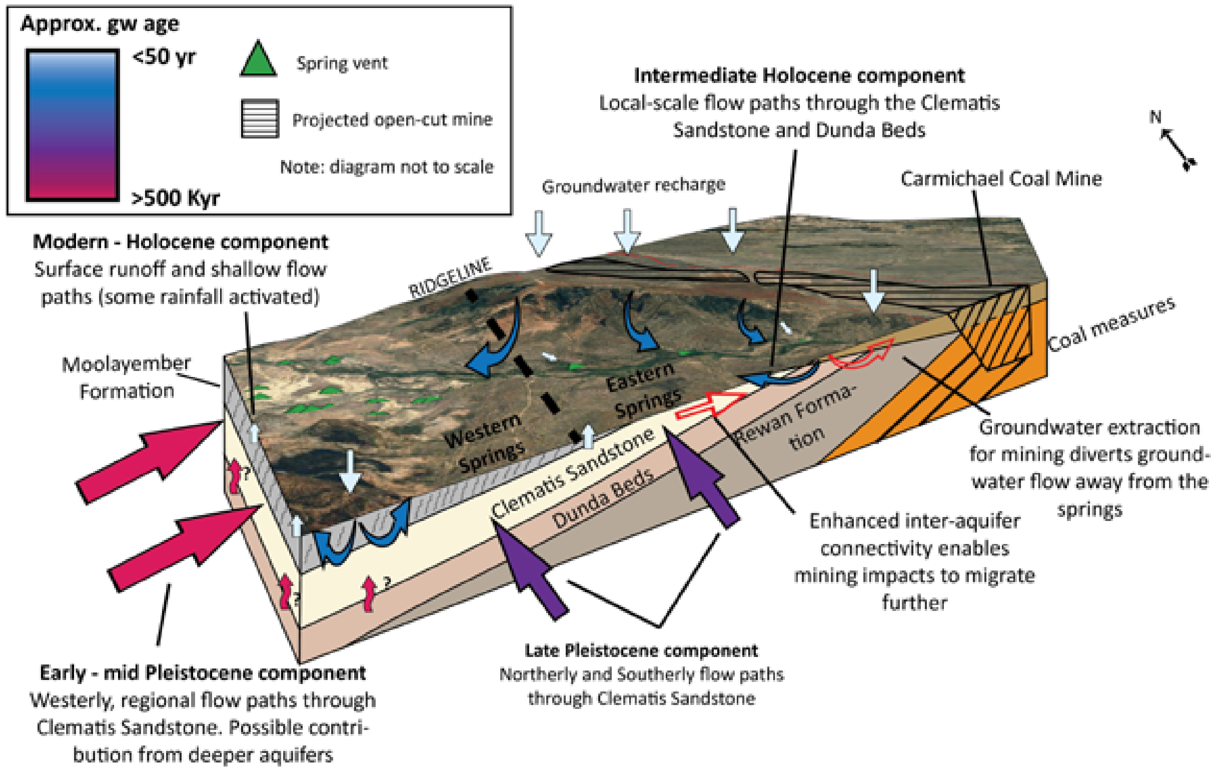


Figure 3: Revised conceptual model of the groundwater processes and hydrogeological system sustaining the Doongmabulla springs. Coloured arrows indicate groundwater flow paths (colour corresponds with water age, see figure legend), while hollow red arrows indicate the likely changes to groundwater flow directions after the completion of the Carmichael mine (based on the findings of this study).

surveys (from Tan et al. 2022) and geological logs revealed weathered sandy zones of substantially increased permeability occur within several stratigraphic layers, and are common in large areas to the south of the current mine pit (Campbell et al. 2024b). ^{3}H, ^{14}C and ^{36}Cl activities in groundwater suggest these weathered sediments contain fresh, relatively young groundwater (residence times of hundreds to thousands of years) and are likely to be preferential pathways for recharge, groundwater flow and inter-aquifer mixing (Fig. 3). Since mine dewatering began in 2019, drawdown has migrated preferentially south of the mine through these high permeability zones, and into shallow units above the coal-bearing sediments that are not targeted by dewatering. Drawdown is also migrating gradually into shallow aquifer units west of the mine, towards the Doongmabulla springs and Carmichael River (Fig. 3). These findings indicate that inter-aquifer connectivity and geological heterogeneity is significantly greater than was assumed in the Carmichael mine's impact assessment, and shallow aquifers which sustain the springs, the Carmichael River and pastoral groundwater resources are more vulnerable to drawdown than has been predicted (Campbell et al. 2024b).

These revised conceptualisations of the Doongmabulla springs, Carmichael River and inter-aquifer connectivity indicate that dewatering for the Carmichael Coal Mine is likely to cause greater impacts to GDEs and pastoral groundwater resources than was anticipated in the mine's approved impact assessment. Local-scale groundwater flow paths near the mine that sustain the eastern springs are likely to be diverted away from the springs (Fig. 3) (Campbell et al. 2024a). The current extent of drawdown and evidence of inter-aquifer connectivity also indicates that drawdown in the aquifers which sustain the Doongmabulla springs, Carmichael River and pastoral groundwater resources will be greater, occur sooner and migrate further than was originally anticipated (Campbell et al. 2024b). The relatively sporadic, spatially variable leakage of surface water from the Carmichael River into the underlying aquifer units is unlikely to buffer drawdown impacts along the river corridor (including beneath the springs), as was conceptualised in the mine's impact assessment. These impacts to the hydrogeological system will likely cause reductions in flow and/or the extinction of these significant GDEs.

Angus is a PhD student at RMIT University, supervised by Professor Matthew Currell (Griffith University and RMIT), Professor Ian Cartwright (Monash University) and Dr Dioni Cendón (ANSTO). Angus's project was part of an Australian Research Council Linkage Project (LP190100713), through which Professor John Webb (La Trobe University) provided secondary supervision and collaboration, and Coast and Country provided field and logistical support.

Angus is supported by an Australian Government Research Training Program Scholarship and an Australian Institute of Nuclear Science and Engineering (AINSE Ltd) Postgraduate Research Award (PGRA) Scholarship. ANSTO support and analytical staff Fiona Bertuch, Peter Freeman, Vladimir Levchenko, Krista Simon and Klaus Wilcken are thanked for their assistance throughout the project. We thank the landowners and managers of pastoral leases on which sampling was undertaken. We also respectfully acknowledge the Wangan and Jagalingou People as the traditional owners and custodians of the lands and waters on which this research was conducted, and that sovereignty was never ceded.

References:

Ah Chee, D 2002, 'Indigenous People's connection with Kwatye (Water) in the Great Artesian Basin', Environment SA, vol. 9, pp. 20-25.

Bonada, N, Cañedo-Argüelles, M, Gallart, F, Von Schiller, D, Fortuño, P, Latron, J, Llorens, P, Múrria, C, Soria, M, Vinyoles, D & Cid, N 2020, 'Conservation and management of isolated pools in temporary rivers', Water (Basel), vol. 12, pp. 1-24.

Campbell, A G, Cartwright, I, Cendón, D I & Currell, M J 2024a, 'Multiple isotope tracers reveal the sources of water sustaining ecologically and culturally significant springs, and their vulnerability to mining development', Journal of Hydrology, vol. 645, pp. 132078.

Campbell, A G, Cartwright, I, Webb, J A., Cendón, D I & Currell, M J .2024b, 'Using geochemical and geophysical data to characterise inter-aquifer connectivity and impacts on shallow aquifers and groundwater dependent ecosystems', Applied Geochemistry, vol. 178, p.106217.

CSIRO & Geoscience Australia 2019, Carmichael Coal Mine—Advice on Groundwater Dependent Ecosystem Management Plan v11b to the Queensland Department of Environment and Science. Geoscience Australia: Canberra, Australia.

Currell, M J, Irvine, D J, Werner, A D & Mcgrath, C 2020, 'Science sidelined in approval of Australia's largest coal mine'. Nature Sustainability, vol. 3, pp. 644-649.

Doody, T M, Colloff, M J, Davies, M, Koul, V, Benyon, R G & Nagler, P L 2015, 'Quantifying water requirements of riparian river red gum (*Eucalyptus camaldulensis*) in the Murray–Darling Basin, Australia – implications for the management of environmental flows'. Ecohydrology, vol. 8, pp. 1471-1487.

Fensham, R J, Fairfax, R J & Sharpe, P J 2004, 'Spring wetlands in seasonally arid Queensland: floristics, environmental relations, classification and conservation values', Australian Journal of Botany, vol. 52, pp. 583-595.

Habermehl, M A 2020, 'Hydrogeological overview of springs in the great artesian basin', The Proceedings of the Royal Society of Queensland, vol. 126, pp. 29-46.

Moggrirdge, B J 2020, 'Aboriginal People and Groundwater', Proceedings of the The Royal Society of Queensland, vol. 126, pp. 11-27.

Post, D A, Crosbie, R S, Viney, N R, Peeters, L J M, Zhang, Y Q, Herron, N F, Wilkins, A, Janardhanan, S, Karim, F, Aryal, S K, Pena-Arancibia, J, Lewis, S, Evans, T, Vaze, J, Chiew, F HH S, Marvanek, S P, Henderson, B, Schmidt, B & Herr, A 2020, 'Impacts of coal mining and coal seam gas extraction on groundwater and surface water,' Journal of hydrology (Amsterdam), vol. 591, 125281.

Tan, K P, Rollet, N, Vizy, J & Kilgour, P 2022, 'Great Artesian Basin eastern recharge assessment - Eastern Eromanga Basin airoborne electromagnetic conductivity model interpretation report', Record 2022/33. Geoscience Australia: Canberra, Australia.

Groundwater recharge on Australia's southern arid margin

Calla N. Gould-Whaley[1,] Russell N. Drysdale[1], Pauline C. Treble[2,3], Jan-Hendrik May[1], Stacey C. Priestley[4], John C. Hellstrom[1], Christopher R. Vardanega[2], Clare C. Buswell[5]

[1] University of Melbourne, Parkville, VIC, Australia

[2] Nuclear Science & Technology (NST), ANSTO, Lucas Heights, NSW, Australia

[3] University of New South Wales, Kensington, NSW, Australia

[4] Drought Resilience Mission, Commonwealth Scientific and Industrial Research Organisation, Adelaide, SA, Australia

[5] Flinders University, Adelaide, SA, Australia

Many regions across Australia are dependent on groundwater resources for agricultural, industrial, and domestic uses. This is especially true of Australia's semi-arid and arid regions where surface water resources are few and far between due to extremely high evapotranspiration rates and sporadic rainfall (Harrington & Cook 2014).

Over the last century, southern Australia has experienced progressive drying and warming trends, which are expected to be amplified under all future emissions scenarios (Grose et al. 2020). Anticipating how future climate will influence groundwater availability in southern Australia's arid and semi-arid regions requires a better understanding of groundwater recharge dynamics. Given that groundwater systems typically develop over multi-millennial timescales, we must look beyond the historical records. Cave formations that precipitate from water percolating through a carbonate bedrock – known as speleothems – provide an invaluable opportunity to interrogate long-term groundwater recharge histories.

Mairs Cave, on Adnyamathanha country in the Central Ikara-Flinders Ranges, lies on Australia's southern arid margin (Fig. 1). At the surface, Mairs Cave is an unassuming hole in the ground, but the 17-meter sheer vertical

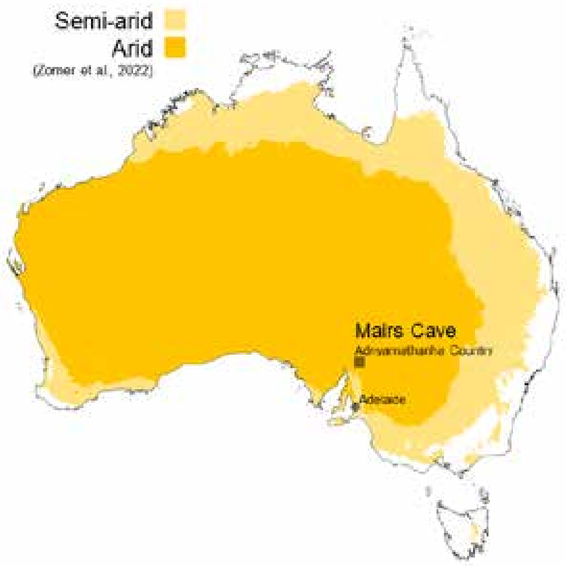


Figure 1: Mairs Cave, on Adnyamathanha Country, lies on Australia's southern arid margin. Australia's arid regions are marked in orange, and semi-arid regions are marked in yellow.

Archaeology, Geosciences and Environmental Sciences AGES

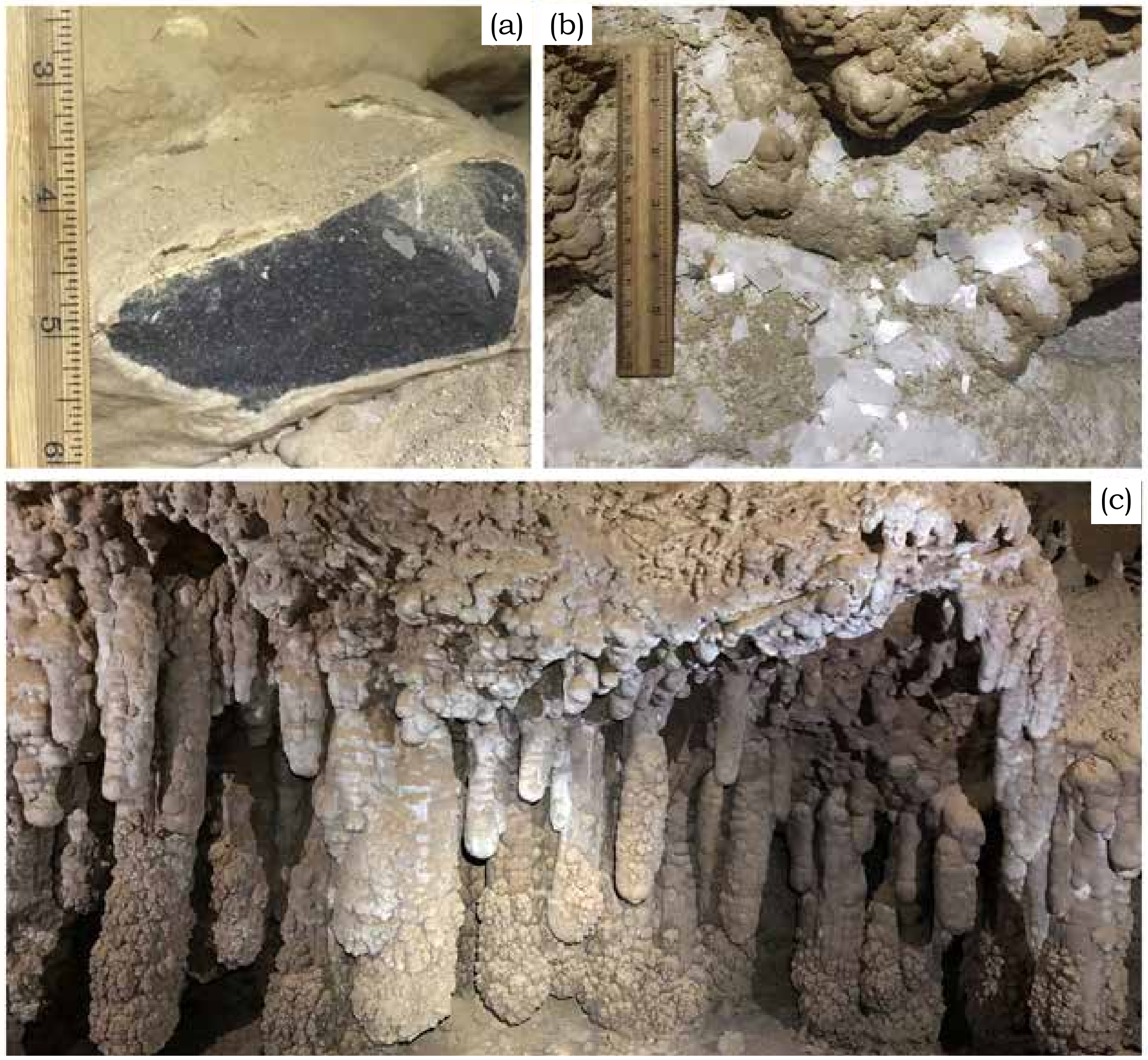


Figure 2: Images from Mairs Cave: a) rock fallen from the cave ceiling that has since been coated in calcite. b) calcite rafts. c) the curtain of hanging speleothems in the main chamber.

entrance shaft empties into a main chamber that is 100 meters long and 12 meters wide. Over the last few years, visitors to Mairs Cave have reported extremely dry conditions; in some parts of the cave the ceiling is damp, but moisture evaporates before a drip can form. In contrast, archives held by the South Australian Department of Mines and the Caving Exploration Group of South Australia report a deep pool of crystal-clear water in the main chamber in 1920, 1922, 1968, 1974 and 1975. Cave flooding events have left physical evidence, including calcite coatings on fallen rocks (Fig. 2a), and calcite rafts scattered through the cave (Fig. 2b). Calcite rafts are thin films of calcite that precipitate on the surface of a water body that is saturated with calcite.

Mairs Cave also contains a curtain of bulbous, hanging formations (Fig. 2c). We were lucky enough to be given access to one of these speleothems that was removed from the cave in 2019. Halving and polishing the speleothem revealed a unique internal structure (Fig. 3). At its centre is a stalactite, with a downwards direction of growth. The stalactite is coated in darker material with more defined growth layers, and a radial direction of growth. This structure is typical of a 'pendulite', a speleothem that begins as a stalactite, then is submerged in water that is saturated with calcite. This causes calcite to be precipitated subaqueously on the existing stalactite surface. From that point forward, the pendulite can only grow while submerged. We hypothesised that cave flooding events were most likely caused by rising of the local water table during periods of enhanced groundwater recharge. Over the past year we have performed geochemical analyses in collaboration with ANSTO's Environment Research & Technology Group to test this hypothesis.

Anticipating how future climate will influence groundwater availability …requires a better understanding of groundwater recharge dynamics.

We collected a groundwater sample from the closest bore (5 km) within the same limestone formation as the cave. The groundwater returned a calcite saturation index of 1.12, indicating that it is possible for calcite to precipitate from the groundwater. We measured calcium, magnesium, and barium concentrations in the groundwater and applied known calcite partition coefficients to determine the Magnesium/Calcium (Mg/Ca) and Barium/Calcium (Ba/Ca) ratios that could theoretically occur in calcites precipitated from the groundwater (as per Drysdale et al. 2019).

We found that the Mg/Ca and Ba/Ca ratios of the subaqueously deposited material fell within the range of values that could arise from the groundwater. Uranium–thorium (U-Th) dating revealed the subaqueous calcite exhibits initial uranium isotope activity ratios between 4.07 to 4.52. Values as high as these are typical of calcite precipitated from groundwaters (Wendt et al. 2020). The groundwater sample returned a Dead Carbon Fraction (DCF) of 45.8 %, meanwhile two calcite rafts returned DCFs of 41.38 and 40.45%. Considering uncertainties inherit to radiocarbon corrections, and the DCF variability observed in speleothems the DCFs of the groundwater and the calcite rafts show remarkable similarity (Griffiths et al. 2012; Hua et al. 2012; Welte et al. 2021).

…dating of the subaqueous growth layers can be used to determine the timing of enhanced groundwater recharge.

All lines of evidence suggest that the subaqueous material precipitated from the groundwater when the cave was flooded due to rising of the local water table. Therefore, dating of the subaqueous growth layers can be used to determine the timing of enhanced groundwater recharge. There appear to have been two multi-millennial periods of subaqueous growth, 68.5 to 65.4 thousand years ago (ka) and 51.2 to 42.3 ka, as well as two short bursts of growth around 18.9 and 16.4 ka. These fall within the Last Glacial Period, when temperatures and evapotranspiration in Australia were much lower than they are today. These findings suggest that the climatic conditions conducive to sustained, effective groundwater recharge on Australia's southern arid margin differ greatly from those that we expect to see under future climate scenarios. The implications of these findings are that the groundwater reservoirs across Australia's southern arid margin are unlikely to experience significant recharge any time soon, and groundwater management plans should be assessed accordingly to prevent irreversible depletion.

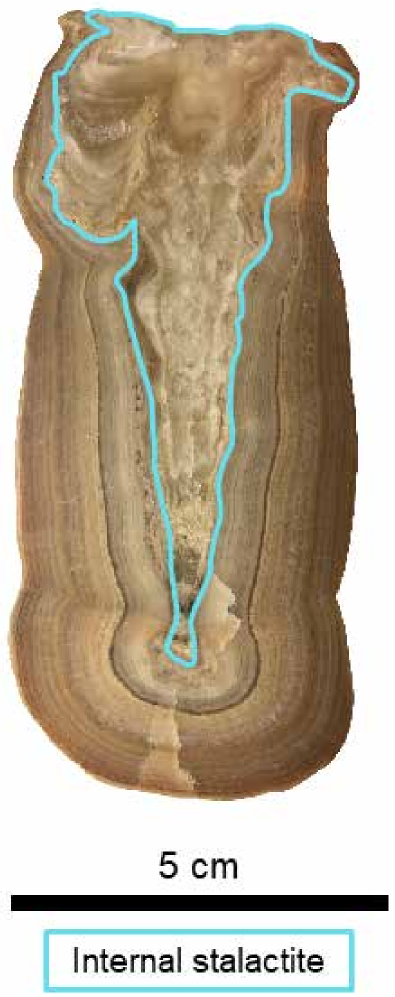


Figure 3: Mairs Cave pendulite. The internal stalactite is circled in blue. Everything beyond the blue line was deposited subaqueously during cave flooding events.

Calla Gould-Whaley is a PhD candidate at the University of Melbourne, supervised by Professor Russell N. Drysdale (University of Melbourne), Dr Pauline Treble (ANSTO), and Dr Jan-Hendrik May (University of Melbourne). Dr Stacey Priestley is a Research Scientist within the Groundwater Systems team at CSIRO. Dr John Hellstrom is a Uranium-Series Geochemistry Specialist at the University of Melbourne. Christopher Vardanega is an Analytical Chemist at ANSTO. Dr Clare Buswell is a Lecturer at Flinders University and a representative of the Cave Exploration Group of South Australia. All have made valuable contributions to this research. This research was supported by an AINSE Ltd. Postgraduate Research Award (PGRA).

References:

Drysdale, RN, Zanchetta, G, Baneschi, I, Guidi, M, Isola, I, Couchoud, I, Piccini, L, Greig, A, Wong, H, Woodhead, JD, Regattieri, E, Corrick, E, Paul, B, Spötl, C, Denson, E, Gordon, J, Jaillet, S, Dux, F, Hellstrom, JC 2019, 'Partitioning of Mg, Sr, Ba and U into a subaqueous calcite speleothem', Geochimica et Cosmochimica Acta, vol. 264, pp. 67–91.

Griffiths, ML, Fohlmeiser, J, Drysdale, RN, Hua, Q, Johnson, KR, Hellstrom, JC, Gagan, MK & Zhao, J-x 2012, 'Hydrological control of the dead carbon fraction in a Holocene tropical speleothem', Quaternary Geochronology, vol. 14, pp. 81–93.

Grose, MR et al. 2020, 'Insights from CMIP6 for Australia's Future Climate', Earth's Future, vol. 8, no. 5, p. e2019EF001469.

Harrington, N & Cook, P 2014, Groundwater in Australia, The National Centre for Groundwater Research and Training: Adelaide, Australia.

Hua, Q, McDonald, J, Redwood, D, Drysdale, R, Lee, S, Fallon & Hellstrom, J 2012, 'Robust chronological reconstruction for young speleothems using radiocarbon', Quaternary Geochronology, vol. 14, pp. 67–80.

Welte, C, Fohlmeister, J, Wertnik, M, Wacker, L, Hattendorf, B, Eglinton, TI & Spotl, C 2021, 'Climatic variations during the Holocene inferred from radiocarbon and stable carbon isotopes in speleothems from a high-alpine cave', Climate of the Past, vol. 17, no. 5, pp. 2165–2177.

Wendt, KA, Pythoud, M, Moseley, GE, Dublyansky, YV, Edwards, RL & Spotl, C 2020 'Paleohydrology of southwest Nevada (USA) based on groundwater 234U/238U over the past 475 k.y.', Bulletin of the Geological Society of America, vol. 132, no. 3–4, pp. 793–802.

Zomer, RJ, Xu, J & Trabucco, A 2022, 'Version 3 of the Global Aridity Index and Potential Evapotranspiration Database', Scientific Data, vol. 9, no. 1, p. 409.

Building fire histories for the Capes region of southwest Western Australia

Casey Ryan[1], Pauline Grierson[1], Joe Dortch[1], Pauline Treble[2], Micheline Campbell[3], Patricia Gadd[2], Daryl Howard[2]

[1] The University of Western Australia, Perth, WA, Australia
[2] Nuclear Science & Technology (NST), ANSTO, Lucas Heights, NSW, Australia
[3] Max Planck Institute for Chemistry, Mainz, Germany

Fire is a fundamental component of the functioning of many ecosystems globally. However, the increased incidence and severity of fires across many vegetation types presents ongoing challenges to fire managers.

A good understanding of local fire regimes can help optimise decision making and management plans for different settings, but there are currently few long-term (> 50-70 years), highly spatially and temporally resolved records of fire occurrence in Australia. This project seeks to address this knowledge gap using environmental proxies and historical records to reconstruct the background variability of components of fire regimes through time, allowing us to better describe and contextualise modern fire regimes.

The project focusses broadly on the southwest region of Western Australia, in particular the westernmost Capes region. This region is where the iconic karri (*Eucalyptus diversicolor*) trees grow over landscapes with carbonate bedrocks and caves with speleothems (stalactites and stalagmites) (Fig. 1). Australia's southwest is a biodiversity hotspot with a long history of anthropogenic fire applied by both Aboriginal and European occupants (Hallam 1975; McArthur 1966). For this research, we are analysing three independent sources of fire history information: historical records, tree ring records, and speleothem records. We aim to use the historical records to extend the record of fire observations in southwest Australia from the pre-satellite modern era to the early colonial era, and to use tree ring and speleothem-based proxies to record local fire occurrence at three sites in the Capes region. Our objective is to combine these records to build a ~300-year long annually resolved, multi-proxy record of past fires that will capture local scale changes to fire frequency, severity, and/or seasonality through the pre-invasion, colonial, and modern periods.

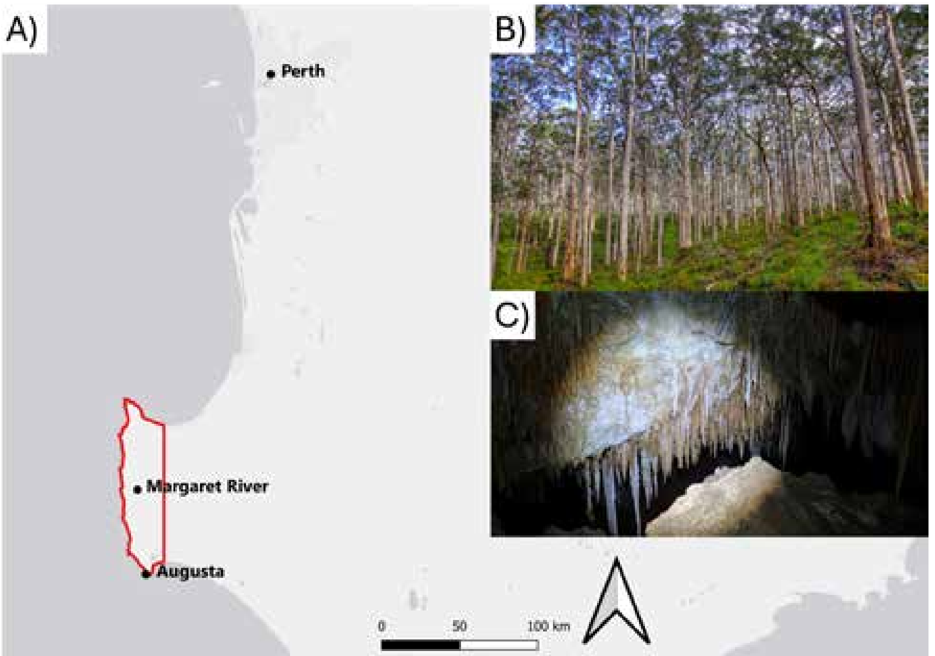


Figure 1: A) Location of the Capes region (red outline) of south-western Australia. B) Karri sampling site at Boranup. C) Speleothems underlying karri forest.

Individual observations of fires have been recorded from the earliest European explorers onwards (Abbott 2002; Hallam 1975). However, early settler records are sparse and there is a long gap in publicly available fire observation records from the 1860s – 1980s, after which government records become more reliable (DBCA 2024). We first utilised Trove, an archiving service that digitises articles from the early colonial era through to the 1950s. We searched for "bushfire" in Western Australian newspapers and gazettes, returning 545 relevant results that were added to the 262 results from Abbott (2002) (Fig. 2). The combined record covers the years 1658 – 1957 and serves as an excellent source of fire seasonality information through time as most records could be dated to the day of a particular fire.

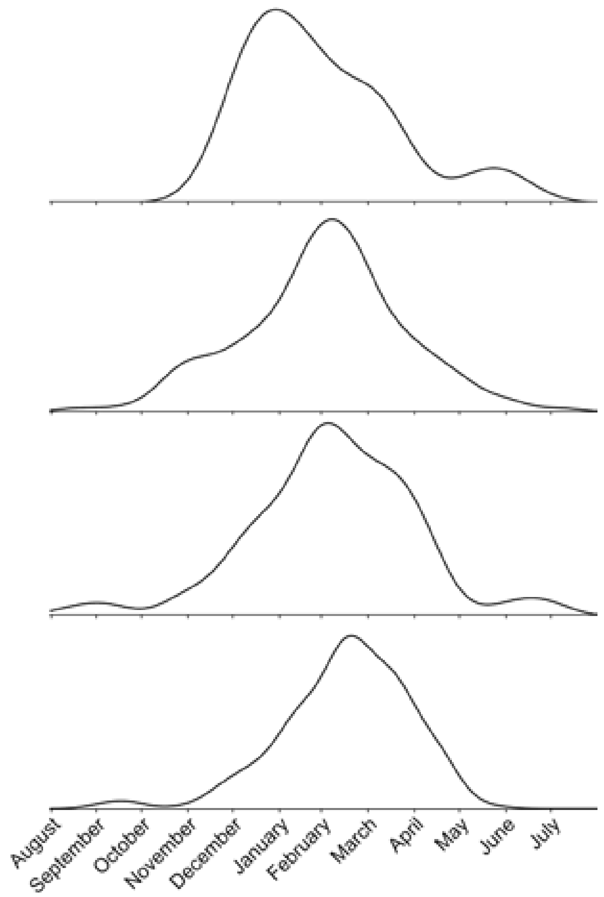


Figure 2: Comparison of modelled fire seasons for different time periods in southwest Australia. Observations from a Trove search for "bushfire" and settler records from Abbott (2002).

A comparison of fire seasonality information over the length of the record shows a similar length of fire season over the period, with a modelled length of between 89 – 110 days for each 50-year block. There was a potential shift of the peak of the fire season from late December in the pre-invasion era to mid-February in the later years of the record. Further analyses of the historical data will include comparison with both the DBCA Fire History database and modern newspaper records to assess consistency in reproduction and reliability of interpretations of the data.

The second aim is to attempt to develop a tree ring record of fire history from karri trees. Tree rings are a widely used environmental proxy that can produce annually resolved climatic and ecological reconstructions over centuries or millennia by crossdating, which aligns tree ring widths from multiples stands of trees to identify a common climatic or ecological signal at a particular time (Swetnam et al. 2009). Oliver (2023) previously showed that karri trees in the Capes region produce annual rings, which can be cross-dated and thus have potential to determine the timing of events (e.g. drought periods, fire disturbance).

Our current research is investigating whether patterns in the elemental composition or disruptions in the wood development of karri tree rings can be used to reconstruct the occurrence and severity of past fires. Karri

A good understanding of local fire regimes can help optimise decision making and management plans for different settings ...

... development of a multi-proxy reconstruction from the three independent archives (historical, tree ring and speleothems) will increase the robustness of the record.

is a long-lived (> 300 years) and fire-tolerant species, so can potentially record repeated fire events. Preliminary results using the X-ray fluorescence beamline at ANSTO's Australian Synchrotron revealed a sharp increase in strontium (Sr), calcium (Ca), and potassium (K) in the latewood of some growth years (Fig. 3). We hypothesise that elevated Sr is related fires of lower severity. Thus, the development of a multi-proxy reconstruction from the three independent archives (historical, tree ring and speleothems) will increase the robustness of the record. If successful, the project will greatly increase the timescales for which we have knowledge of fire regimes in the Capes region. This is significant as it will allow fire managers

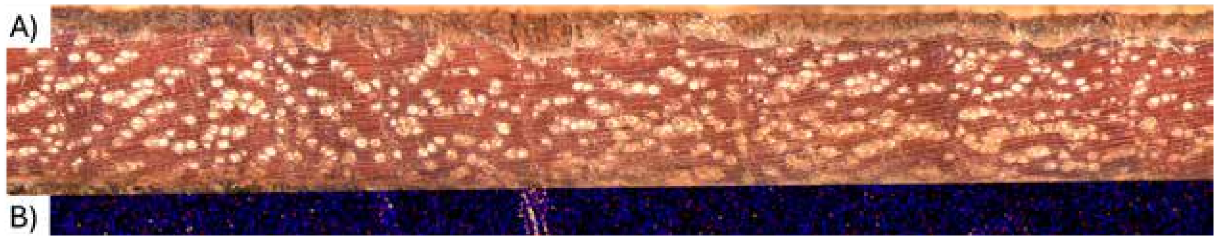


Figure 3: A) optical scan of karri wood. B) X-ray fluorescence map of strontium distribution in the same sample showing a potential drought or fire signal.

to an increase in water uptake from deeper sources as a response to drought and/or fire. We are currently awaiting confirmation from Accelerator Mass Spectrometry (AMS) 14C bomb-pulse dating at ANSTO's Centre for Accelerator Science (CAS), Lucas Heights, to verify our chronologies. Once we confirm our chronologies, we will assess years with strong elemental signals or wood distortions against known drought or fire years at our sampling sites to assess our hypothesis.

We will also cross-validate our approach by comparing tree ring data with speleothem records (Treble et al. 2003; Priestley et al. 2023). We have sampled karri trees directly above both deep and shallow caves containing speleothems.

The speleothem records examined to date contain elemental concentrations indicative of large fires, which have been detected using the X-ray fluorescence beamline at the Australian Synchrotron (McDonough et al. 2022). However, tree ring archives may add records of and fire ecologists to take a much longer view of their work in relation to fire regime change and will open avenues to exploring the dendrochemical potential of other eucalypts.

References:

Abbott, I 2002, Historical records of Noongar fires, 1658-1888: a compendium, Department of Conservation & Land Management: Perth, Western Australia. Available from: https://library.dbca.wa.gov.au/static/FullTextFiles/916489.pdf.

DBCA 2024, DBCA Fire History (DBCA-060), Department of Biodiversity, Conservation and Attractions: Perth, Western Australia. Available from: https://catalogue.data.wa.gov.au/dataset/dbca-fire-history.

Hallam, SJ 1975, Fire and Hearth: Karla Yoorda: a Study of Aboriginal Usage and European Usurpation in South-western Australia, Apollo Books: Perth, Western Australia.

McArthur, AG 1966, 'Prescribed burning in Australian fire control', Australian Forestry, vol. 30, no. 1, pp. 4–11.

McDonough, LK, Treble, PC, Baker, A, Borsato, A, Frisia, S, Nagra, G, Coleburn, K, Gagan, MK, Zhao, J-X & Paterson, D 2022, 'Past fires and post-fire impacts reconstructed from a southwest Australian stalagmite', Geochimica et Cosmochimica Acta, vol. 325, pp. 258–277.

Oliver, J 2023, 'Dendroclimatological potential of karri (*Eucalyptus diversicolor* F. Muell)', PhD thesis, The University of Western Australia.

Priestley, SC, Treble, PC, Griffiths, AD, Baker, A, Abram, NJ & Meredith, KT 2023, 'Caves demonstrate decrease in rainfall recharge of southwest Australian groundwater is unprecedented for the last 800 years', Communications Earth & Environment, vol. 4, no. 1, p. 206.

Swetnam, TW, Baisan, CH, Caprio, AC, Brown, PM, Touchan, R, Anderson, RS & Hallett, DJ 2009, 'Multi-Millennial Fire History of the Giant Forest, Sequoia National Park, California, USA', Fire Ecology, vol. 5, no. 3, pp. 120–150.

Treble, P, Shelley, JMG & Chappell, J 2003, 'Comparison of high resolution sub-annual records of trace elements in a modern (1911–1992) speleothem with instrumental climate data from southwest Australia', Earth and Planetary Science Letters, vol. 216, no. 1, pp. 141–153.

Investigating the recent depositional history of nutrients, heavy metals, and fire markers in Tasmanian highland lakes

Harrison Stevens[1] Bernadette C. Proemse[1,2], Leon A. Barmuta[1], Zanna Chase[1], Krystyna Saunders[1,3]

[1] University of Tasmania, Hobart, TAS, Australia.
[2] Derwent Estuary Program, Hobart, TAS, Australia.
[3] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia.

Fire is an extremely important global phenomenon that is not yet fully understood (Bowman et al. 2009). Fire impacts many aspects of vegetation, climate, and human life, all of which are closely interlinked.

To better predict how fire regimes may be changing in the future due to climate change, we need to fully understand historical fire events at a geological scale. To achieve this understanding, my research focussed on reconstructing the recent depositional history of certain chemical markers within sediment cores from dammed lakes in Central Highlands, Tasmania, Australia (Fig. 1). The dammed lakes of the Central Highlands provided the perfect study sites due to their increased sedimentation rates, therefore increased resolution for reconstructing recent (< 150 year) depositional history. To provide context to geochemical changes, the sediment cores were age-dated at ANSTO's Centre for Accelerator Science (CAS) by 210Pb (Lead), and Pu (Plutonium) and U (Uranium) age dating techniques.

The compounds levoglucosan (LEV), mannosan (MAN), and galactosan (GAL), collectively referred to as 'fire sugars', are produced almost exclusively by biomass burning, meaning that they are ideal tracers of past and current fire regimes (Simoneit et al. 1999; Kuo et al. 2008). Furthermore, the ratio between the fire sugars (e.g. levoglucosan/mannosan (L/M)) can provide information on the type of biomass that burnt during the fire (Engling et al. 2006; Bhattarai et al. 2019). The application of fire sugars as fire tracers is the subject of many studies in recent decades, typically focussing on aerosol samples (e.g. Bhattarai et al. 2019; Marynowski & Simoneit 2022). However, the analysis of fire sugars in freshwater sediments is less common.

Due to the limited number of studies analysing fire sugars in sediment cores, my work aimed to:

1) Create an environmentally friendly extraction method for analysing fire sugars in sediments; and

2) Determine if L/M ratios in sediments are comparable to those in corresponding aerosols.

Figure 1: Harrison collecting sediment cores using a Uwitec hammer corer.

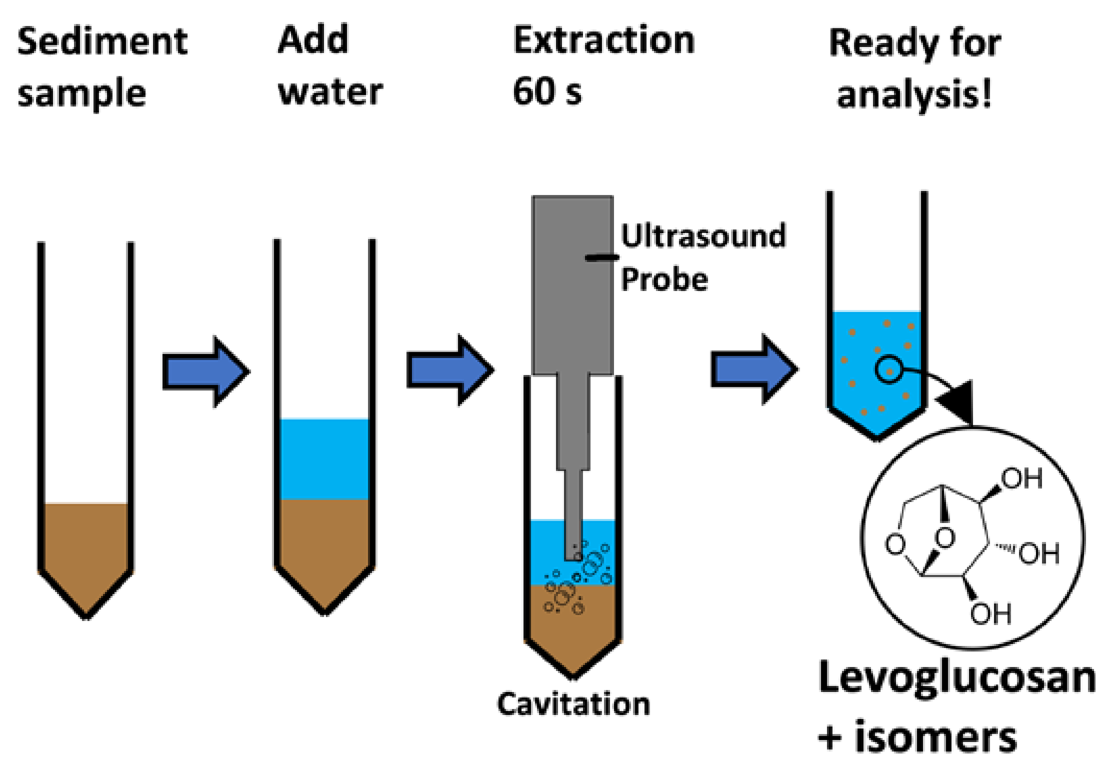


Figure 2: Simplified overview of the fire sugar extraction method for sediments.

After extensive testing and optimisation, we developed a simple extraction method allowing the rapid, sensitive, and selective determination of fire sugars in sediments (Fig. 2). The extraction method involved ultrasound probe sonication (60 s) using water as the solvent. The method was validated by the analysis of levoglucosan and mannosan in NIST® 1649b Urban Dust reference material and the resulting concentrations were in excellent agreement with previously reported values (Kirchgeorg et al. 2014; Buiarelli et al. 2018; Stevens et al. 2023). This method is faster, greener, safer, cheaper, and more simple than existing extraction methods because it requires no derivatisation steps and does not use organic solvents. This method is beneficial for all future work analysing fire sugars in freshwater (and likely marine) sediments.

To address the second aim, fire sugar ratios (L/M) in surface sediment samples were compared to the ratios in corresponding aerosol samples collected approximately 100 km away and showing the same fire period (2018/19 bushfire season in Tasmania, Australia). In this way, it was possible to identify if fire sugar ratios in sediments are comparable to those in aerosols and are therefore representative of the type of biomass burnt. The results showed that L/M ratio in surface sediments (1.42 – 2.58) were significantly lower than in corresponding aerosols (5.08 – 15.62) (Stevens et al. 2024). We propose two hypotheses that may explain the lower average L/M of sediments. Firstly, the degradation rate of levoglucosan (L) is higher than mannosan

To better predict how fire regimes may be changing in the future due to climate change, we need to fully understand historical fire events at a geological scale.

Archaeology, Geosciences and Environmental Sciences AGES

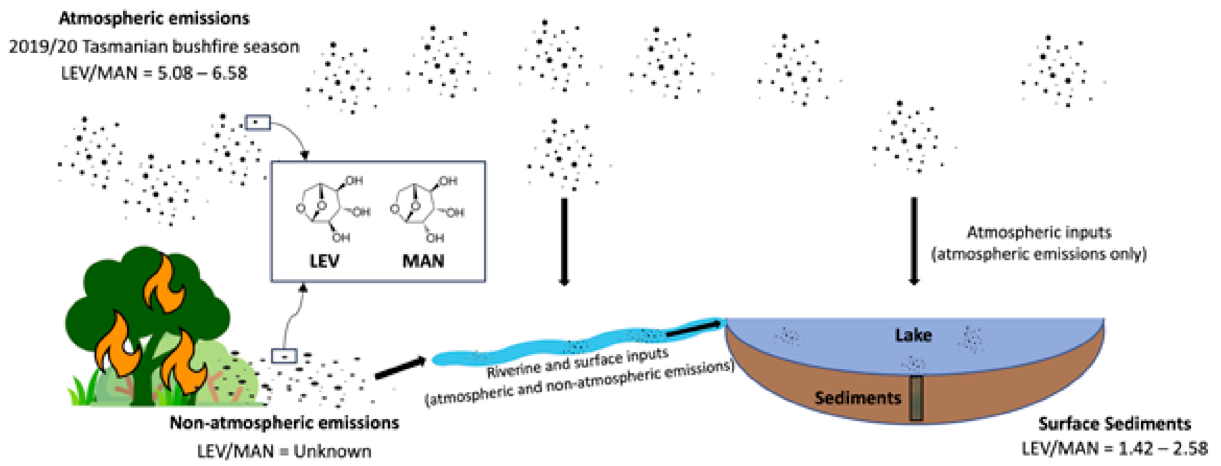


Figure 3: A schematic representing the source-to-sink pathway of fire sugars originating from a fire and settling in lake sediments. Levoglucosan/mannosan (L/M) values are based on results from Stevens et al. (2024).

(M) in the water column, sediment-water interface, and/or sediment. Secondly, the L/M ratio of non-atmospheric emissions during fires may be lower than that of atmospheric emissions from the same fire (Fig. 3). Due to the uncertainties about transport partitioning (atmospheric versus non-atmospheric emissions) and fire sugar degradation along all stages of the source-to-sink pathway, we advise caution when inferring biomass type

... we developed a simple extraction method allowing the rapid, sensitive, and selective determination of fire sugars in sediments.

(e.g. softwood, hardwood, or grasses) based purely on fire sugar ratios in sediments (e.g. L/M ratio). Future investigations are required to increase the efficacy of fire sugars as fire tracers in sediments.

This work would not have been possible without my primary supervisors Assoc. Prof. Leon Barmuta, Dr. Bernadette Proemse, and Prof. Zanna Chase (University of Tasmania), close collaborators Dr Estrella Sanz Rodriguez, Prof. Brett Paull, and Prof. Andrew Bowie (University of Tasmania), my ANSTO co-supervisor Dr. Krystyna Saunders, and all other collaborators.

My research was supported by an Australian Government Research Training Program (RTP) Scholarship and an Australian Institute of Nuclear Science and Engineering (AINSE Ltd.)

Postgraduate Research Award (PGRA). My research was further supported by ANSTO Research Portal Proposals AP15176 (Pu and U isotopic measurements with Mr. David Child and Dr. Michael Hotchkis), AP15186 (δ13C stable isotope analysis with Ms. Linda Barry), and AP13286 (210Pb dating analysis with Ms. Atun Zawadzki and ICP-AES analysis with Mr. Henri Wong).

References:

Bhattarai, H, Saikawa, E, Wan, X, Zhu, H, Ram, K, Gao, S, Kang, S, Zhang, Q, Zhang, Y, Wu, G, Wang, X, Kawamura, K, Fu, P & Cong, Z 2019, 'Levoglucosan as a tracer of biomass burning: Recent progress and perspectives', Atmos Res, vol. 220, pp. 20-33.

Bowman, D, Balch, J, Artaxo, P, Bond, W, Carlson, J, Cochrane, M, D'Antonio, C, Defries, R, Doyle, J, Harrison, S, Johnston, F, Keeley, J, Krawchuk, M, Kull, C, Marston, J, Moritz, M, Prentice, I, Roos, C, Scott, A & Pyne, S 2009, 'Fire in the Earth System', Science, vol. 324, pp. 481-484.

Buiarelli, F, Di Filippo, P, Pomata, D, Riccardi, C & Simonetti, G 2018, 'A rapid method for the determination of levoglucosan in NIST standard reference material 1649a by HPLC-MS/MS', Atmos Environ, vol. 195, p. 24.

Engling, G, Carrico, CM, Kreidenweis, SM, Collett, JL, Day, DE, Malm, WC, Lincoln, E, Min, Hao W, Iinuma, Y & Herrmann, H 2006, 'Determination of levoglucosan in biomass combustion aerosol by high-performance anion-exchange chromatography with pulsed amperometric detection', Atmospheric Environment, vol. 40, pp. 299-311.

Kirchgeorg, T, Schüpbach, S, Kehrwald, N, McWethy, DB & Barbante, C 2014, 'Method for the determination of specific molecular markers of biomass burning in lake sediments', Organic Geochemistry vol. 71, pp. 1-6.

Kuo L-J, Herbert, B & Louchouarn, P 2008, 'Can levoglucosan be used to characterize and quantify char/charcoal black carbon in environmental media?', Organic Geochemistry, vol. 39, pp. 1466-1478.

Simoneit, BRT, Schauer, JJ, Nolte, CG, Oros, DR, Elias, VO, Fraser, MP, Rogge, WF & Cass, GR 1999, 'Levoglucosan, a tracer for cellulose in biomass burning and atmospheric particles', Atmospheric Environment, vol. 33, pp. 173-182.

Stevens, H, Sanz Rodriguez, E, Paull, B, Bowie, AR, Chase, Z, Barmuta, LA & Proemse, BC 2023, 'A fast and simple extraction method for analysing levoglucosan and its isomers in sediments by ion chromatography tandem mass spectrometry', Analytical Methods vol. 15, no. 21, pp. 2631-2640.

Stevens, H, Barmuta, LA, Chase, Z, Saunders, KM, Zawadzki, A, Bowie, AR, Perron, MMG, Rodriguez, ES, Paull, B, Child, DP, Hotchkis, MAC & Proemse, BC 2024, 'Comparing levoglucosan and mannosan ratios in sediments and corresponding aerosols from recent Australian fires', Science of The Total Environment, p. 174068.

Environmental co-behaviour and mechanisms of arsenic and antimony sorption onto jarosite: Insights from multi-edge synchrotron X-ray absorption spectroscopy

Niloofar Karimian[1,2,4], Andrew J. Frierdich[2], Jessica Hamilton[3], Edward D. Burton[4].

[1] Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia.
[2] Monash University, Clayton, VIC, Australia.
[3] Nuclear Science & Technology (NST), ANSTO, Clayton, VIC, Australia.
[4] Southern Cross University, NSW, Australia.

Arsenic (As) and antimony (Sb) are highly toxic, carcinogenic metalloids designated as priority pollutants due to their pervasive occurrence in mining-impacted regions abundant in sulfide and sulfosalt minerals (Herath et al. 2017; Majzlan, J 2021; Wilson et al. 2010; Burton et al. 2020).

Although As and Sb have traditionally considered to exhibit similar geochemical behaviours, recent research has revealed distinct differences in their environmental dynamic (Burton et al. 2020; Burton et al. 2010; Karimian et al. 2017; Karimian et al. 2018). shown a notable ability to sequester significant amounts of these metalloids (Karimian et al. 2017; Karimian et al. 2018; Leuz et al. 2006; Asta et al. 2009; Burton et al. 2021; Burton et al. 2022; Karimian et al. 2018; Johnston et al. 2012). However, while the individual sorption behaviours of As(V) and Sb(V) on Fe(III) minerals such as ferrihydrite and goethite are well-documented (Leuz et al. 2006; Savage et al. 2005; Baron & Palmer 1996; Ehlert et al. 2018), the mechanisms underlying their co-sorption onto jarosite remain poorly understood. This knowledge gap is particularly important because As(V) and Sb(V) may compete for sorption sites or co-sorb through

Understanding the modes of association and bonding of contaminants like As and Sb to host minerals is crucial for predicting their environmental behaviour and potential health impacts.

Sorption processes – where one substance becomes attached to another – play a pivotal role in controlling the mobility and bioavailability of As(V) and Sb(V) in soils, sediments, and aquatic systems (Herath et al. 2017; Wilson et al. 2010). Among iron (Fe(III)) minerals, jarosite [$KFe_3(SO_4)_2(OH)_6$] is a common phase in acidic sulfur-rich environments and has synergistic interactions, ultimately affecting their environmental mobility in jarosite-rich systems like acid sulfate soils, mining waste, and acid mine drainage environments.

This project systematically explored the sorption mechanisms of As(V) and Sb(V) onto jarosite under acidic conditions, emphasising competitive and interactive molecular-

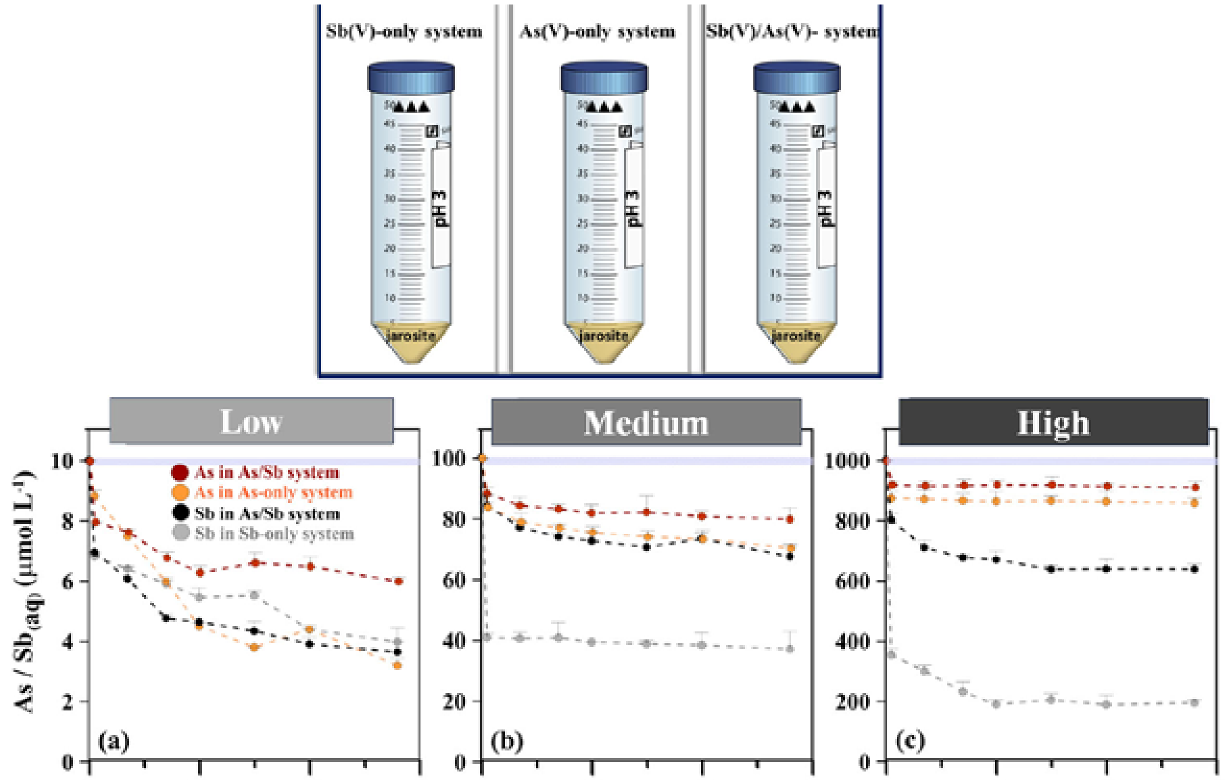


Figure 1: Changes in aqueous concentrations of Sb(V) and As(V) at low, medium and high loadings of over 56 days reaction period

scale processes. Sorption experiments were conducted at pH 3 with metalloid concentrations of 10 (low), 100 (medium), and 1000 (high) μmol L^{-1}. Samples were agitated on an orbital shaker for up to 56 days to approach equilibrium and examine long-term sorption mechanisms. Understanding the modes of association and bonding of contaminants like As and Sb to host minerals is crucial for predicting their environmental behaviour and potential health impacts. These associations directly influence the mobility, bioavailability, and persistence of the contaminants in natural systems. For instance, contaminants that form weak, reversible bonds or are only loosely associated with mineral surfaces can be rapidly released into surrounding soils and water. This increases their availability for uptake by organisms and amplifies the risk of toxicity to ecosystems and human health. Conversely, contaminants that are strongly bound to minerals through mechanisms such as surface

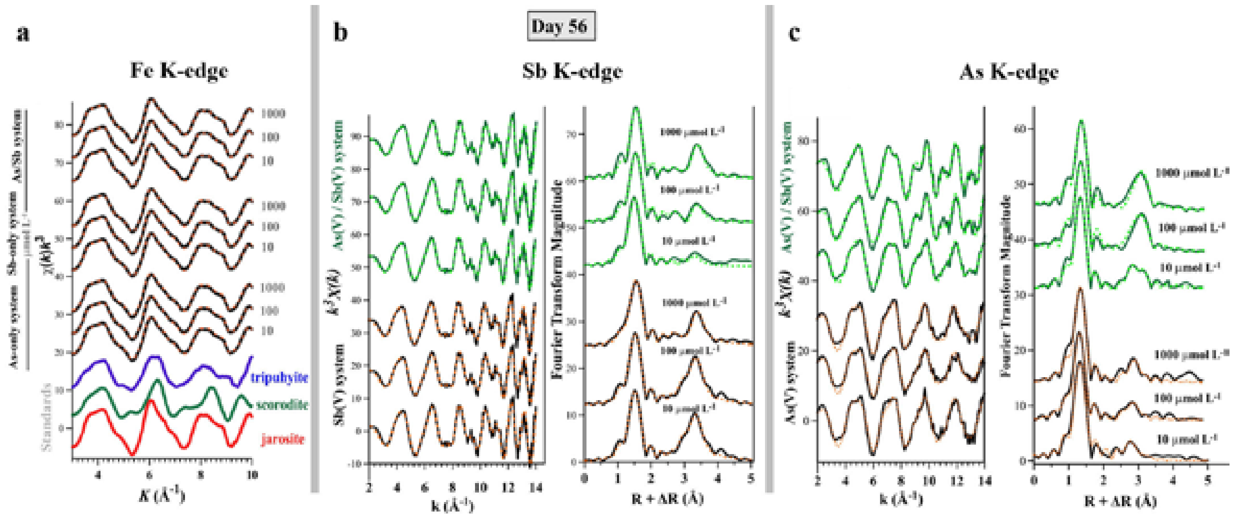


Figure 2: Iron K-edge k3-weighted EXAFS spectra of reference minerals (a); Antimony K-edge k3-weighted EXAFS spectra and the corresponding Fourier transform magnitude of solid-phase samples (b); Arsenic K-edge k3-weighted EXAFS spectra and the corresponding Fourier transform magnitude of solid-phase samples (c)

precipitation or inner-sphere complexation (where metal ions bind directly to a surface without water molecules) are likely to exhibit reduced mobility. Whilst this potentially lowers their immediate environmental impact, it poses long-term risks if destabilised by changes in environmental conditions such as pH, redox potential, or competing ions. By elucidating these bonding mechanisms, we can better predict the fate of As and Sb in contaminated sites, design targeted remediation strategies, and mitigate their release, thereby safeguarding environmental and public health. To elucidate the local coordination environments of the sorbed metalloids, multi-edge X-ray absorption spectroscopy (XAS) at the Fe, As, and Sb K-edges was employed, utilising the advanced XAS beamline at ANSTO's Australian Synchrotron.

The results demonstrated that jarosite sorbs Sb(V) more effectively than As(V) in both single- and dual-metalloid systems. However, in dual-metalloid systems, the presence of both As(V) and Sb(V) resulted in a significant decrease in sorption for both metalloids, reducing their uptake by nearly 50% compared to single-metalloid systems (Fig. 1). This competitive behaviour highlights the complex interactions between these toxic elements in co-contaminated environments.

Iron K-edge extended X-ray absorption fine structure (EXAFS) analysis revealed no significant changes in the jarosite mineralogy across all As/Sb loadings (Fig. 2). However, Sb K-edge EXAFS analysis identified surface precipitation of a polynuclear Sb(V) oxide species as the dominant sorption mechanism for Sb(V) (Fig. 2). This finding represents a breakthrough in understanding Sb(V) interactions, as it is the first report of such surface precipitation on jarosite, formed from undersaturated bulk aqueous conditions. Surface precipitation involving polynuclear species is a well-documented sorption mechanism for cationic heavy metals on oxide surfaces (e.g., Xu et al. 2007; Voegelin et al. 2007), and similar behaviour has been observed for Sb(V) on Aluminium (Al) oxides (ref. 30). Nevertheless, the discovery of this mechanism for Sb(V) sorption onto jarosite in As and Sb co-contaminated systems is unprecedented and underscores the novel insights provided by this study.

Conversely, As(V) sorption predominantly occurred through surface complexation, as revealed by As K-edge EXAFS spectroscopy (Fig. 2). Bidentate corner-sharing complexes were observed on the jarosite surface in systems with low Sb(V) loadings or in its absence. At higher Sb(V) concentrations, As(V) interacted with the newly formed Sb(V) oxide surface precipitate, revealing a previously unidentified, non-competitive, yet mutual interaction between the two metalloids during co-sorption.

These findings offer a transformative perspective on the interactions between As(V) and Sb(V) in acidic, sulfur-rich environments, such as those affected by mining activities. By uncovering the competitive and interactive sorption mechanisms through advanced XAS techniques, this study provides critical insights that can guide strategies for predicting, managing, and mitigating the mobility and environmental impact of these toxic metalloids in contaminated ecosystems. The use of advanced XAS techniques in this research also provided a valuable framework for future studies exploring the structural and chemical nature of sorption processes in environmental systems.

These findings offer a transformative perspective on the interactions between As(V) and Sb(V) in acidic, sulfur-rich environments, such as those affected by mining activities.

Figure 3: Dr Karimian changing sample at XAS beamline at Australian Synchrotron.

This research was supported by a grant from the Australian Research Council (FT200100449). The XAS work was conducted at the Australian Synchrotron (Melbourne, Australia), with support from Dr Jessica Hamilton. This research was supported by the Environmental Analysis Laboratory (EAL), which is a Southern Cross University NATA accredited research support facility. This research was supported by an AINSE Early Career Researcher Grant (ECRG).

References:

Asta, MP, Cama, J, Martínez, M & Giménez, J 2009, 'Arsenic removal by goethite and jarosite in acidic conditions and its environmental implications', Journal of Hazardous Materials, vol. 171, no. 1-3, pp. 965-972.

Baron, D & Palmer, CD 1996, 'Solubility of jarosite at 4-35 °C', Geochimica et Cosmochimica Acta, vol. 60, no. 2, pp. 185-195.

Burton, ED, Johnston, SG, Watling, K, Bush, RT, Keene, AF & Sullivan, LA 2010, 'Arsenic Effects and Behavior in Association with the Fe(II)-Catalyzed Transformation of Schwertmannite', Environmental Science and Technolology, vol. 44, no. 6, pp. 2016-2021.

Burton, ED, Hockmann, K, & Karimian, N 2020, 'Antimony Sorption to Goethite: Effects of Fe(II)-Catalyzed Recrystallization', ACS Earth and Space Chemistry vol. 4, no. 3, pp. 476-487.

Burton, ED, Karimian, N, Johnston, SG, Schoepfer, VA, Choppala, G & Lamb, D 2021, 'Arsenic-imposed effects on schwertmannite and jarosite formation in acid mine drainage and coupled impacts on arsenic mobility', ACS Earth and Space Chemistry, vol. 5, no. 6, pp. 1418-1435.

Burton, ED, Karimian, N, Hamilton, JL, & Frierdich, AJ 2022, 'Iron Isotopes in Acid Mine Drainage: Extreme and Divergent Fractionation between Solid (Schwertmannite, Jarosite, and Ferric Arsenate) and Aqueous Species', Environmental Science & Technology, vol. 56. no. 24, pp. 18060-18068.

Ehlert, K, Mikutta, C, Jin, Y & Kretzschmar, R 2018, 'Mineralogical Controls on the Bioaccessibility of Arsenic in Fe(III)–As(V) Coprecipitates', Environmental Science & Technology, vol. 52, no. 2, pp. 616-627.

Herath, I, Vithanage, M & Bundschuh, J 2017, 'Antimony as a global dilemma: Geochemistry, mobility, fate and transport', Environmental Pollution, vol. 223, pp. 545-559.

Johnston, SG, Burton, ED, Keene, AF, Planer-Friedrich, B, Voegelin, A, Blackford, MG, & Lumpkin, GR 2012, 'Arsenic mobilization and iron transformations during sulfidization of As(V)-bearing jarosite', Chemical Geology, vol. 334, pp. 9-24.

Karimian, N, Johnston, SG & Burton, ED 2017, 'Antimony and Arsenic Behavior during Fe(II)-Induced Transformation of Jarosite', Environmental Science & Technology, vol. 51, no. 8, pp. 4259-4268.

Karimian, N, Johnston, SG & Burton, ED 2018, 'Antimony and arsenic partitioning during Fe2+-induced transformation of jarosite under acidic conditions', Chemosphere, vol. 195, pp. 515-523.

Karimian, N, Johnston, SG & Burton, ED 2018, 'Iron and sulfur cycling in acid sulfate soil wetlands under dynamic redox conditions: A review', Chemosphere, vol. 197, pp. 803-816.

Leuz, A-K, Mönch, H & Johnson, CA 2006, 'Sorption of Sb (III) and Sb (V) to goethite: influence on Sb (III) oxidation and mobilization. Environmental science & technology, vol. 40, no. 23, pp. 7277-7282.

Majzlan J 2021, 'Chapter 2: Primary and secondary minerals of antimony', In *Antimony* (pp. 17-47). Berlin/Boston: De Gruyter.

Savage, KS, Bird, DK, & O'Day, PA 2005, 'Arsenic speciation in synthetic jarosite', Chemical Geology, vol. 215, no. 1-4, pp. 473-498.

Voegelin, A, Weber, F-A & Kretzschmar, R 2007, 'Distribution and speciation of arsenic around roots in a contaminated riparian floodplain soil: Micro-XRF element mapping and EXAFS spectroscopy', Geochimica et Cosmochimica Acta, vol. 71, no. 23, pp. 5804-5820.

Wilson, SC, Lockwood, PV, Ashley, PM & Tighe, M 2010, 'The chemistry and behaviour of antimony in the soil environment with comparisons to arsenic: A critical review', Environmental Pollution, vol. 158, no. 5, pp. 1169-1181.

Xu, Y, Zhou, G-p & Zheng, X-f 2007, 'Redetermination of iron(III) arsenate dihydrate', Acta Crystallographica Section E-structure Reports Online, vol. 63, pp. i67-i69

Exploring 65,000 years of monsoonal history: hydroclimatic insights from Kimberley floodplain sediments

Teresa Dixon[1], Hamish McGowan[1], Rachel Rudd[2], Sam Marx[3], Patrick Moss[4], Quan Hua[5], Justine Kemp[6]

[1] The University of Queensland, Brisbane, QLD, Australia
[2] Max Planck Institute of Geoanthropology, Jena, Germany
[3] University of Wollongong, Wollongong, NSW, Australia
[4] Queensland University of Technology, Brisbane, QLD, Australia
[5] Environment Research and Technology Group, ANSTO, Lucas Heights, NSW, Australia
[6] Griffith University, Brisbane, QLD, Australia.

The Indo-Australian summer monsoon (IASM) characterises the climate of the Kimberley region in tropical northwest Australia. It profoundly influences the region's hydrological cycles, ecosystems, and human and economic activity.

Despite its importance, there remain gaps in our knowledge about the IASM's response to changes in sea level, ocean circulation, and orbital forcing, as well as its role in driving landscape evolution. Understanding how the hydroclimate of this region has varied through geological history is crucial to addressing these gaps. This knowledge is also essential for understanding the environmental context that Australia's first inhabitants encountered around 65,000 years ago (or 65 ka) (Clarkson et al. 2017; Maloney et al. 2018; Bird et al. 2018).

To address these gaps, sediment cores were collected from the Kimberley region in August 2021. One core was retrieved from the Bullo River floodplain, located 60 km south of the Joseph Bonaparte Gulf and in the direct zone of IASM activity, and another from Birrindudu, 400 km further south, near the southernmost extent of current day precipitation associated with the IASM (Fig. 1). These floodplain sediments, deposited during the wet season, capture a record of catchment-wide landscape and biological processes influenced by hydroclimatic variability.

Piecing together a story from these cores first required establishing chronologies, which

Understanding how the hydroclimate of this region has varied through geological history is crucial...

was done in collaboration with ANSTO's Centre for Accelerator Science (CAS) and ITRAX facilities. The results from ^{210}Pb (lead), ^{14}C (carbon) and OSL (optically stimulated luminescence) dating indicated that the core from Bullo River spanned ~65 ka and the core from Birrindudu spanned ~47 ka. We have completed analysing the core from Bullo River, with work on the Birrindudu core still ongoing. The Bullo River core was divided into four units based on stratigraphy and visual properties (Fig. 2). Once the age-depth model of the Bullo River core had been established, it was evident that these units corresponded to marine isotope stage (MIS) 4 and early MIS 3 (~65 – 38 ka), late MIS 3 until the Last Glacial

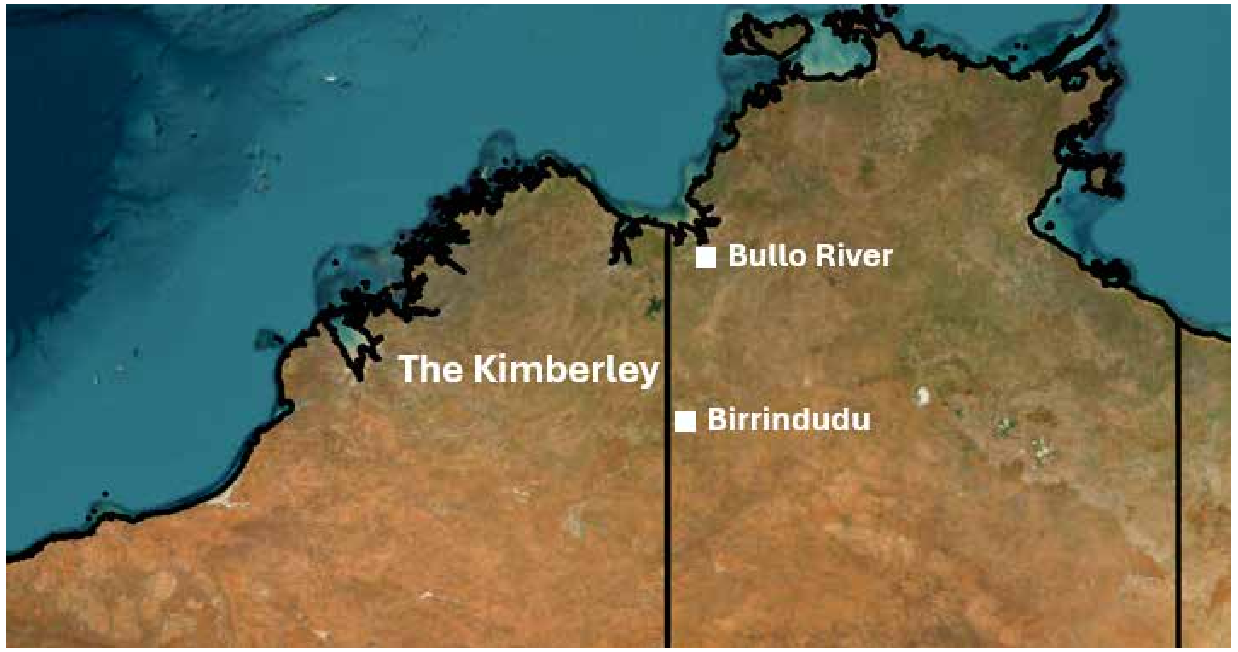


Figure 1: Map of northwest Australia showing the Kimberley region and the two sampling sites of Bullo River and Birrindudu for the sediment cores used in this study.

Maximum (LGM) (~38 – 18 ka), the deglacial and early-mid Holocene (18 – 5.5 ka) and the mid Holocene until present (5.5 – 0 ka). Pollen and stable carbon isotope analysis provided insights into vegetation changes. Grain size and geochemical analysis offered information on sediment transport capacity (as a proxy for precipitation) and the degree of weathering of the core's material (as a proxy for vegetation cover and soil-root interaction). Mass accumulation rates were calculated to infer flooding frequency and sediment carrying capacity (Fig. 2).

So far, our research has revealed that the Bullo River site experienced long-term hydroclimatic stability between 65 ka and the LGM. During this period, when sea levels were lower and the coastline was a further 300–600 km away than at present (Grant et al. 2012), precipitation and moisture availability were reduced. A subtle shift during mid MIS 3 (~38 ka) to even drier conditions is indicated, although the exact timing of this shift cannot be pinpointed. However, the low temporal resolution of our record means we cannot exclude the possibility of short-term (centennial or decadal) increases in IASM activity.

Significant shifts in IASM dynamics began shortly after the LGM, coinciding with rising sea levels that brought the coastline closer to the site (Grant et al. 2012). This proximity appears to have altered the monsoon system, by increasing its southward penetration or increasing convection across the now-exposed continental shelf, or both. The deglacial period was marked by high variability, culminating in the most sustained hydroclimatic change recorded, starting at 12.8 ka and continuing through until the mid-Holocene at ~5.5 ka. This interval was characterised by increased wet-season precipitation, and its onset coincided with a combination of rapidly rising sea levels (Grant et al. 2012), increased atmospheric CO_2 (Bauska et al. 2021), and a persistent La Niña-like sea surface temperature (SST) pattern (Koutavas et al. 2002).

This research provides a critical long-term perspective on hydroclimatic variability in monsoonal northwest Australia...

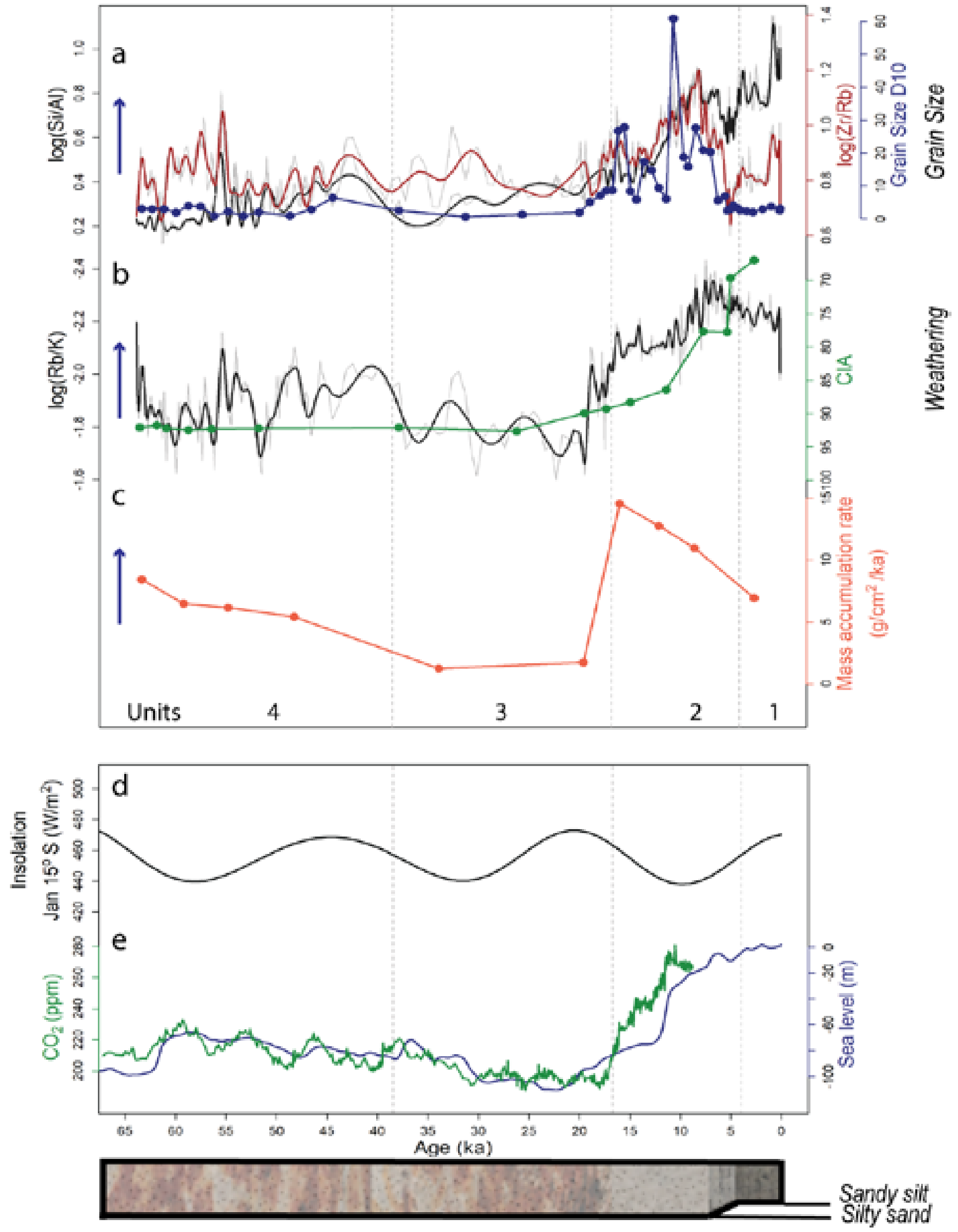


Figure 2: Top box: Sedimentary and geochemical indicators plotted through time in the Bullo River core including a) indicators of grain size (D10 particle diameter representing the 10% cumulative percentile values of particle size, log(Si/Al) and log(Zr/Rb) ratios, b) indicators of weathering (chemical index of alteration (CIA) and log(Rb/K) (note the reversed axes)), and c) mass accumulation rates. Bottom box: Plotted for comparison are d) January insolation at 15° S, and e) modelled global sea level relative to present day (Grant et al., 2012) and atmospheric CO_2 levels (Bauska et al., 2021). Blue arrows indicate the inferred effect of increased moisture availability or wet season precipitation of the plotted data. Dotted lines and numbers indicate the different sedimentary units identified in the core. Graphic representing sedimentary characteristics of the core at base.

From 5.5 ka onward, a decline in biogenic productivity and reduced woody vegetation is indicated, suggesting diminished moisture availability, likely due to enhanced El Niño Southern Oscillation activity. This trend continued until approximately 1 ka, at which point water availability increased, marking the transition to modern hydroclimatic conditions.

Our findings highlight the complex interplay between climatic drivers and the evolution of the IASM. The long-term stability observed during the 65 ka to LGM interval contrasts sharply with the variability and amplitude of changes in the IASM that followed. These changes underscore the sensitivity of the IASM to sea level rise. This research provides a critical long-term perspective on hydroclimatic variability in monsoonal northwest Australia, a region with few continuous records extending back to the first human arrival on the continent.

Continuing this work to include the findings of the record from Birrindudu, 400 km further south, will add detail to our understanding of the southern extent of the monsoon during times of varying boundary conditions in the past.

This work is the subject of a PhD thesis of Teresa Dixon (The University of Queensland), with supervision from Professor Hamish McGowan (University of Queensland), with research interests including climate dynamics, earth surface – atmosphere interactions and energetics, meteorological hazards, long range dust transport and climate impacts and palaeoclimate reconstruction; Dr Rachel Rudd (Max Planck Institute of Geoanthropology), with research interests including palaeoclimate and palaeoenvironmental reconstruction; Dr Sam Marx (University of Wollongong), with research interests including atmospheric aerosols, isotope geochemistry and Quaternary environments; Professor Patrick Moss (Queensland University of Technology/ The University of Queensland), with research interests including physical geography and environmental geoscience, archaeology and environmental management; and Dr Quan Hua (ANSTO/ The University of Queensland) with research interests including radiocarbon and earth sciences, climate change studies and archaeology. Other major collaborators include Dr Justine Kemp (Griffith University). This research was supported by an AINSE Ltd. Postgraduate Research Award (PGRA) and support from ANSTO through ANSTO Portal Grants AP16418 and AP15056. Further support was provided by Dunkeld Pastoral Co Pty. Ltd., Rock Art Australia and ARC Linkage Grant LP170100242.

References:

Bauska, TK, Marcott, SA, Brook, EJ 2021, ‘Abrupt changes in the global carbon cycle during the last glacial period’, Nature Geoscience, vol. 14, pp. 91–96.

Bird, MI, Beaman, RJ, Condie, SA, Cooper, A, Ulm, S, Veth, P 2018, ‘Palaeogeography and voyage modeling indicates early human colonization of Australia was likely from Timor-Roti’, Quaternary Science Reviews, vol. 191, pp. 431–439.

Clarkson, C, Jacobs, Z, Marwick, B, Fullagar, R, Wallis, L, Smith, M, Roberts, RG, Hayes, E, Lowe, K, Carah, X, Florin, SA, McNeil, J, Cox, D, Arnold, LJ, Hua, Q, Huntley, J, Brand, HE, Manne, T, Fairbairn, A, Shulmeister, J, Lyle, L, Salinas, M, Page, M, Connell, K, Park, G, Norman, K, Murphy, T, Pardoe, C 2017, ‘Human occupation of northern Australia by 65,000 years ago’, Nature, vol. 547, pp. 306–310.

Grant, KM, Rohling, EJ, Bar-Matthews, M, Ayalon, A, Medina-Elizalde, M, Ramsey, CB, Satow, C, Roberts, AP 2012, ‘Rapid coupling between ice volume and polar temperature over the past 150,000 years’, Nature, vol. 491, 744–747.

Koutavas, A, Lynch-Stieglitz, J, Marchitto, TM, Sachs, JP 2002, ‘El Nino-like pattern in ice age tropical Pacific sea surface temperature’, Science vol. 297, no. 5579, pp. 226–230.

Maloney, T, O’Connor, S, Wood, R, Aplin, K, Balme, J 2018, ‘Carpenters Gap 1: A 47,000 year old record of indigenous adaption and innovation’, Quaternary Science Reviews, vol. 191, pp. 204–228.

Uncovering molecular structures of disordered proteins that form liquid droplets inside cells

Andrew C. Marshall[1], Heidar Koning[1], Emma Knowling[1], Andrew E. Whitten[2], Anthony P. Duff[2], Ashish Sethi[2], Charles S. Bond[1].

[1] The University of Western Australia, Perth, Western Australia

[2] Nuclear Science & Technology (NST), ANSTO, Lucas Heights, NSW, Australia

Proteins are the machines and scaffolds required for biological life. Different proteins are composed of different sequences of amino acids, which determine their emergent shapes and hence roles in catalysing chemical reactions, organising cellular compartments and scaffolding cellular structures.

Understanding protein molecular structure is essential for informing both therapeutic strategies and the design of biological molecules and materials with bespoke functions. The huge diversity of stable folded 3D structures formed by proteins with complex amino acid sequences has been well characterised and can be confidently predicted (Jumper et al. 2021). A large proportion of proteins, however, contain regions composed of few amino acids types - commonly predicted to be highly flexible, or ‘intrinsically disordered regions’ (IDRs) (Ward et al. 2004). Relationships between the amino acid composition of these IDRs, molecular structure, and emergent material properties are poorly understood.

Drosophila behaviour/human splicing (DBHS) proteins are multifunctional RNA-binding scaffold proteins abundant in the nucleus of human cells, heavily involved in many stages of gene expression regulation and repairing damaged DNA (Knott et al. 2016). The three different DBHS proteins in humans - named SFPQ, NONO and PSPC1 – interact with themselves or one another to form dimers (two proteins associated together as one unit) (Huang et al. 2018; Lee et al. 2015, 2022). The part of the protein responsible for dimerisation is the central core region, which is nearly identical in all three proteins. This core region has a stable folded 3D structure that has been described in atomic detail using X-ray crystallography and small-angle X-ray scattering (SAXS) beamlines at the Australian Synchrotron (Fig. 1a). However, this well-ordered core region is flanked on either side by extended regions that are highly variable, predicted to be IDRs, and are poorly understood. We have shown that these predicted IDRs cause liquid demixing via a process called liquid-liquid phase separation, resulting in the formation of liquid droplets (‘condensed phase’) containing protein concentrations approximately 1000x greater than the surrounding solution (‘dilute phase’) (Fig. 1b) (Marshall et al. 2023; Zhang et al. 2022). In the cell, these condensed droplets are referred to as 'biomolecular condensates' or ‘membrane-less organelles’

Understanding protein molecular structure is essential for informing both therapeutic strategies and the design of biological molecules...

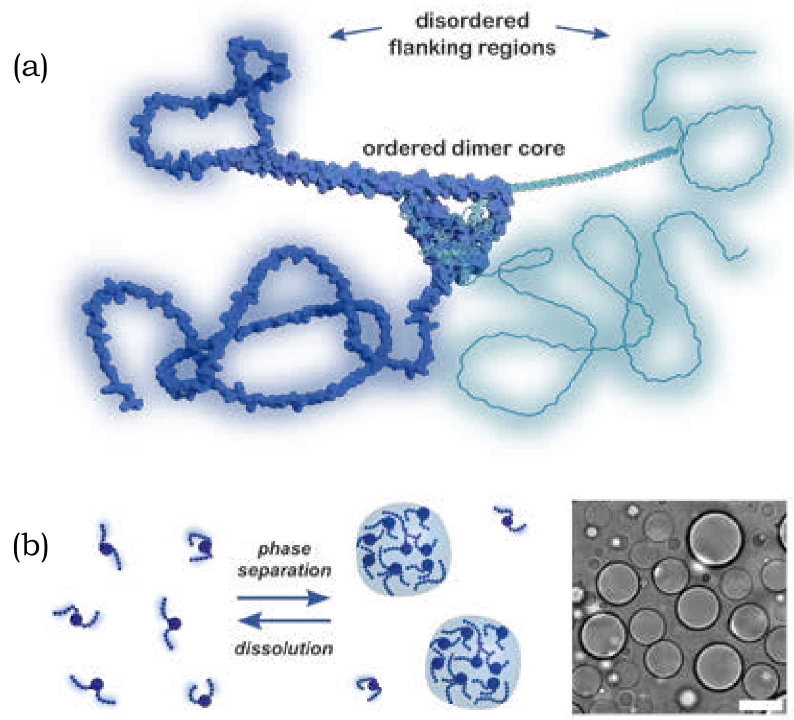


Figure 1: DBHS proteins have a well-ordered dimer core flanked by long flexible, intrinsically disordered regions. Here, one protein in the dimer is displayed to show the surface of all atoms in the molecule (a, top left); the other protein partner is shown as a cartoon to trace the chain of amino acids that make up the protein (a, top right). These flanking regions allow the protein to undergo liquid-liquid phase separation, where the liquid solution separates into two coexisting liquid phases: a condensed phase composed of highly concentrated protein molecules, surrounded by a dilute phase, depleted in protein molecules (b, bottom). Droplets of condensed phase SFPQ protein are shown on the right (scale bar = 20 µm). This process is essential for forming membrane-less compartments inside human cells.

(Banani et al. 2017). Having proteins that can form these condensates gives cells the ability to organise molecules in a dynamic and reversible way, allowing rapid responses to changing environmental conditions. Our work also indicates that the phase separation behaviour conferred by a given flanking region on a protein is context-dependent, that is, dependent on the composition of other regions present in the protein (Marshall et al. 2023). The fact that each of the three DBHS proteins contains flanking regions of different lengths and amino acid composition, and that these proteins can mix-and-match to form six different dimer combinations, makes these proteins an ideal model for studying composition-function relationships of protein IDRs.

Using ANSTO's small-angle scattering facilities, we aim to determine the molecular structure of these proteins, both in dilute and condensed phases, and in response to changing chemical environments. SFPQ is the most abundant of these proteins in the cell nucleus, and has the longest flanking regions, and therefore has been the focus of the project thus far.

To investigate protein structure in the dilute phase we have collected SAXS data on SFPQ and four different truncated versions of decreasing size. First, these data show that the flexible nature of the protein emerges dramatically upon addition of the flanking predicted IDRs to the dimer core. This shows that these flanking regions are indeed highly flexible – the first experimental confirmation of their intrinsically disordered nature (Fig. 2). Modelling and careful comparison between SAXS data from full-length SFPQ and a version lacking IDR #2 suggests that this second IDR may directly interact with IDR #1. This is consistent with our hypothesis that IDR #1 regulates phase separation of SFPQ via direct interaction with IDR #2 (Marshall et al. 2023). SAXS data also suggest that IDR #1 collapses under certain conditions via interactions with the dimer core, consistent with the idea that, when in dilute solution, IDR-containing proteins collapse via self-interactions under conditions that would otherwise result in phase separation if the protein concentration was greater (Martin et al. 2021).

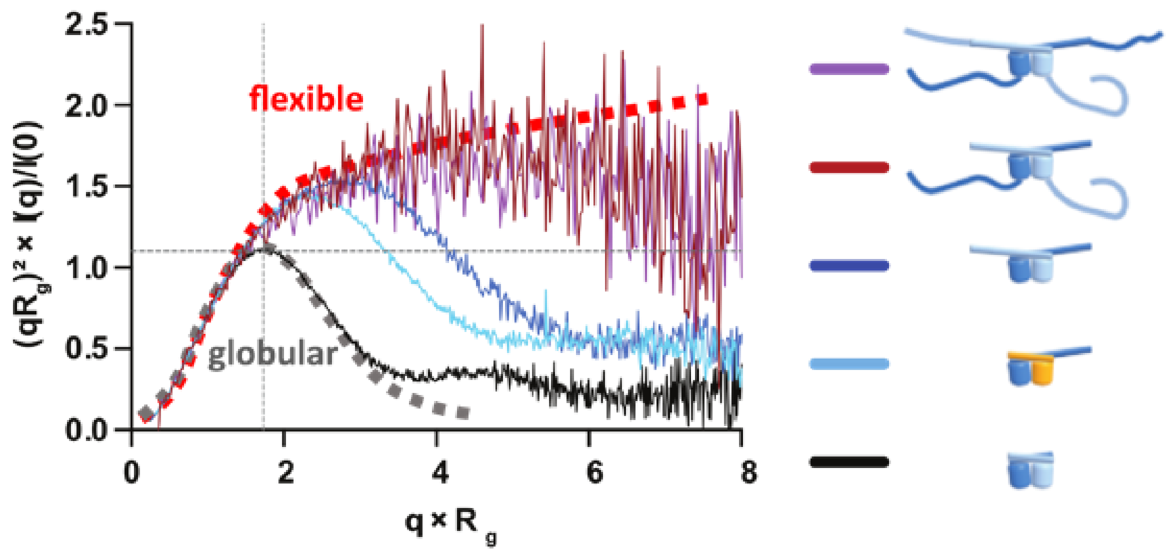


Figure 2: Small-angle X-ray scattering (SAXS) data shows that the flexibility of the protein increases dramatically upon inclusion of the flanking regions, demonstrating that they are intrinsically disordered. For reference, theoretical scattering profiles for a well-ordered, approximately spherical ('globular') protein and a purely flexible polymer are shown in grey and red, respectively.

Protein liquid-liquid phase separation is becoming increasingly recognised as a central mechanism underlying a myriad of normal cellular functions. However, to our knowledge, the molecular structure of a constituent protein molecule within a condensed liquid phase has not been reported to date. To investigate protein structure in the condensed phase we are attempting to use small-angle neutron scattering (SANS), where the bulk of the protein molecules in the material can be made 'invisible' by matching their ability to scatter neutrons with the surrounding solvent via incorporation of deuterium. The scattering from a small number of unmatched protein molecules in the material can then be measured, providing the structure of individual molecules within the condensed phase (Fig. 3). Sample preparation for this experiment has proved to be technically very challenging. Thus far, we have found that the unmatched protein molecules have all associated together rather than dispersed evenly throughout the sample. Despite this, we have successfully produced enough bulk condensed phase for the experiment (Fig. 3), shown that we can match-out the bulk of the deuterated molecules (making them invisible) and that matched and unmatched protein molecules can exchange dimeric partners in the dilute phase. Further optimisation of the SANS sample preparation process will hopefully allow us to see scattering from individual molecules in this condensed protein liquid.

In summary, our experiments are uncovering a complex network of intra- and intermolecular interactions, building a picture to understand how proteins can drive the formation of dynamic compartments in the cell to quickly respond to changes in their environment.

References:

Banani, SF, Lee, HO, Hyman, AA & Rosen, MK 2017, 'Biomolecular condensates: organizers of cellular biochemistry', Nature Reviews

To investigate protein structure in the condensed phase we are attempting to use small-angle neutron scattering (SANS)...

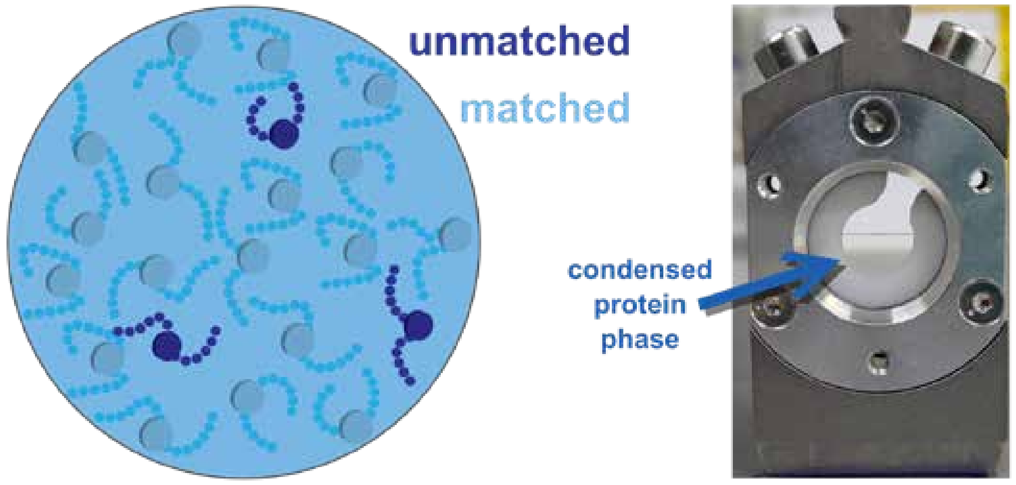


Figure 3: Small-angle neutron scattering (SANS) combined with selective deuteration is used to 'match out' the bulk of the molecules in the condensed phase so that only unmatched molecules (the minority) can be seen, allowing us to describe the structure of individual protein molecules in the condensed phase. On the right is shown the bulk condensed phase of SFPQ in the sample cell used for SANS data collection.

Molecular Cell Biology, vol. 18, pp. 285–298.

Huang, J, Casas Garcia, GP, Perugini, MA, Fox, AH, Bond, CS & Lee, M 2018, 'Crystal structure of a SFPQ/PSPC1 heterodimer provides insights into preferential heterodimerization of human DBHS family proteins', Journal of Biological Chemistry, vol. 293, pp. 6593–6602.

Jumper, J, Evans, R, Pritzel, A, Green, T, Figurnov, M, Ronneberger, O, Tunyasuvunakool, K, Bates, R, Žídek, A, Potapenko, A, Bridgland, A, Meyer, C, Kohl, SAA, Ballard, AJ, Cowie, A, Romera-Paredes, B, Nikolov, S, Jain, R, Adler, J, Back, T, Petersen, S, Reiman, D, Clancy, E, Zielinski, M, Steinegger, M, Pacholska, M, Berghammer, T, Bodenstein, S, Silver, D, Vinyals, O, Senior, AW, Kavukcuoglu, K, Kohli, P & Hassabis, D 2021, 'Highly accurate protein structure prediction with AlphaFold', Nature, vol. 596, pp. 583–589.

Lee, M, Sadowska, A, Bekere, I, Ho, D, Gully, BS, Lu, Y, Iyer, KS, Trewhella, J, Fox, AH & Bond, CS 2015, 'The structure of human SFPQ reveals a coiled-coil mediated polymer essential for functional aggregation in gene regulation', Nucleic Acids Research, vol. 43, pp. 3826–3840.

Lee, PW, Marshall, AC, Knott, GJ, Kobelke, S, Martelotto, L, Cho, E, McMillan, PJ, Lee, M, Bond, CS & Fox, AH 2022, 'Paraspeckle subnuclear bodies depend on dynamic heterodimerisation of DBHS RNA-binding proteins via their structured domains', Journal of Biological Chemistry, vol. 298, p. 102563.

Marshall, AC, Cummins, J, Kobelke, S, Zhu, T, Widagdo, J, Anggono, V, Hyman, A, Fox, AH, Bond, CS & Lee, M 2023, 'Different Low-complexity Regions of SFPQ Play Distinct Roles in the Formation of Biomolecular Condensates', Journal of Molecular Biology, vol. 435, p. 168364.

Martin, EW, Hopkins, JB & Mittag, T 2021, 'Small-angle X-ray scattering experiments of monodisperse intrinsically disordered protein samples close to the solubility limit', Methods in Enzymology, vol. 646, pp. 185–222.

Ward, JJ, Sodhi, JS, McGuffin, LJ, Buxton, BF & Jones, DT 2004, 'Prediction and Functional Analysis of Native Disorder in Proteins from the Three Kingdoms of Life', Journal of Molecular Biology, vol. 337, pp. 635–645.

Zhang, S, Cooper, JAL, Chong, YS, Naveed, A, Mayoh, C, Jayatilleke, N, Liu, T, Amos, S, Kobelke, S, Marshall, AC, Meers, O, Choi, YS, Bond, CS & Fox, AH 2022, 'NONO enhances mRNA processing of super-enhancer-associated GATA2 and HAND2 genes in neuroblastoma', EMBO Reports, vol. 24, pp. e54977.

Developing phage depolymerase enzymes to disarm *Klebsiella pneumoniae*

Daniel E. Williams[1], Chathura Suraweera[1], Sheena McGowan[1], Rhys Dunstan[1], Simon Corrie[2], Eleanor Jameson[3], Jason Brenker[4], Stephen Harrop[5].

[1] Monash University, Melbourne, VIC, Australia.
[2] Monash University, Melbourne, VIC, Australia.
[3] University of Warwick, United Kingdom.
[4] Monash University, Melbourne, VIC, Australia.
[5] Nuclear Science and Technology (NST), ANSTO, Clayton, VIC, Australia.

Hospital-acquired infections (HAIs) with multi-drug resistant (MDR) bacteria result in significant burdens to the patient; causing illness, extended hospitalisation and even death.

MDR infections involving the ESKAPE pathogens (six highly virulent and antibiotic resistant bacterial pathogens) alone cost AU$72 million to the Australian healthcare system in 2020 (Wozniak et al. 2022). Yet despite rigorous cleaning protocols, HAIs often result from bacteria contaminating equipment and surfaces in hospitals. An Australian study has shown that despite enhanced cleaning of an intensive care unit with traditional cleaning agents, MDR bacteria could still be cultured from equipment and furnishings (Vickery et al. 2012). Therefore, new ways of disinfecting surfaces to prevent HAIs are desperately needed.

One strategy is to exploit the anti-bacterial enzymes that bacteriophages – viruses that infect bacteria – produce during their normal lifecycle. One such enzyme family, the depolymerases, have the potential to 'disarm' bacteria, leaving otherwise MDR strains susceptible to simple cleaning agents. This approach could ultimately produce a depolymerase disinfectant cocktail that can act as a bespoke enzymatic surface biocide for use in hospitals – another weapon in the war against multi-drug resistance. However, depolymerases are poorly characterised in the literature and are highly variable in sequence, enzymatic mechanism, specificity, and structure.

This research focused on strategies to target the WHO priority pathogen *Klebsiella pneumoniae* (WHO 2024). *K. pneumoniae* uses its thick, sticky and mucinous capsule, in concert with excreted biofilms, to evade clearance of the bacterium via cleaning and desiccation of surfaces (Chen & Wen 2011; Jolivet-Gougeon & Bonnaure-Mallet 2019; Guerra et al. 2022). Our work identified a panel of depolymerases from environmental bacteriophage genomes

> *Hospital-acquired infections (HAIs) with multi-drug resistant (MDR) bacteria result in significant burdens to the patient.*

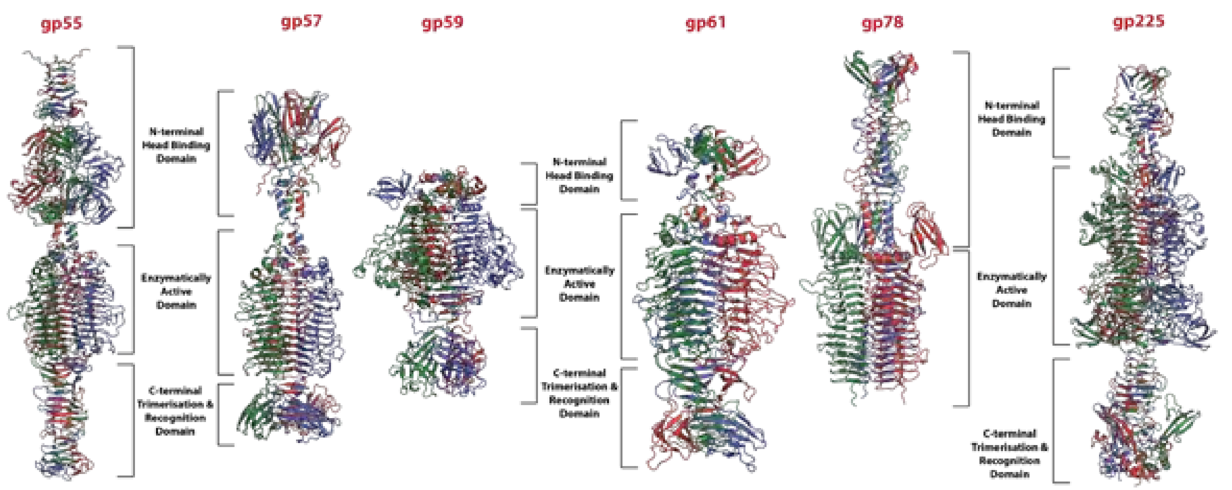


Figure 1: Schematic and summary of depolymerase structures in this study.

that proved to be potent *K. pneumoniae* capsule and biofilm degraders. A multi-method approach including the Macromolecular and Microfocus Crystallography (MX) beamlines at the Australian Synchrotron uncovered the structural features of each molecule (Fig. 1). Each enzyme we analysed formed an elongated, homotrimeric arrangement with a structurally conserved, central enzymatically critical domain. However, each enzyme showed significant structural heterogeneity in their N- and C-termini. This data helped identify putative active site clefts, which provided additional context in uncovering the detail of each depolymerase's enzymatic mechanism.

This study also aimed to understand whether developing depolymerases as additives to cleaning agents would be a viable strategy against MDR *K. pneumoniae.* Detergents and disinfectants are harsh chemical environments for any protein to withstand, so some modifications to the depolymerase enzymes were required. The structural features discovered from our multi-disciplinary studies, which included data from the Australian Synchrotron, allowed for the guided development of rationally designed, engineered depolymerase variants that would be suitable for formulation as biocide additives. These modified depolymerase designs saw no losses in thermostability, and showed an enhanced ability to prevent the formation of *K. pneumoniae* biofilms compared to unmodified forms (Fig. 2A). All designs were stable, folded and functional when formulated with cleaning agents at concentrations presently used in the clinic (alcohols, benzalkonium chloride, and sodium hypochlorite) (Fig. 2B,C). Stability was maintained at higher disinfectant concentrations and with reduced aggregation propensity in modified designs compared to the parent, especially so in the gold-standard disinfectant sodium hypochlorite (bleach) (Fig. 2B).

While this study focused on the development of depolymerase biocide additives, the data

This study also aimed to understand whether developing depolymerases as additives to cleaning agents would be a viable strategy against MDR K. pneumoniae.

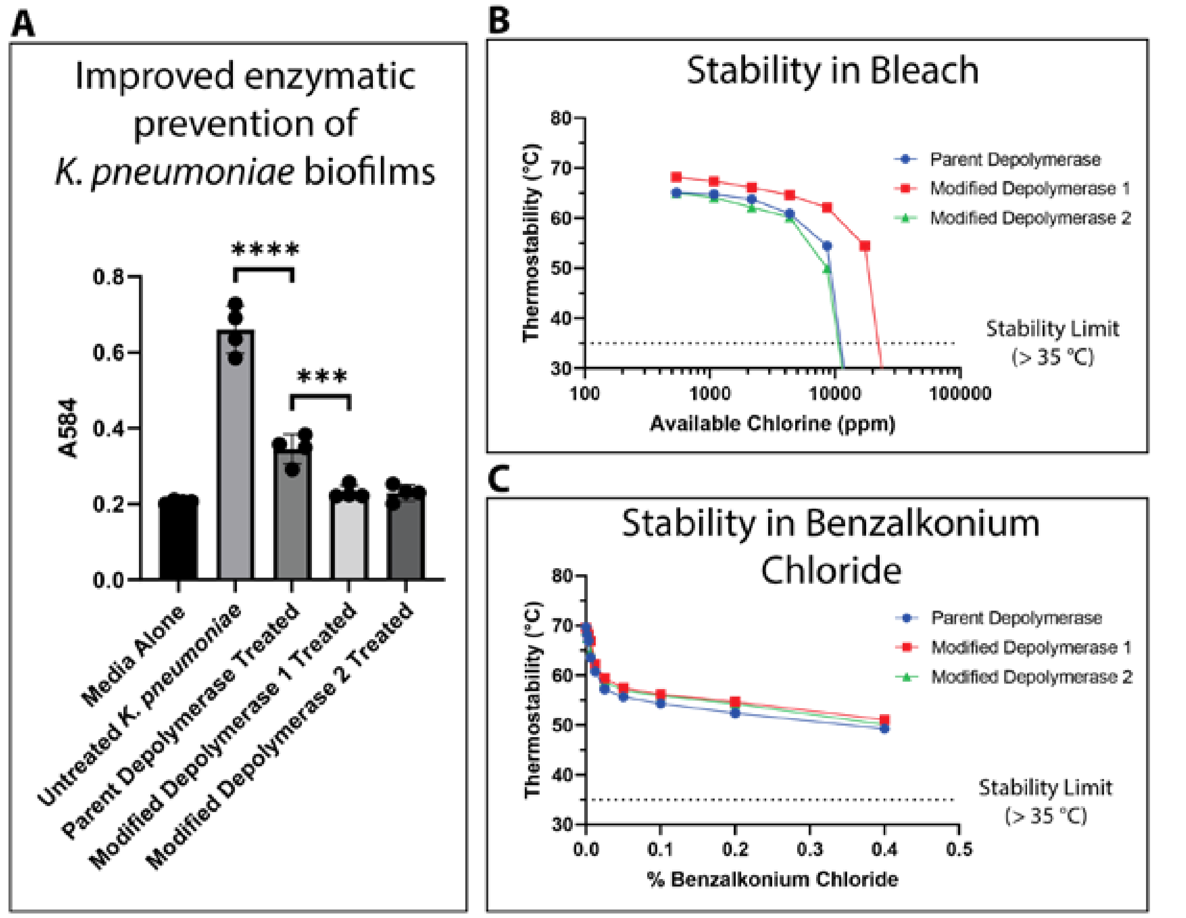


Figure 2: A) Modified depolymerase enzymes saw an enhanced ability to prevent K. pneumoniae biofilms compared to the parental depolymerase molecule. Stability of the modified depolymerases in B) bleach (as represented by percentage of available chlorine) and C) benzalkonium chloride.

showed that these enzymes were remarkably stable. Therefore, it may be possible to aerosolise these depolymerases as inhaled treatments for *K. pneumoniae*-induced pneumonia, allowing for direct lung access. The lungs are a difficult infection site to treat when therapeutics are delivered systemically due to diffusion barriers and other pharmacokinetic factors (Valcke et al. 1990). Proof-of-principle data showed that depolymerases could be aerosolised by existing clinical aerosolisation devices at the correct droplet size for inhalation deep into the lungs, pertinent for treatment of *K. pneumoniae* lung infections, with little to no loss of function (Fig. 3). This data suggests an attractive potential for these depolymerases as future inhaled biologics for *K. pneumoniae* pulmonary infections.

The adage that "prevention is better than a cure" applies to HAIs, and prevention relies heavily on our ability to decontaminate hospital equipment and environment. New approaches and agents to improve cleaning outcomes are needed to reduce the HAI burden. The depolymerase enzymes produced in this study may provide valuable leads for developing

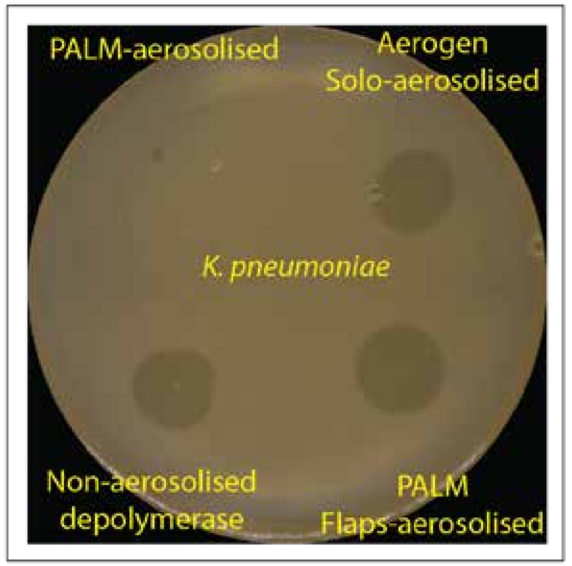


Figure 3: Depolymerases could survive aerosolisation by a variety of commercial and experimental aerosolisation apparatuses, as evidenced by the zone of clearing on the plate against hypervirulent K. pneumoniae.

practical agents as additives to present general-purpose biocides or as specialised bespoke enzymatic cleaners. It would be fascinating to determine in a future study whether a depolymerase-based cleaning agent reduces the burden of *K. pneumoniae* contamination in a real-world clinical environment, compared to current best practices. Engineering robust depolymerase scaffolds could transform the battle against antimicrobial resistance, leading to improved patient outcomes and reduced healthcare burden of HAIs.

This work would not be possible without the support of my supervisory team at Monash University – A/Prof Sheena McGowan, Dr Simon Corrie and Dr Rhys Dunstan. My ANSTO supervisor Dr Stephen Harrop was an invaluable source of expertise and dedication who assisted in bringing many of the structural characterisations in this study to life. I'd like to thank other members of the MX beamlines team who assisted with this work, including Dr Eleanor Campbell, as well as the MX beamline directors Dr Rachel Williamson and Dr Alan Riboldi-Tunnicliffe. My collaborator, Dr. Eleanor Jameson (Department of Microbiology and Virology, University of Warwick), kindly provided the phage genomes and associated protein sequences used in this study. I'd also like to acknowledge Dr Edward Henderson, Dr Chris Barlow, Dr Geoffrey Kong, Hariprasad Venugopal, Dr Sylvain Trepout, Dr Jason Brenker, Dr Slawomir Michniewski and Dr Chathura Suraweera for their support in this project. This work was supported by an Australian Government Research Training Program (RTP) Scholarship and an AINSE Postgraduate Research Award.

References:

Chen, L & WEN, YM 2011, 'The role of bacterial biofilm in persistent infections and control strategies', International Journal of Oral Science, vol. 3, pp. 66-73.

Guerra, MES, Destro, G, Vieira, B, Lima, AS, Ferraz, LFC, Hakansson, AP, Darrieux, M & Converso, TR 2022, '*Klebsiella pneumoniae* Biofilms and Their Role in Disease Pathogenesis', Frontiers in Cellular and Infection Microbiology, vol. 12, p. 877995.

Jolivet-Gougeon, A & Bonnaure-Mallet, M 2019, 'Bacterial Persistence in Biofilms and Antibiotics', in: JL Capelo-Martínez & G Igrejas (eds.), Antibiotic Drug Resistance, John Wiley & Sons: New Jersey, USA.

Valcke, Y, Pauwels, R & Van Der Straeten, M 1990, 'Pharmacokinetics of antibiotics in the lungs', European Respiritory Journal, vol. 3, pp. 715-722.

Vickery, K, Deva, A, Jacombs, A, Allan, J, Valente, P & Gosbell, IB 2012, 'Presence of biofilm containing viable multiresistant organisms despite terminal cleaning on clinical surfaces in an intensive care unit', Journal of Hospital Infection, vol. 80, pp. 52-55.

WHO. WHO Bacterial Priority Pathogens List, 2024: Bacterial pathogens of public health importance to guide research, development and strategies to prevent and control antimicrobial resistance. World Health Organisation (WHO): Geneva, Switzerland.

Wozniak, TM, Dyda, A, Merlo, G & Hall, L 2022, 'Disease burden, associated mortality and economic impact of antimicrobial resistant infections in Australia', The Lancet Regional Health – Western Pacific , vol. 27, p. 100521.

Nanodosimetric studies and characterisation of silicon detectors for the assessment of radiation on the Moon

Jay W. Archer[1], Matthew J. Large[2], E. Giulio Villani[4,5], James Vohradsky[1], Vladimir Pan[1], Daniel Bennett[1], Martin Gazi[4,5], Sebastien Incerti[6], Hoang N. Tran[6], Daniel Hynds[5], Dousatsu Sakata[7], Daniela Bortoletto[5], Stefania Peracchi[8], Zeljko Pastuovic[8], Melanie Ferlazzo[8], Nick Howell[8], Linh T. Tran[1], A. Rosenfeld[1], Jeremy M. C. Brown[3], S. Guatelli[1]

[1] University of Wollongong, Wollongong, NSW, Australia

[2] Swinburne University of Technology, Hawthorn, VIC, Australia

[3] Swinburne University of Technology, Hawthorn, VIC, Australia

[4] Rutherford Appleton Laboratory, Harwell Campus, Didcot, United Kingdom

[5] University of Oxford, Oxford, United Kingdom

[6] University of Bordeaux, CNRS, Gradignan, France

[7] National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan

[8] Centre for Accelerator Science, ANSTO, Lucas Heights, NSW, Australia

With the growing interest in long-term space travel, the assessment of the health risks of space radiation is of increasing importance.

While several methods are used by space agencies to gauge the effects of space radiation, the risks associated with space radiation are still considered to be one of the most important and uncertain considerations for astronaut health (Cucinotta & Durante 2006). These methods consist of the scaling of the radiation dose by radiation quality factors to obtain an effective dose. Quality factors are functions of the particle type and energy (Cucinotta et al. 2021), the macroscopic linear energy transfer (ICRP 2007) or the microdosimetric lineal energy transfer (ICRU 1986). However, the long-term effects of radiation is fundamentally due to sub-cellular damage and, in particular, complex DNA damage such as double strand breaks (DSBs). The assessment of DNA damage from radiation is often referred to as nanodosimetry.

There have been an increasing number of studies developing models of particle interactions on the DNA-scale through track structure physics models. This, combined with complex DNA geometries (moleculardna.org, Chatzipapas et al., 2023), dedicated DNA damage scoring techniques (Nikjoo, O'Neill & Terrissol, 1997) as well as induction and tracking of chemical species induced by radiation (Tran et al. 2024) allow for the sophisticated understanding of DNA damage induced by radiation. These are implemented in several different Monte Carlo codes such as Geant4 (geant4.org) through Geant4-DNA (geant4-dna.org, Incerti et al., 2016).

... the assessment of the health risks of space radiation is of increasing importance.

... this project aims to improve our understanding and capabilities for the monitoring of space radiation on the lunar surface ...

As a result, this project aims to improve our understanding and capabilities for the monitoring of space radiation on the lunar surface through 1) the development of Monte Carlo simulations to understand early DNA damage induced by space radiation, 2) validation of these simulations through radiobiological experiments performed at ANSTO, and 3) the characterisation of silicon radiation detectors to improve radiation dosimetry in the space radiation environment.

We have developed the first complete simulation pipeline to assess DNA damage on the lunar surface (Archer et al. 2024). This was achieved through a multiscale simulation where we assessed radiation on the scale of astronauts on the moon. We then tracked this radiation moving through organs through detailed human phantoms (Kim et al. 2020) to obtain the radiation on the scale of cells. Finally, we performed DNA damage simulations. A summary of this pipeline can be seen in Figure 1.

In order to validate these simulations, we have been performing radiobiological experiments at ANSTO's Centre for Accelerator Science (CAS). This process involves irradiation of a human skin fibroblast cells using the ANTARES beamline. The cells are then stained using γ-H2AX fluorescence to show the locations of DSBs in the cell nucleus. This is imaged using a confocal microscope to obtain a three-dimensional distribution of DNA damage. We compared these simulations to a simulated distribution using Geant4-DNA. This involved modelling the beamline geometry and performing DNA damage induction simulations through the implementation of the actual cell nucleus positions. A slice of simulated and experimental foci distributions are shown in Figure 2.

The Centre for Medical Radiation Physics (CMRP) at the University of Wollongong also develop arrays of small (~10 μm) silicon radiation detectors to perform radiation dosimetry for radiotherapy and space radiation monitoring (Tran et al. 2021). However, there are currently limitations in the detection of

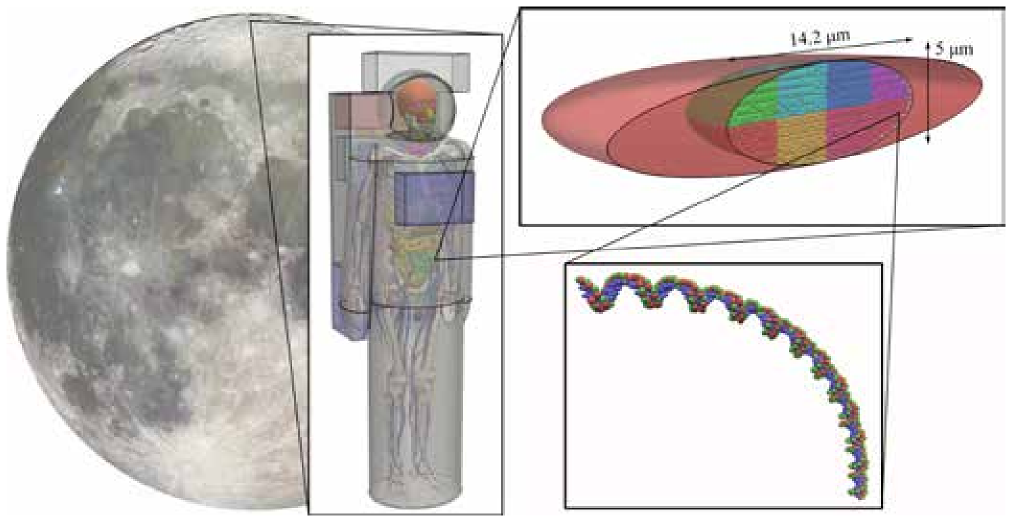


Figure 1: Multiscale simulation developed in Geant4, consisting of simulating galactic cosmic radiation (GCR) incident on the Moon (left), a detailed human phantom (middle), a detailed cell model (upper right). This is performed to obtain the early DNA damage along the DNA (lower right).

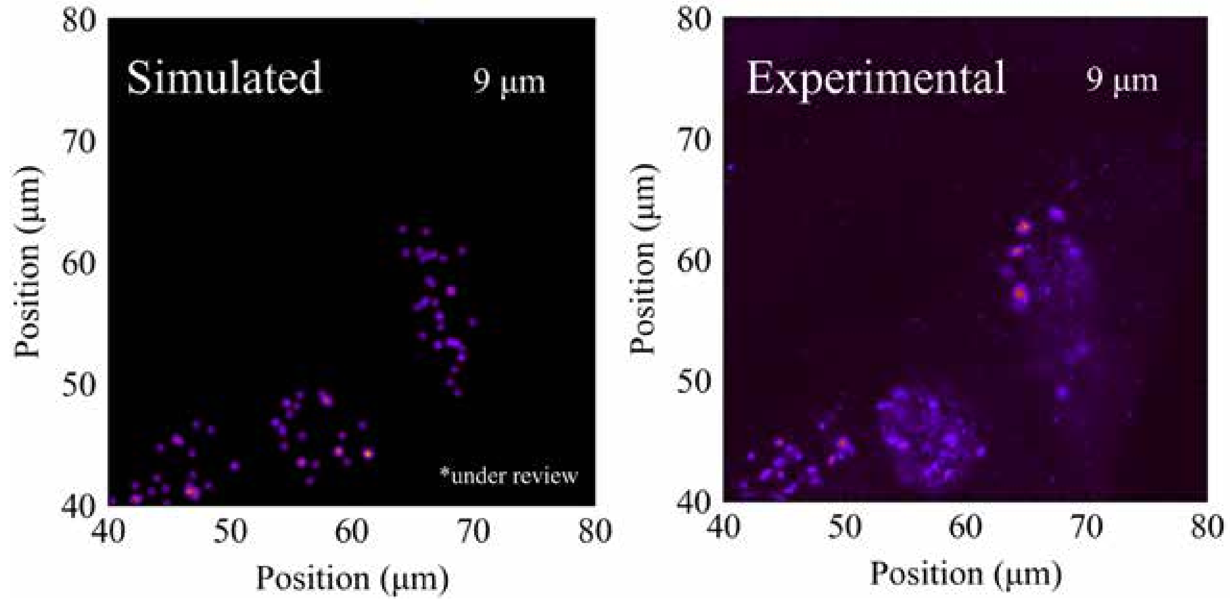


Figure 2: y-H2AX foci as simulated using our Geant4 simulation (left) and our experiment at ANSTO (right).

low LET radiation such as that from galactic cosmic radiation (GCR) in space. As such, we explored the use of low gain avalanche diodes (LGADs) as a candidate for a microdosimeter in space. LGADs were identified due to their inclusion of a gain layer which improves the signal-to-noise ratio of the signal induced by radiation.

Using the SIRIUS beamline at CAS, we assessed the gain of the detectors for different LET protons and carbon ions (Archer et al. 2024) as well as for different levels of radiation damage imposed on the detector. Since the SIRIUS beamline contains a scanning microprobe which confines the ion beam to within ~1 um, we can resolve the spatial dependence of the detector response as shown in Fig. 3. We found that the gain was highly sensitive to the LET of the radiation traversing the detector.

This is a result of the screening of the internal electric field by a high density of induced charge carriers, leading to a reduction in gain with increasing LET. We also found that the gain reduces with radiation damage due to a smaller mean free path of charge carriers through the gain layer but ultimately reducing the variability of the gain between radiation types. Thus, we are currently investigating methods to improve applications of LGADs where the radiation field may not be known a priori.

This work would not be possible without the expertise of my supervisory team and collaborators. The direction of the work has been guided by my supervisory team consisting of Prof. Susanna Guatelli (UOW), D/Prof. Anatoly Rosenfeld (UOW), A/Prof. Jeremy Brown (Swinburne) and Dr. Stefania Peracchi (ANSTO). Experiments were performed with Dr. Zeljko Pastuovic (ANSTO), Dr. Melanie Ferlazzo (ANSTO), Nick Howell (ANSTO), Dr. Linh Tran (UOW), Dr. James Vohradsky (UOW), Dr. Vladimir Pan (UOW) and Daniel Bennett (UOW). The detectors were developed at the University of Oxford by Dr. E. Giulio Villani, Dr. Martin Gazi, Dr. Daniel Hynds and Prof. Daniela Bortoletto. Simulations were developed in collaboration with the expertise of Dr. Sebastien Incerti and Dr. Hoang Ngoc Tran of the University of Bordeaux, A/Prof. Dousatsu Sakata (National Metrology Institute of Japan) and Dr. Matthew Large (Swinburne).

This research was supported by the Australian Government Research Training Program (RTP) and the AINSE Post-Graduate Research Award (PGRA).

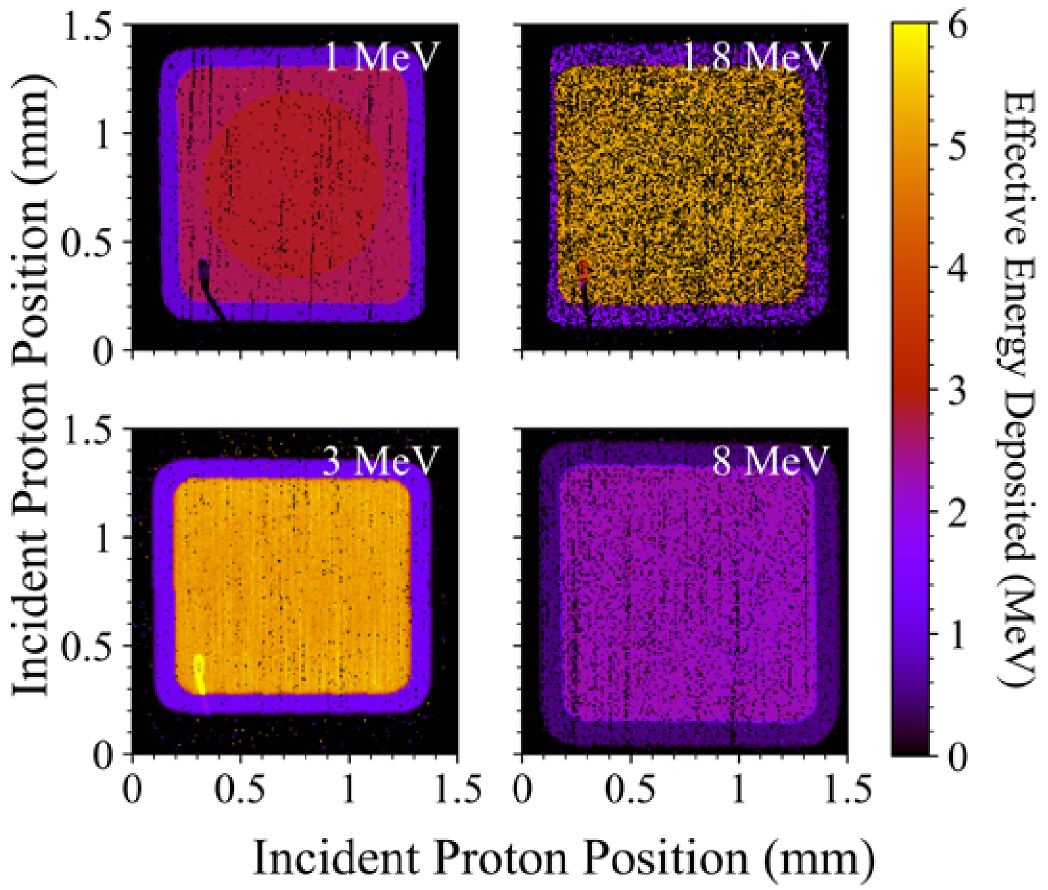


Figure 3: Response of a LGAD in response to a scanning proton beam of varying energy.

REFERENCES:

Archer, JW, Large, MJ, Bolst, D, Sakata, D, Tran, HN, Chatzipapas, KP, Ivantchenko, V, Rosenfeld, AB, Incerti, S, Brown JMC & Guatelli, S 2024, 'A multiscale nanodosimetric study of GCR protons and alpha particles in the organs of astronauts on the lunar surface', Radiation Physics and Chemistry, vol. 229 p. 112448.

Archer, JW. et al. 2024, 'A Two-Dimensional Characterization of Low-Gain Avalanche Diodes for Low-LET Microdosimetry', IEEE Transactions on Nuclear Science, vol. 71, no. 3, pp. 342–351.

Chatzipapas, KP et al. 2023, 'Simulation of DNA damage using Geant4-DNA: an overview of the "molecularDNA" example application', Precision Radiation Oncology, vol. 7, no. 1, pp. 4–14.

Cucinotta, F , Cacao, EE, Saganti, PB & Kim, M-H 2021, 'NASA Space Cancer Risk (NSCR) Model 2020', In: 43rd COSPAR Scientific Assembly, 28 January - 4 February, Online, vol. 43, pp. 1857.

Cucinotta, FA & Durante, M 2006, 'Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings', The Lancet Oncology, vol. 7, no. 5, pp. 431–435.

ICRP 2007, 'The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103.', Annals of the ICRP, vol. 37, no. 2–4, pp. 1-332.

ICRU 1986, 'The Quality Factor in Radiation Protection', ICRU Report 40 [Preprint], viewed 5 September 2024, https://www.icru.org/report/the-quality-factor-in-radiation-protection-report-40/

Incerti, S, Douglass, M, Penfold, S, Guatelli, S & Bezak, E 2016, 'Review of Geant4-DNA applications for micro and nanoscale simulations', Physica Medica, vol. 32, no. 10, pp. 1187–1200.

Kim, CH, Yeom, YS, Petoussi-Henss, N, Zankl, M, Bolch, WE, Lee, C, Choi, C, Nguye,n TT, Eckerman, K, Kim, HS, Han, MC, Qiu, R, Chung, BS, Han, H, Shin, B 2020, 'Adult Mesh-Type Reference Computational Phantoms', Ann ICRP, vol. 49, no. 3, pp. 13-201

Nikjoo, H, O'Neill, P & Terrissol, M 1997, 'Computational modelling of low-energy electron-induced DNA damage by early physical and chemical events', International Journal of Radiation Biology, vol. 71, no. 5, pp. 467–483.

Tran, HN et al. 2024, 'Review of chemical models and applications in Geant4-DNA: Report from the ESA BioRad III Project', Medical Physics, vol. 51, no. 9, pp. 5873–5889.

Tran, LT et al. 2021, 'Silicon 3D Microdosimeters for Advanced Quality Assurance in Particle Therapy', Applied Sciences, vol. 12, no. 1, p. 328.

Enhanced detection of synchrotron X-rays with a flexible organic X-ray sensor

Jessie A. Posar[1], Aishah Bashiri[1,2], Matthew J. Large[1], Matthew J. Griffith[3], Laurance Papale[4], Bronson Philippa[4], Chris Hall[5], David Bolst[1], Susanna Guatelli[1], Attila J. Mozer[6], Marco Petasecca[1]

[1] University of Wollongong, Wollongong, NSW, Australia
[2] Faculty of Science and Arts, Najran University, Najran, Saudi Arabia
[3] University of South Australia, Mawson Lakes, SA, Australia
[4] James Cook University, Townsville, QLD, Australia
[5] Australian Synchrotron, Clayton, VIC, Australia
[6] University of Wollongong, Wollongong, NSW, Australia

Medical radiation procedures such as diagnostic imaging and radiation therapy are life-saving tools in modern medical practice.

Advanced radiation modalities including image-guided radiotherapy (combined use of low keV and high MeV energies) or innovative radiotherapy modalities such as microbeam radiation therapy (MRT) (high dose-rate micron-sized radiation beams), have been introduced to improve treatment outcomes. Steep dose gradients and high intensities occurring in these novel radiation modalities are challenging to be monitored with traditional and commercial equipment as the sensor must exhibit: 1) superior spatial resolution (sub-micron), 2) no dependence on beam energy (termed tissue equivalent), and 3) high radiation tolerance. Furthermore, real-time monitoring or in-vivo dosimetry has now become compulsory in many countries to instantaneously detect, evaluate, and correct for any deviations from the planned exposure. This becomes extremely complex as the sensor must conform to the shape of the patient and detect the incoming beam with real-time feedback (Posar et al. 2021).

Our team has embarked on a research effort to develop wearable x-ray sensors by employing carbon-based flexible sensors on Kapton (a polyimide film) substrates. Kapton was used as the desired substrate and was compared to Polyethylene (PE) based substrates, which are commercially used for large-scale manufacturing of flexible sensors (Large et al. 2021). The thin 260 nm active layer consists of a polymer donor, P3HT, and non-fullerene acceptor, o-IDTBR, with an Indium Tin Oxide (ITO) bottom contact and Aluminium (Al) top contact resulting in a 6 mm2 active area. The diodes were connected to a custom-made data acquisition system for real-time readout. Experiments were conducted on the Imaging and Medical Beamline at ANSTO's Australian Synchrotron which is one of two beamlines worldwide developing MRT (Fig. 1). MRT uses small 'micro'-sized x-ray beams instead of a single large, uniform, and collimated (parallel rays) beam. The average energy and dose rate of the beam were varied between 48 – 117 keV and 212 – 4470 Gy/s by using a combination of copper (Cu) and/or aluminium (Al) filters. The highest sensitivity per unit area for the flexible direct organic X-ray sensor on Kapton substrates was measured to be (1958 ± 31) pC $Gy^{-1}cm^{-2}$ for the Al-Al filter condition (Bashiri et al. 2024).

Our team has embarked on a research effort to develop wearable x-ray sensors by employing carbon-based flexible sensors ...

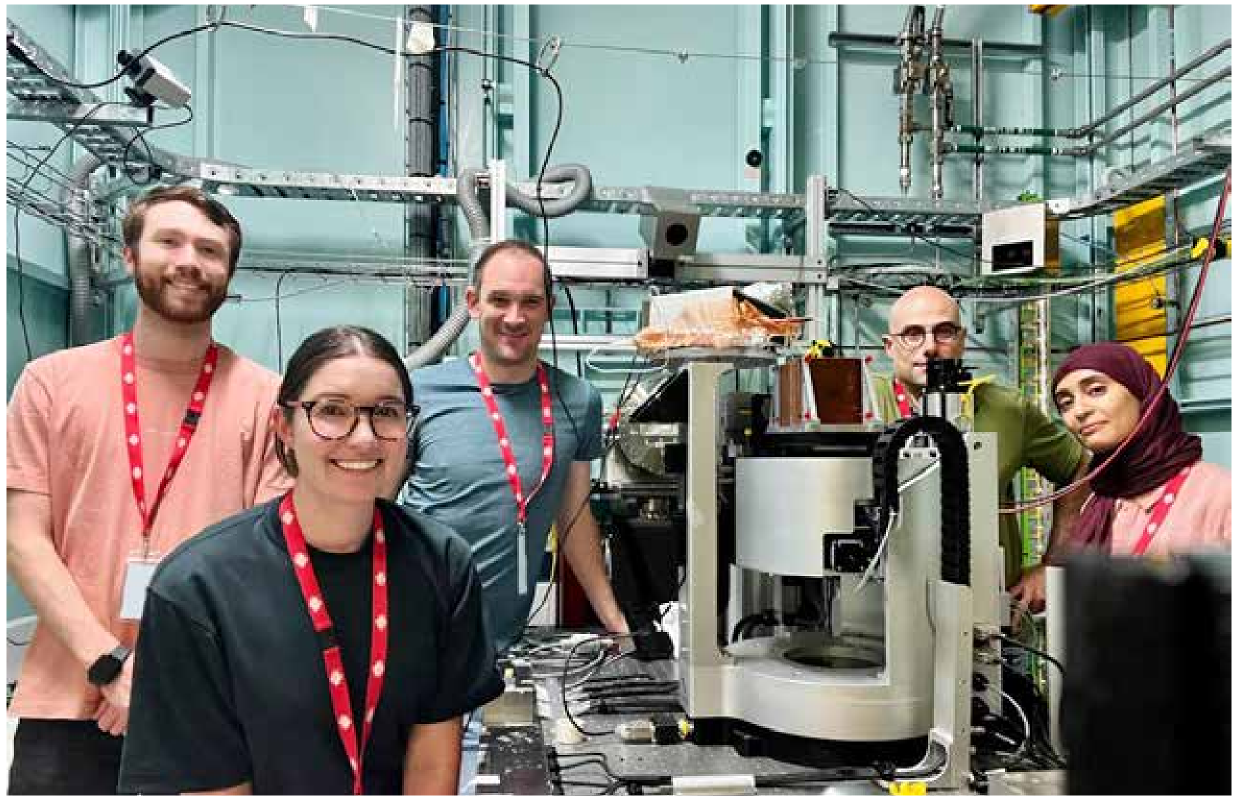


Figure 1: Photo during experiments at the Imaging and Medical Beamline, Australian Synchrotron. From left to right, Matthew J. Large, Jessie A. Posar, Matthew J. Griffith, Marco Petasecca and Aishah Bashiri.

Tissue equivalence of the device is achieved when the sensitivity across all beam conditions, known as the calibration factors, is constant. Any variation in the calibration factor must be corrected for to ensure accurate monitoring of the amount of ionizing radiation deposited in the human body if used for dosimetry. While the use of an organic active layer reduces the variation in the calibration factor, the high Z contacts, specifically indium tin oxide (ITO) which was positioned in between the active layer and incident beam, was experimentally demonstrated. This was verified with Monte-Carlo based Geant4 simulations, to vary the sensitivity by 1.6 times across x-ray energies of 47.8 keV to 117 keV. MRT is characterised by highly spatially fractionated x-ray beam into an array of 50 microbeams with a Full-Width-Half-Max of 50 µm and a peak-to-peak distance of 400 µm. The organic sensor was able to measure all 50 microbeams with a full-width-half-max of (51.6 ± 1.9) µm averaged across 3 beam conditions. X-ray Beam Induced Charge (XBIC) mapping was explored to quantitatively map the spatially dependent charge carrier collection efficiency across the pixel. Relative to the physical active area, 3.0 mm x 2.0 mm, defined by the electrical contacts, the bulk of the mapped charge was 3.0 × 2.3 mm, demonstrating a well-defined active area.

Experiments were conducted on the Imaging and Medical Beamline at ANSTO's Australian Synchrotron ...

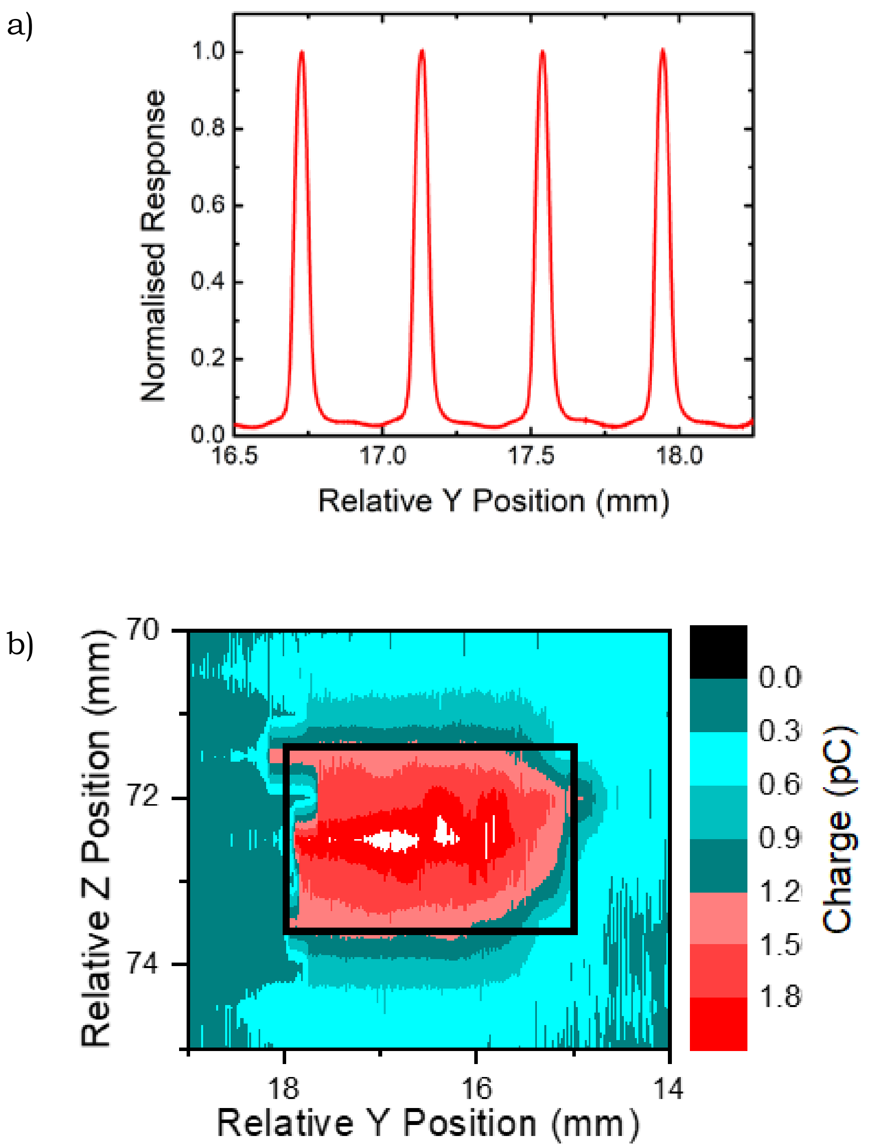


Figure 2: a) Three central x-ray microbeams for Al-Al beam conditions and b) X-Ray Beam Induced Current (XBIC) map of pixel area for an organic sensor on a flexible Kapton substrate. The black solid line indicates the physical dimensions of the pixel from the top and bottom contracts. Reproduced from (Bashiri et al. 2024) with permission from John Wiley & Sons. © 2024 Wiley-VCH GmbH.

The experiments were replicated on an organic sensor with a flexible PE substrate. During sensitivity measurements, the output current changed polarity during each scan causing unreliable detection of the x-ray beam. Device simulations revealed that when the x-ray beam interacted with the substrate, the direct ionization generated an electrostatic charge which accumulated at the interface between the substrate and the organic semiconducting layer. The PE induced an opposite electrostatic charge, causing a momentarily reverse direction of the local electric field. Microbeam measurements determined a FWHM (full width at half maximum) of (58.7 ± 3.7) µm across all beam conditions and X-Ray Beam Induced Current (XBIC) mapping revealed that the bulk of the mapped charge was significantly larger than the expected pixel area, 6.1 × 2.2 mm. The increased charge collection outside of the pixel area and increased FWHM was determined to be due to the PE layer generating x-ray induced fluorescence which was detected by the organic layer outside of the field as observed with other devices with PE based substrates (Posar, Large, et al. 2021).

The radiation hardness was explored up to a total irradiation dose of 45 kGy. The performance of the organic sensor decreased by 35% compared to 33.5% for flexible amorphous silicon diodes under the same x-ray field (Large et al. 2024). This result was improved relative to our previous radiation hardness studies showing a decrease of 65% using different organic active materials based on fullerene acceptors (Posar, Davis, et al. 2021; Posar et al. 2020).

This work demonstrates that organic semiconductors can exhibit high spatial resolution and radiation hardness for development as a flexible x-ray sensor under extreme ionising radiation conditions by careful selection of the active materials and device packaging.

The authors acknowledge the support from AINSE for the Early Career Research Award (ECRG). This project is in collaboration with Dr Chris Hall at the Imaging and Medical Beamline (Australian Synchrotron) who has provided access and assistance at the beamline, PhD student Laurance Papale and A/Prof Bronson Philippa (James Cook University) with expertise in device simulations, and Matthew J. Griffith (University of South Australia) with expertise in organic sensors. The project was driven by the team at University of Wollongong, including PhD students Aishah Bashiri and Matthew J. Large, Prof Marco Petasecca, Dr David Bolst, Prof Susanna Guatelli and Prof Attila Mozer, and lead by Dr Jessie A. Posar. Jessie A. Posar is the recipient of the Office of National Intelligence National Intelligence Postdoctoral Grant (project number NIPG202307) funded by the Australian Government.

References:

Bashiri, A, Large, MJ, Griffith, MJ, Papale, L, Philippa, B, Hall, C, Bolst, D, Guatelli, S, Mozer, AJ, Petasecca, M & Posar, JA 2024, 'Flexible Organic X-Ray Sensors: Solving the Key Constraints of PET Substrates', Advanced Functional Materials, vol. 35, no. 8, p. 2415723.

Large, MJ, Kanxheri, K, Posar, J, Aziz, S, Bashiri, A, Calcagnile, L, Calvo, D, Caputo, D, Caricato, AP, Catalano, R, Cirio, R, Cirrone, GAP, Croci, T, Cuttone, G, De Cesare, G, De Remigis, P, Dunand, S, Fabi, M, Frontini, L, Talamonti, C. 2024, 'Dosimetry of microbeam radiotherapy by flexible hydrogenated amorphous silicon detectors', Physics in Medicine & Biology, vol. 69, p. 155022.

Large, MJ, Posar, JA, Mozer, AJ, Nattestad, A, Alnaghy, S, Carolan, M, Sellin, PJ, Davies, J, Pastuovic, Z, Lerch, MLF, Guatelli, S, Rosenfeld, A, Griffith, MJ, & Petasecca, M 2021, 'Flexible Polymer X-ray Detectors with Non-fullerene Acceptors for Enhanced Stability: Toward Printable Tissue Equivalent Devices for Medical Applications', ACS Applied Materials & Interfaces, vol. 13, no. 48, pp. 57703-57712.

Posar, JA, Davis, J, Alnaghy, S, Wilkinson, D, Cottam, S, Lee, DM, Thompson, KL, Holmes, NP, Barr, M, Fahy, A, Nicolaidis, NC, Louie, F, Fraboni, B, Sellin, PJ, Lerch, MLF, Rosenfeld, AB, Petasecca, M, & Griffith, MJ 2021, 'Polymer Photodetectors for Printable, Flexible, and Fully Tissue Equivalent X-Ray Detection with Zero-Bias Operation and Ultrafast Temporal Responses', Advanced Materials Technologies, vol. 6, no. 9, p. 2001298.

Posar, JA, Davis, J, Large, MJ, Basiricò, L, Ciavatti, A, Fraboni, B, Dhez, O, Wilkinson, D, Sellin, PJ, Griffith, MJ, Lerch, MLF, Rosenfeld, A & Petasecca, M 2020, 'Characterization of an organic semiconductor diode for dosimetry in radiotherapy', Medical Physics, vol. 47, no. 8, pp. 3658-3668.

Posar, JA, Large, M, Alnaghy, S, Paino, JR, Butler, DJ, Griffith, MJ, Hood, S, Lerch, MLF, Rosenfeld, A, Sellin, PJ, Guatelli, S & Petasecca, M 2021, 'Towards high spatial resolution tissue-equivalent dosimetry for microbeam radiation therapy using organic semiconductors', Journal of Synchrotron Radiation, vol. 28, no. 5, pp. 1444-1454.

Posar, JA, Petasecca, M & Griffith, MJ 2021, 'A review of printable, flexible and tissue equivalent materials for ionizing radiation detection', Flexible and Printed Electronics, vol. 6, no. 4, p. 43005.

Finding synergy: Understanding the effect of the peptide Lactofungin on the antifungal drug Amphotericin B

Lissy M. Hartmann[1], Charles G. Cranfield[1], Evelyne Deplazes[1,2], Stephen A. Holt[1,3], Robert A. Russell[4], Anton P. Le Brun[3], Andrew J. Clulow[5], Richard J. Payne[6,7], Sameer S. Kulkarni[6,7]

[1] University of Technology Sydney, Ultimo, NSW, Australia
[2] University of Queensland, St Lucia, QLD, Australia
[3] Australian Centre for Neutron Scattering (ACNS), ANSTO, Lucas Heights, NSW, Australia
[4] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia
[5] Australian Synchrotron, ANSTO, Clayton, VIC, Australia
[6] The University of Sydney, Sydney, NSW, Australia
[7] The University of Sydney, Sydney, NSW, Australia

Invasive fungal infections (IFIs) are an underappreciated and worsening public health threat, which cause over 1.6 million deaths annually worldwide, with mortality rates of up to 80% even in advanced health settings (WHO, 2022; Casalini et al. 2024).

Pathogenic fungi can evoke systemic infections with severe or life-threatening disease progression, mainly in immunocompromised people (WHO, 2022). Due to similarities in structure and composition of fungal and mammalian cells, drug targets are limited and most treatments for IFIs show high toxicity (Ben-Ami & Kontoyiannis, 2021). Additionally, many antifungal drugs are rendered ineffective due to resistance development (WHO, 2022) or are limited by inadequate access stemming from high treatment costs (Lee et al. 2024).

Amphotericin B (AmB) is one of the most effective antifungal drugs for treating IFIs. Even though it was discovered over 60 years ago, AmB has almost no acquired resistance and is fungicidal, as opposed to other drugs that are only fungistatic. AmB targets ergosterol in fungal cell membranes and kills fungal cells by a complex and multipronged mechanism. This mechanism includes the formation of pores and membrane-associated aggregates, resulting in membrane permeabilisation and subsequent cell lysis (Cavassin et al. 2021; Kamiński, 2014). Due to the structural similarity of ergosterol with cholesterol abundant in all human cells, AmB causes off-target activity, leading to severe side effects (Maji et al. 2023; Lewandowska et al. 2021). It is therefore important to find either less toxic antifungal agents or substances that can be added (adjuvants) to existing antifungals that improve their efficacy.

Lactofungin (LFG) is a 30-residue peptide derived from the milk protein Lactoferrin (Fernandes et al. 2021). LFG reduces the AmB dose needed to reach the minimum inhibitory concentration by 4 to 8-fold in the clinically relevant pathogens *Candida* albicans, *Candida auris* and *Cryptococcus neoformans* (Fernandes et al. 2021). Interestingly, LFG exhibits no anti-fungal activity on its own and is non-toxic to mammalian cells, making it a potentially new type of synergist that might be a starting point to develop adjuvant drugs that indirectly lower AmB toxicity.

... LFG increases the membrane permeability of AmB.

At the core of this project is answering the question: How does LFG affect the known membrane-damaging properties of AmB? Recent work in the lab of Dr Deplazes at the University of Queensland and the University of Technology Sydney has demonstrated that LFG increases the membrane permeability of AmB. Specifically, the in-vitro synergy observed in fungal cells can be reproduced using model membranes composed of phospholipids and ergosterol. This means we can elucidate the yet unknown mechanism of LFG-AmB synergy using a four-component system of phospholipids, ergosterol or cholesterol, AmB and LFG. However, understanding LFG-AmB synergy requires molecular-level details that are hard to achieve with standard biophysical or biochemical techniques, making synchrotron experiments particularly valuable.

A combination of biophysical methods has been selected to address two main objectives: i) where in the membrane the LFG-AmB synergy mechanism occurs and ii) how the membrane changes due to the addition of LFG and AmB in a model environment with controllable parameters. At ANSTO, the project utilises quartz crystal microbalance with dissipation monitoring (QCM-D) and neutron reflectometry (NR). These techniques have previously been widely used to study peptide-membrane and drug-membrane interactions. They are ideally suited to study the effect of AmB and LFG on membrane properties but require careful validation (Deolal & Mishra, 2022).

QCM-D is used to examine the impact on membrane structure between a peptide or drug and a biological membrane in real-time in situ, providing information about the mass and structural changes occurring to the membrane (Mechler et al. 2007). We use this technique to investigate how much LFG and AmB bind to lipid membranes, how they disrupt the lipid bilayer, and whether the binding and/or disruption is isolated to the membrane surface or inside the membrane core. First results suggest a decrease in lipid rigidity when AmB is added to and incubated on the lipid bilayers

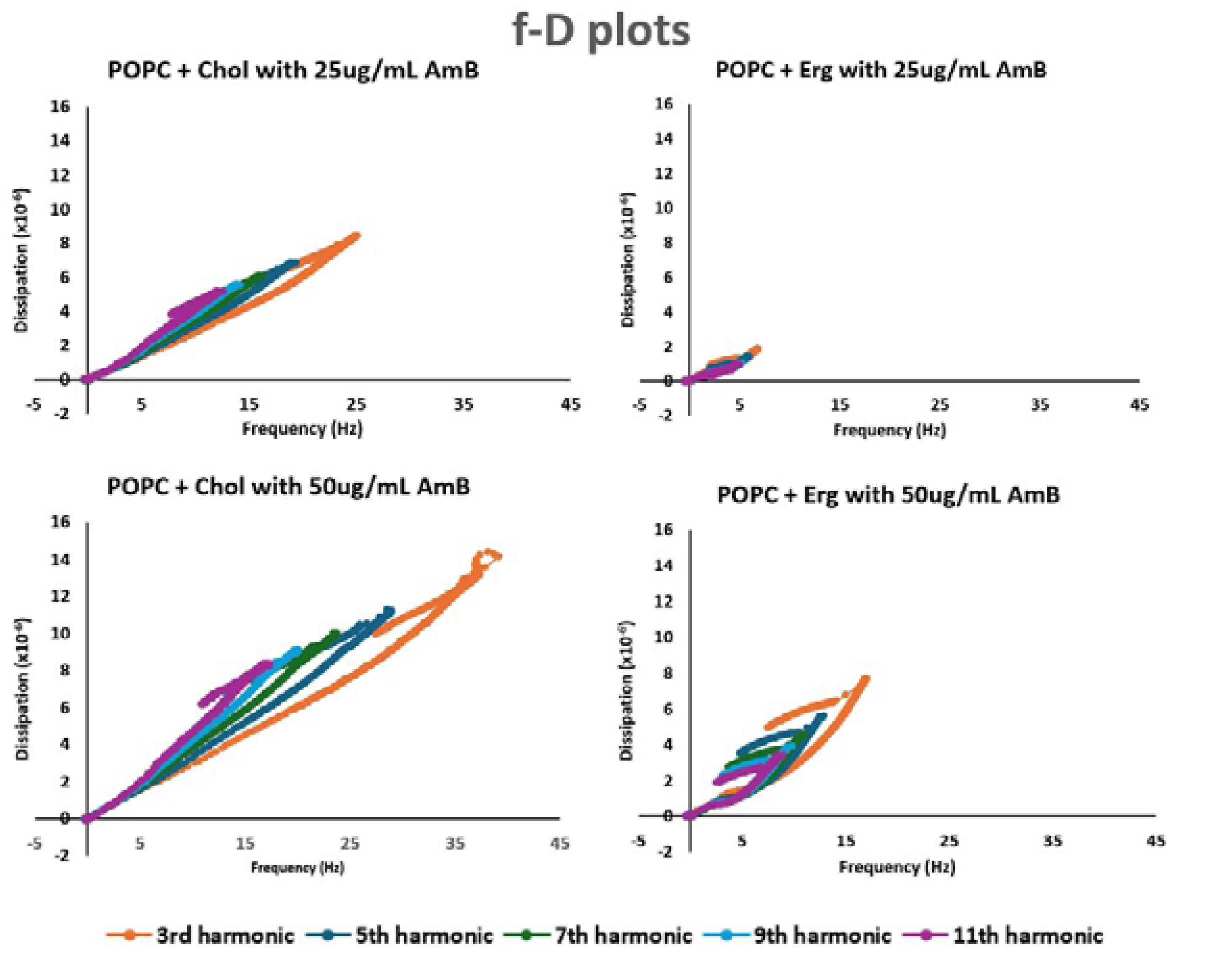


Figure 1: f–D plots for the addition of 25 µg/mL or 50 µg/mL AmB solutions with subsequent washing to ergosterol or cholesterol containing lipid bilayers.

QCM-D is used to examine the impact on membrane structure between a peptide or drug and a biological membrane in real-time in situ ...

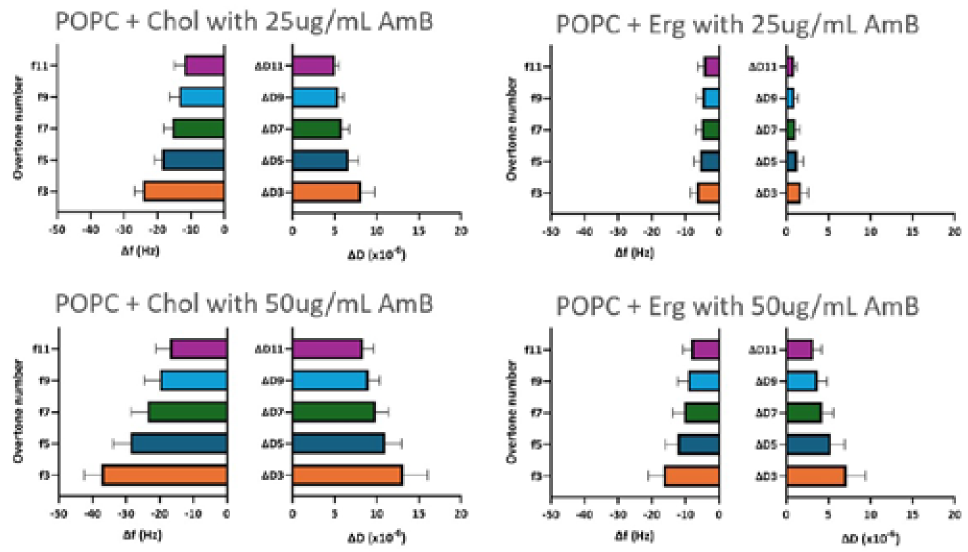


Figure 2: Bar charts for the addition of 25 µg/mL or 50 µg/mL AmB solutions with subsequent washing to ergosterol or cholesterol containing lipid bilayers.

(Fig. 1). Due to a similar response across all frequencies for low AmB concentration on an ergosterol-containing membrane, the data suggests AmB inserts into the membrane. In contrast, the extenuated response at higher frequencies for the other membrane compositions and higher AmB concentrations indicates AmB only binding to the surface (Fig. 2). This indicates that AmB activity we record on membranes depends on lipid composition and AmB concentration. This is consistent with the known mechanism of the drug, thus validating our approach to investigate the AmB/LFG synergy. In future experiments, we will explore even lower AmB concentrations, closer to the ones used in cell-based assays, and the effect of LFG on those AmB-induced changes in the membrane.

In addition to QCM, we are using NR at ANSTO to investigate how LFG-AmB synergy changes the structure and morphology of the membrane as well as the extent of water penetration into the membrane. An introduction of water into the membrane upon AmB and LFG addition indicates pore formation, whereas the change in ergosterol positioning could show the formation of membrane-associated aggregates. Deuteration of lipids and sterols allows us to observe the specific structures of AmB or LFG impact due to the contrast between hydrogenated and deuterated molecules. Comparison of a first set of volume fractions of samples with a bilayer of deuterated phospholipids (d-POPC) and deuterated ergosterol (d-Erg) of high substrate coverage (~97%) in the absence (Fig. 3A) and presence of 25 ug/mL AmB (Fig. 3B) shows that AmB thins the bilayer as shown by the narrower peak for the lipid tails, which is consistent with previously described effects of AmB (Kamiński, 2014). Current data with 25 µg/mL AmB and 200 µM LFG (Fig. 3C) shows no difference to AmB only. However, it has been shown that 100 times lower AmB

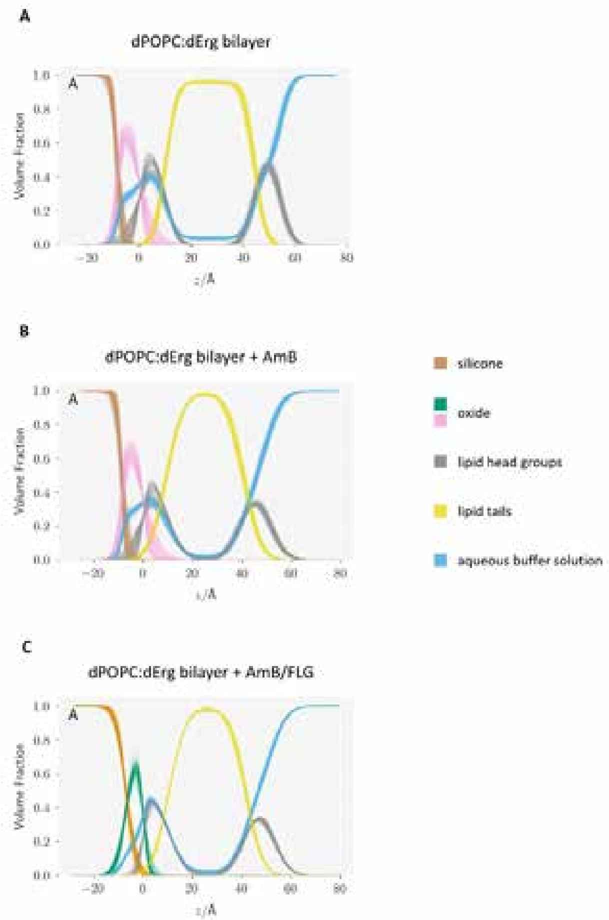


Figure 3: Volume fraction profiles of dPOPC:dErg bilayers. (A) dPOPC:dErg bilayer only. (B) dPOPC:dErg bilayer with AmB treatment. Treatment causes bilayer thinning and increased water at the headgroups. (C) dPOPC:dErg bilayer with AmB/LFG treatment. No apparent difference to AmB only, likely due to a 100x higher AmB concentration than known to cause changes in bilayer structure cholesterol containing lipid bilayers.

concentrations suffice to cause changes to membrane structure (Kamiński, 2014). A previously successful NR study (Delhom et al. 2020) used AmB concentration 40 times higher than our experiments at concentrations much closer to clinical applications. Thus, we are confident in trying even lower AmB concentrations to minimise a potential saturation of the system that could hide the impact of LFG on the membrane system in 2025.

Further, we are excited to return to the newly operational biological small angle X-ray scattering (BioSAXS) beamline at the Australian Synchrotron in 2025. AmB is highly insoluble in aqueous solutions and forms aggregates, and the aggregation state of AmB and the size of aggregates critically affect AmB toxicity, where the monomeric form is required for its pharmacological activity. This year's initial experiments tested this method's feasibility in investigating another aspect of the system. BioSAXS can be used to determine the structure, form, and average size of particles in solutions and will allow us to investigate the impact of LFG on the AmB aggregation in solution.

Lissy Hartmann is undertaking this research as part of a PhD in the Membrane Biophysics Group (MBG) at the University of Technology Sydney (UTS). The supervisory team includes the principal supervisor, A/Prof Charles Cranfield (UTS), the co-supervisor, Dr Evelyne Deplazes (University of Queensland), and the external supervisor, Dr Stephen Holt (ANSTO). Lissy and this research are supported by an Australian Government Research Training Program Scholarship and an AINSE Postgraduate Research Award (PGRA). Thanks to Prof Richard Payne and Dr Sameer Kulkarni for the LFG synthesis. The National Deuteration Facility is partly funded by the National Collaborative Research Infrastructure Strategy (NCRIS) – an Australian Government initiative. NR experiments were undertaken on Spatz at ANSTO (D/N16492) under the guidance of Dr Stephen Holt and Dr Robert Russell, who provided deuterated materials. BioSAXS experiments were conducted on the BSX beamline at the Australian Synchrotron, part of ANSTO (PA21519), with thanks to Dr Andrew Clulow for his support. Additional thanks go to Dr Anton LeBrun for his guidance on the QCM-D experiments. This independent research was supported by the Gilead Sciences Research Scholars Program in Anti-Fungals to Dr Evelyne Deplazes. We respectfully acknowledge the Dharawal nation at Lucas Heights, the Kulin nation at Clayton, and the Gadigal people of the Eora Nation at the UTS campus. We would also like to pay respect to the Elders, both past and present, acknowledging them as the traditional custodians of knowledge for these lands.

References:

Ben-Ami, R. & Kontoyiannis, DP 2021, 'Resistance to Antifungal Drugs', Infectious Disease Clinics of North America, vol. 35, pp. 279-311.

Casalini, G, Giacomelli, A, Antinori, S 2024, 'The WHO fungal priority pathogens list: a crucial reappraisal to review the prioritisation', The Lancet Microbe, vol. 5, pp. 717-724.

Cavassin, FB, Baú-Carneiro, JL, Vilas-Boas, RR, Queiroz-Telles, F 2021, 'Sixty years of amphotericin B: an overview of the main antifungal agent used to treat invasive fungal infections', Infectious Diseases and Therapy, vol. 10, pp. 115-147.

Delhom, R, Nelson, A, Laux, A, Haertlein, M, Knecht, W, Fragneto, G, Wacklin-Knecht, HP 2020, 'The Antifungal Mechanism of Amphotericin B Elucidated in Ergosterol and Cholesterol-Containing Membranes Using Neutron Reflectometry', Nanomaterials vol. 10, p. 2439.

Deolal, P, Mishra, K 2022, 'An adaptable live-cell imaging protocol to analyze organelle morphology in Saccharomyces cerevisiae', STAR Protocols vol. 3, p. 101124.

Fernandes, KE, Payne, RJ, Carter, DA 2020, 'Lactoferrin-derived peptide lactofungin is potently synergistic with amphotericin B', Antimicrobial Agents and Chemotherapy, vol. 64, p. e00842-00820.

Kamiński, DM 2014, 'Recent progress in the study of the interactions of amphotericin B with cholesterol and ergosterol in lipid environments', European Biophysics Journal, vol. 43, pp. 453-467.

Lee, JSF, Cohen, RM, Khan, RA, Burry, J, Casas, EC, Chung, HY, Costa, LH, Ford, N, Galvao, DLN, Giron, N, Jarvis, JN, Mondal, M, Odionyi, JJ, Casas, CP, Rangaraj, A, Rode, J, Ruffell, C, Sued, O, Ribeiro, I 2024, 'Paving the way for affordable and equitable liposomal amphotericin B access worldwide', The Lancet Global Health, vol. 12, pp. e1552-e1559.

Lewandowska, A, Soutar, CP, Greenwood, AI, Nimerovsky, E, De Lio, AM, Holler, JT, Hisao, GS, Khandelwal, A, Zhang, J, SantaMaria, AM, Schwieters, CD, Pogorelov, TV, Burke, MD, Rienstra, CM 2021, 'Fungicidal amphotericin B sponges are assemblies of staggered asymmetric homodimers encasing large void volumes', Nature Structural & Molecular Biology vol. 28, pp. 972-981.

Maji, A. et al. 2023, 'Tuning sterol extraction kinetics yields a renal-sparing polyene antifungal', Nature, vol. 623, pp. 1079-1085.

Mechler, A, Praporski, S, Atmuri, K, Boland, M, Separovic, F, Martin, LL 2007, 'Specific and Selective Peptide-Membrane Interactions Revealed Using Quartz Crystal Microbalance', Biophysical Journal, vol. 93, pp. 3907-3916.

World Health Organization 2022, WHO fungal priority pathogens list to guide research, development and public health action, World Health Organization (WHO): Geneva, Switzerland.

Biotechnology and Biomedical Sciences BBS

Understanding selective bacterial nutrient uptake through structural and functional analysis

Michael C. Newton-Vesty[1,2], Santosh Panjikar[3,4], Ashish Sethi[3], Andrew E. Whitten[5] & Renwick C.J. Dobson[1,2,*]

[1] MacDiarmid Institute for Advanced Materials and Nanotechnology, University of Canterbury, Christchurch, New Zealand

[2] Bio21 Molecular Science and Biotechnology Institute, University of Melbourne, Parkville, VIC, Australia

[3] Nuclear Science and Technology (NST), ANSTO, Clayton, VIC, Australia

[4] Monash University, Melbourne, VIC, Australia

[5] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia

Bacteria evolve mechanisms to compete for limited resources and survive in a diverse range of environments. A key to this versatility is their ability to acquire essential nutrients, often through highly specialised proteins embedded in their cell membranes, known as transporters.

Due to the production of toxic hydrogen sulfide, sulfate-reducing bacteria contribute to several human diseases including ulcerative colitis, irritable bowel syndrome and colorectal cancer (Singh et al. 2023). They are problematic in the energy industry due to the accelerated corrosion of machinery induced by hydrogen sulfide (Enning & Garrelfs, 2014), although they also hold the potential for bioremediation in environmental cleanup applications (Bagheri Novair et al. 2024). Understanding how these transport systems work offers valuable insights into fundamental processes in bacterial nutrient acquisition and reveals new targets for antimicrobial strategies. Specifically, we are investigating how the sulfate-reducing bacterium Oleidesulfovibrio alaskensis imports the nutrient isethionate to use as an energy source.

... sulfate-reducing bacteria contribute to several human diseases ...

O. alaskensis imports isethionate through a tripartite ATP-independent periplasmic (TRAP) transporter (IsePQM) (Peck et al. 2019). This system consists of a soluble substrate-binding protein (IseP) and a membrane-embedded component (IseQM), which uses an electrochemical Na^+ (sodium ion) gradient to transport the substrate. IseP is required to scavenge isethionate and deliver it to the membrane component (IseQM) for

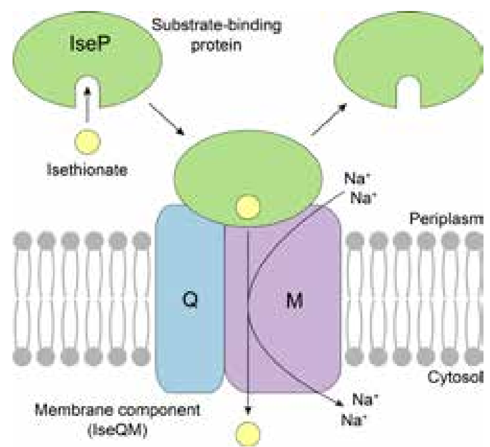


Figure 1: The isethionate TRAP transporter system utilises a substrate-binding protein (IseP, green) to capture isethionate (yellow) and deliver it to the membrane component (IseQM, blue and lilac) for transport into the cell.

Biotechnology and Biomedical Sciences BBS

transport into the cell (Fig. 1). The most widely studied TRAP transporters are specific to the nutrient sialic acid (Davies et al. 2023, Currie et al. 2024), while much less is known about those specific to other substrates (Davies et al. 2024, King-Hudson et al. 2024).

We first demonstrated that IseP is specific to isethionate by measuring its melting temperature in the presence of several sulfur-containing compounds. Isethionate was the only compound that considerably stabilised IseP, with a 6.5 °C increase in melting temperature (57.2 °C to 63.7 °C) compared to IseP in the absence of any compounds. We then used X-ray crystallography to determine high-resolution structures of IseP in unbound (open) and isethionate-bound (closed) conformations using ANSTO's Australian Synchrotron Macromolecular Crystallography MX2 beamline (Newton-Vesty et al. 2024). These structures allowed us to define the mechanism of isethionate binding, illustrating that in the presence of isethionate, the two domains of IseP fold over the substrate adopting a closed conformation similar to a 'Venus flytrap' (Fig. 2A). Isethionate binding is stabilised by the formation of specific interactions between both domains of IseP and isethionate, explaining the observed specificity towards isethionate (Fig. 2B and 2C).

We conducted small-angle X-ray scattering experiments at ANSTO's Australian Synchrotron, both with and without isethionate, to verify whether the conformations of IseP in solution were comparable to the crystal structures. The theoretical scattering profiles from the crystal structures were calculated and fitted to our experimental scattering data (Fig. 3). We found that the theoretical scattering profile of the IseP unbound crystal structure fits the experimental scattering data in the absence of isethionate better than that of the IseP isethionate-bound structure (Fig. 3). In comparison, the theoretical scattering profile of the IseP isethionate-bound crystal structure fits the experimental scattering data better in the presence of isethionate than that of the IseP unbound crystal structure. This data supports the conformational change upon isethionate binding is similar in solution to what was observed in the crystal structures of IseP.

Our investigation helps to expand the current understanding of TRAP transporters, shedding light on a system specific to isethionate (Newton-Vesty et al. 2024). With crystal structures of the substrate-binding protein (IseP) and mechanistic knowledge of isethionate binding, the next step will be to determine the structure of the membrane component (IseQM) as well as a model of how it interacts with IseP to transport isethionate. With the growing clinical relevance of sulfate-reducing bacteria, our work will help inform antibiotic development targeting isethionate transport as a means of inhibiting hydrogen sulfide production in biological and industrial settings.

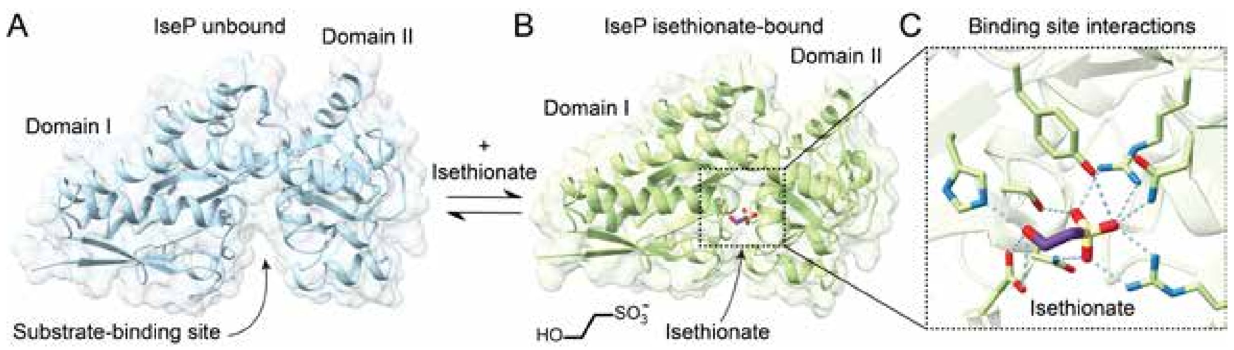


Figure 2: The crystal structures of IseP. A) The structure of IseP in the unbound conformation, with the substrate-binding site located between the two domains. B) The structure of IseP in the isethionate-bound conformation, where the domains have closed around isethionate in the substrate-binding site. C) The interactions formed when isethionate is bound to IseP.

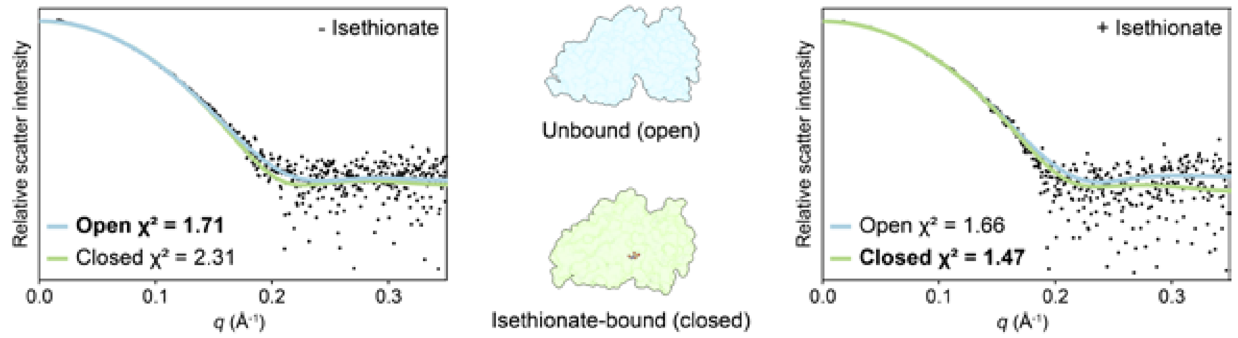


Figure 3: Small-angle X-ray scattering data for IseP in the absence (left) and presence (right) of isethionate. The theoretical scattering fits of the crystal structures are overlayed onto the experimental scattering data with corresponding χ2 values.

... our work will help inform antibiotic development targeting isethionate transport as a means of inhibiting hydrogen sulfide production in biological and industrial settings.

This project was supervised by Prof Renwick Dobson (University of Canterbury) and co-supervised by Dr Santosh Panjikar (ANSTO) and Dr Andrew Whitten (ANSTO). We would like to thank Dr Ashish Sethi (ANSTO) for his assistance with small-angle X-ray scattering data collection. This research was undertaken in part using the MX2 beamline, the BioSAXS beamline and made use of the Australian Cancer Research Foundation (ACRF) detector at the Australian Synchrotron, part of ANSTO. This research was supported by an AINSE Ltd. Postgraduate Research Award (PGRA) and a University of Canterbury Aho Hīnātore | Accelerator PhD Scholarship.

References:

Bagheri Novair, S, Biglari Quchan Atigh, Z, Asgari Lajayer, B, Shu, W & Price, GW 2024, 'The role of sulphate-reducing bacteria (SRB) in bioremediation of sulphate-rich wastewater: focus on the source of electron donors', Process Safety and Environmental Protection, vol. 184, pp. 190-207.

Currie, MJ, Davies, JS, Scalise, M, Gulati, A, Wright, JD, Newton-Vesty, MC, Abeysekera, GS, Subramanian, R, Wahlgren, WY, Friemann, R, Allison, JR, Mace, PD, Griffin, MDW Demeler, B, Wakatsuki, S, Drew, D, Indiveri, C, Dobson, RCJ & North, RA 2024, 'Structural and biophysical analysis of a *Haemophilus influenzae* tripartite ATP-independent periplasmic (TRAP) transporter', eLife, vol. 12.

Davies, JS, Currie, MJ, Dobson, RCJ, Horne, CR & North, RA 2024, 'TRAPs: the 'elevator-with-an-operator' mechanism', Trends in Biochemical Sciences, vol. 49, pp. 134-144.

Davies, JS, Currie, MJ, North, RA, Scalise, M, Wright, JD, Copping, JM, Remus, DM, Gulati, A, Morado, DR, Jamieson, SA, Newton-Vesty, MC, Abeysekera, GS, Ramaswamy, S, Friemann, R, Wakatsuki, S, Allison, JR, Indiveri, C, Drew, D, Mace, PD & Dobson, R CJ 2023, 'Structure and mechanism of a tripartite ATP-independent periplasmic TRAP transporter', Nature Communications, vol. 14, p. 1120.

Enning, D & Garrelfs, J 2014, 'Corrosion of iron by sulfate-reducing bacteria: new views of an old problem', Applied and Environmental Microbiology, vol. 80, pp. 1226-1236.

King-Hudson, T-RJ, Davies, JS, Quan, S, Currie, MJ, Tillett, ZD, Copping, J, Panjikar, S, Friemann, R, Allison, JR, North, RA & Dobson, RCJ 2024, 'On the function of TRAP substrate-binding proteins: conformational variation of the sialic acid binding protein SiaP', Journal of Biological Chemistry, vol. 300, p. 107851.

Newton-Vesty, MC, Currie, MJ, Davies, JS, Panjikar, S, Sethi, A, Whitten, AE, Tillett, ZD, Wood, DM, Wright, JD, Love, MJ, Allison, TM, Jamieson, SA, Mace, PD, North, RA, Dobson, RCJ 2024, 'On the function of TRAP substrate-binding proteins: the isethionate-specific binding protein IseP', Biochemical Journal, vol. 481, pp. 1901-1920.

Peck, SC, Denger, K, Burrichter, A, Irwin, SM, Balskus, EP & Schleheck, D 2019, 'A glycyl radical enzyme enables hydrogen sulfide production by the human intestinal bacterium *Bilophila wadsworthia*', Proceedings of the National Academy of Sciences USA, vol. 116, pp. 3171-3176.

Singh, SB, Carroll-Portillo, A & Lin, HC 2023, '*Desulfovibrio* in the gut: the enemy within?' Microorganisms, vol. 11, p. 1772.

Biotechnology and Biomedical Sciences BBS

Development of non-toxic glycosylation inhibitors to enhance cancer radiotherapy

Rebecca E. Farrell[1], Harrison Steele[1], Ryan J. Middleton[2], Danielle Skropeta[1], Guo-Jun Liu[2,3].

[1] University of Wollongong. Wollongong, NSW, Australia.
[2] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia.
[3] The University of Sydney, Sydney, NSW, Australia.

Radiotherapy is one of the most extensively used cancer therapies alongside surgery, chemotherapy and immunotherapy. Half of all cancer patients in Australia receive radiotherapy due to its cost effectiveness and applicability towards a variety of tumour types (Barton et al. 2014).

However, several cancers show resistance to radiotherapy. It has been observed for several decades that tumour cells overexpress a sugar called sialic acid on the cell surface in a process known as hypersialylation. This process promotes metastasis (cancer cells spreading from the primary site to other parts of the body), angiogenesis (new blood vessels forming from pre-existing ones) and therapy resistance (Dobie & Skropeta 2021). One mechanism of hypersialylation is the overexpression of sialyltransferases (STs), the enzymes which catalyse the addition of sialic acid onto the cell surface. Previous studies have identified hypersialylation as a potential promoter of radiotherapy resistance, and therefore we wanted to explore ST inhibitors as novel radiosensitising agents (Lee et al. 2008; Lee et al. 2010; Smithson et al. 2022).

The Skropeta Lab at the University of Wollongong has developed several selective ST inhibitors targeting the ST6GAL1 subtype (Dobie et al. 2021). To advance these compounds toward clinical use, enhancing cell membrane permeability is essential, as they possess negatively charged phosphonate groups that can hinder cellular uptake (Fig. 1A). Therefore, several phosphonate prodrug derivatives of the ST inhibitors were synthesised where the prodrug groups mask

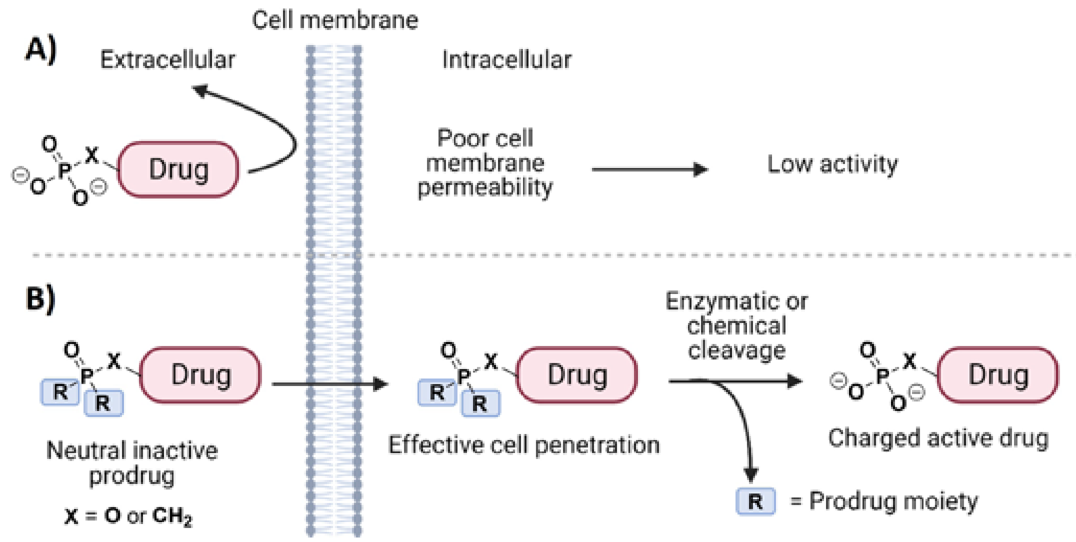


Figure 1: Representation of the prodrug concept. A) Phosph(on)ate is deprotonated at physiological pH resulting in poor membrane permeability. B) Neutral phosph(on)ate prodrug allows for efficient cell membrane permeability before being cleaved intracellularly into the charged active drug. Created with https://Biorender.com.

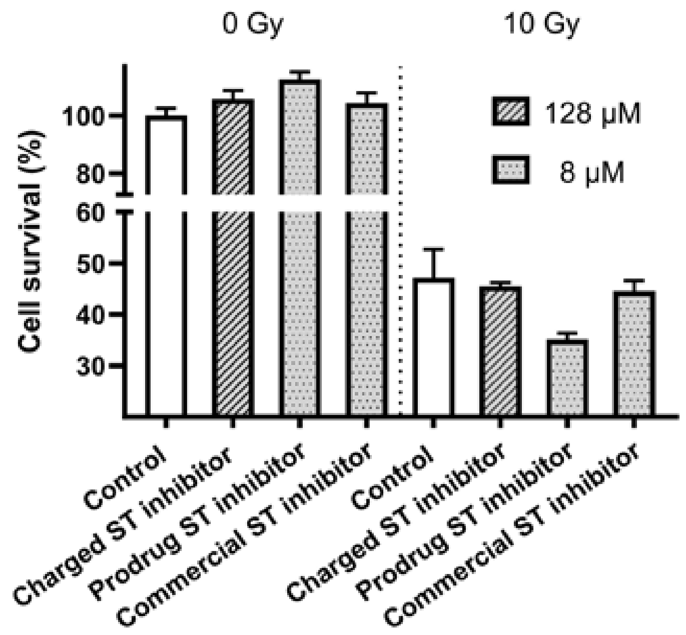


Figure 2: Radiosensitisation of BxCP3 cells by phosphonate prodrug sialyltransferase (ST) inhibitor. Cells were treated with 0 Gy or 10 Gy of radiation, with or without ST inhibitors. Cell viability was assessed five days post-irradiation using a CyQUANT assay. The prodrug ST inhibitor showed greater sensitisation than its charged analogue or the commercially available ST inhibitor 3Fax-Neu5Ac.

this negative charge, allowing the drug to cross the cell membrane. Then once inside the cell, these prodrug groups are cleaved to release the active drug (Fig. 1B).

We evaluated several prodrug ST inhibitors for their ability to sensitize human pancreatic cancer BxPC3 cells, a radioresistant cell line with high ST expression. We also tested the charged ST inhibitor with no prodrug, as well as a commercially available, non-selective ST inhibitor 3Fax-Peracetyl Neu5Ac. The cell lines were treated with the inhibitors and some cells received an additional treatment of 10 Gy radiation. Five days post-irradiation cell viability was determined using a CyQUANT cell proliferation assay. As shown in Figure 2, radiation alone reduced cell viability to 47%, however this was further enhanced by treatment with 8 µM of prodrug ST inhibitor which reduced viability to 35%. In comparison, the commercial ST inhibitor produced no significant radiosensitisation at 8 µM. Similarly, the non-prodrug ST inhibitor did not sensitise the cells even when used at significantly higher concentrations (128 µM) (Fig. 2). These preliminary results show promising potential for ST inhibitors to be used as radiosensitisers using a phosphonate prodrug strategy. Future work will continue to explore other ST inhibitors being developed by the Skropeta lab, expand the number of cancer types explored, and look at these inhibitors in combination with chemotherapy or chemoradiotherapy. Overall, this work contributes to the vital need for safer drugs to overcome therapy resistant cancers.

Intriguingly, one prodrug ST inhibitor showed significant cytotoxicity compared to other prodrug inhibitors, despite them both

... radiation alone reduced cell viability to 47%...enhanced by treatment with 8 µM of prodrug ST inhibitor which reduced viability to 35%.

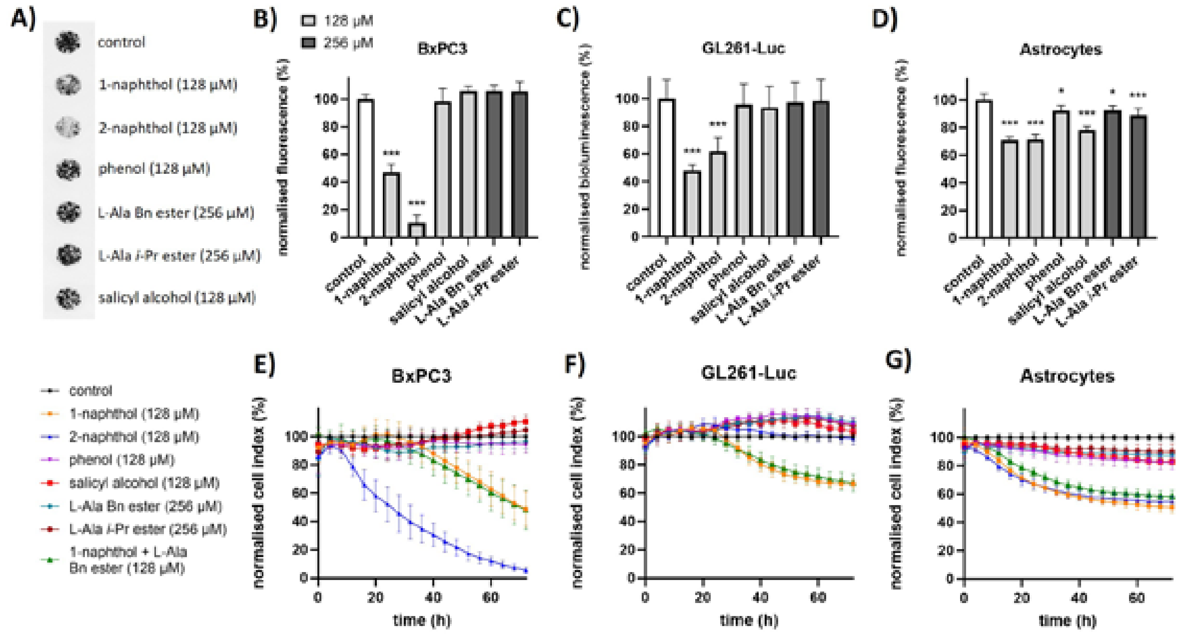


*Figure 3: Evaluation of the viability of BxPC3, GL261-Luc and primary mouse astrocytes treated with prodrug moieties. A) Fluorescence image of BxPC3 cells treated with prodrug moieties for 72 hours and then measured with CyQUANT. The image was produced using the Amersham™ Typhoon 5™. B) and D) cell viability measured 72 hours after treatment using CyQUANT assay. Fluorescence readings were quantified using ImageQuant™ TL and normalised to the control. C) Viability measured by luciferase assay 72 hours after treatment where luminescence was measured by plate reader and normalised to the control. E–G) Time-course of cell index reflecting viability over 72 hours using the xCELLigence system. The cell index measurements were taken every hour and normalised to the control. Statistical significance is shown relative to the control. * p ≤0.05, ** p ≤ 0.01, *** p ≤ 0.001. Data is shown as mean ± S.D of three independent experiments.*

We also performed real-time xCELLigence experiments which showed the healthy cells were affected by the prodrugs in as little as 4 hours.

sharing the same parent scaffold. This was unexpected as targeting sialylation should not have cytotoxic effects. We then hypothesised that the metabolites generated upon liberation of the prodrug may be cytotoxic. To investigate this further we performed the first evaluation of the potential cytotoxicity of currently used phosph(on)ate prodrugs including phosphoramidate, bis-amidate and cycloSal prodrugs (Farrell et al. 2024). These metabolites included 1-naphthol, 2-naphthol, phenol, L-alanine benzyl and isopropyl ester, and salicyl alcohol. We tested these metabolites on tumour cell lines including BxPC3 human pancreatic cancer cells, and GL261-Luc mouse glioblastoma cells. To determine the toxicity of the prodrugs on healthy cells, we also explored their toxicity on primary cultured mouse astrocytes as a healthy control.

Using CyQUANT viability assays it was found that 2-naphthol had significant toxicity on BxPC3 cells (ED50 = 21 µM) while 1-naphthol was less toxic (ED50 = 82 µM) (Fig. 3B). Interestingly, on GL261-Luc cells the reverse was found where 1-napthol showed greater toxicity than 2-naphthol. This was further supported by caspase 3/7 activation experiments to measure apoptosis (programmed cell death for targeted cells only) (Fig. 3C). The other prodrugs showed no significant toxicity on the tumour cell lines but when tested on primary cultured mouse astrocytes as a healthy control, all prodrugs showed significant toxicity at 128 to 256 μM (Fig. 3D). We also performed real-time xCELLigence experiments which showed the healthy cells were affected by the prodrugs in as little as 4 hours (Fig. 3G). These results show that there is a cell-type-dependent sensitivity to phosph(on)ate prodrug metabolites, with normal cells showing greater susceptibility than corresponding tumour cells. The findings of this study will guide the selection of non-toxic prodrugs for ST inhibitors as we continue to explore their potential to enhance cancer therapy. Additionally, these results offer valuable insights applicable beyond ST inhibitors by encouraging drug development programs to consider the off-target effects of their prodrug metabolites to produce safer drugs with fewer side effects.

This research was conducted as part of Rebecca's PhD under the primary supervision of Prof. Danielle Skropeta. Biological experiments were performed under the guidance of ANSTO co-supervisors Prof. Guo-Jun Liu and Dr. Ryan Middleton. Rebecca is supported by an Australian Government Research Training Program (RTP) scholarship and AINSE Ltd. Postgraduate Research Award (PGRA).

References:

Barton, MB, Jacob, S, Shafiq, J, Wong, J, Thompson, SR, Hanna, TP & Delaney, GP 2014, 'Estimating the demand for radiotherapy from the evidence: a review of changes from 2003 to 2012', Radiotherapy and Oncology, vol. 112, no. 1, pp. 140-144.

Dobie, C, Montgomery, AP, Szabo, R, Yu, H & Skropeta, D 2021, 'Synthesis and biological evaluation of selective phosphonate-bearing 1,2,3-triazole-linked sialyltransferase inhibitors', RSC Medicinal Chemistry, vol. 12: no. 10, pp. 1680-1689.

Dobie, C & Skropeta, D 2021, 'Insights into the role of sialylation in cancer progression and metastasis', British Journal of Cancer, vol. 124, no. 1, pp. 76-90.

Farrell, RE, Steele, H, Middleton, RJ, Skropeta, D & Liu, G-J 2024, 'Cytotoxicity of phosphoramidate, bis-amidate and cycloSal prodrug metabolites against tumour and normal cells', RSC Medicinal Chemistry, vol. 15, pp. 1973-1981.

Lee, M, Lee, H-J, Bae, S & Lee, Y-S 2008, 'Protein sialylation by sialyltransferase involves radiation resistance', Molecular Cancer Research, vol. 6, no. 8, pp. 1316-1325.

Lee, M, Lee, H-J, Seo, WD, Park, HK & Lee, Y-S 2010, 'Sialylation of integrin beta-1 is involved in radiation-induced adhesion and migration in human colon cancer cells', International Journal of Radiatiation Oncology – Biology - Physics, vol. 76, no. 5, pp. 1528-1536.

Smithson, Mary, Regina Irwin, Gregory Williams, Katie L. Alexander, Lesley E. Smythies, Marie Nearing, M. Chandler McLeod, Sameer Al Diffalha, Susan L. Bellis, and Karin M. Hardiman. 2022. 'Sialyltransferase ST6GAL-1 mediates resistance to chemoradiation in rectal cancer', J. Biol. Chem., vol. 298, p. 101594.

Thermo-electro-magnetic coupling for enhanced thermoelectricity

Kyle Portwin[1,2], Zhenxiang Cheng[2], Roger Lewis[1], Kirrily Rule[1,3], David Cortie[3], Pablo Galaviz[3], Caleb Stamper[1,2], Dehong Yu[3], Richard Mole[3], Rezoan Rahman[1,2]

[1] University of Wollongong, Wollongong, NSW, Australia
[2] University of Wollongong, North Wollongong, NSW, Australia
[3] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia

Effectively managing thermal energy lost as waste heat is a critical challenge in addressing the global energy crisis. Industrial processes and energy systems release significant amounts of heat into the environment, representing an untapped resource. Waste heat recovery, which involves capturing and repurposing this thermal energy, offers a sustainable pathway to improve energy efficiency and reduce reliance on fossil fuels.

Thermoelectric materials have emerged as a promising technology for harvesting this waste heat. These materials convert temperature gradients into electrical energy through the Seebeck effect (the generation of an electric potential across two different conductors or semi-conductors), enabling efficient recovery of thermal energy. Recent advancements have shown that incorporating nanoparticles can enhance thermoelectric performance by optimising electron and phonon transport. Additionally, magnetic nanoparticles introduce a supplementary degree of freedom (magnetism) for further optimisation, allowing researchers to explore new mechanisms for improving thermoelectric efficiency (Sun et al. 2021; Zhao & Xiao 2021; Yang et al. 2023; Liu et al. 2023).

My research focuses on understanding and leveraging the interactions between magnetic nanoparticles and thermoelectric materials to enhance performance. These systems are complex due to the interplay of electrons, phonons (quantised lattice vibrations), and magnons (quantised spin waves). Electrons can couple with both phonons and magnons, while phonons and magnons can also interact independently. This results in a coupled system where these three entities influence one another, collectively impacting thermoelectric properties. Deciphering these interactions is crucial for developing advanced thermoelectric materials with multiple pathways for optimisation.

Techniques such as inelastic neutron scattering (INS) and density functional theory (DFT) are key to understanding fundamental quasiparticle interactions. Time-of-flight INS, capable of capturing excitations over the whole Brillouin zone (exempt from selection rules), is an extremely powerful tool to identify quasiparticle broadening and softening,

We showed that embedding magnetic nanoparticles in thermoelectric materials creates exotic quasiparticle states...

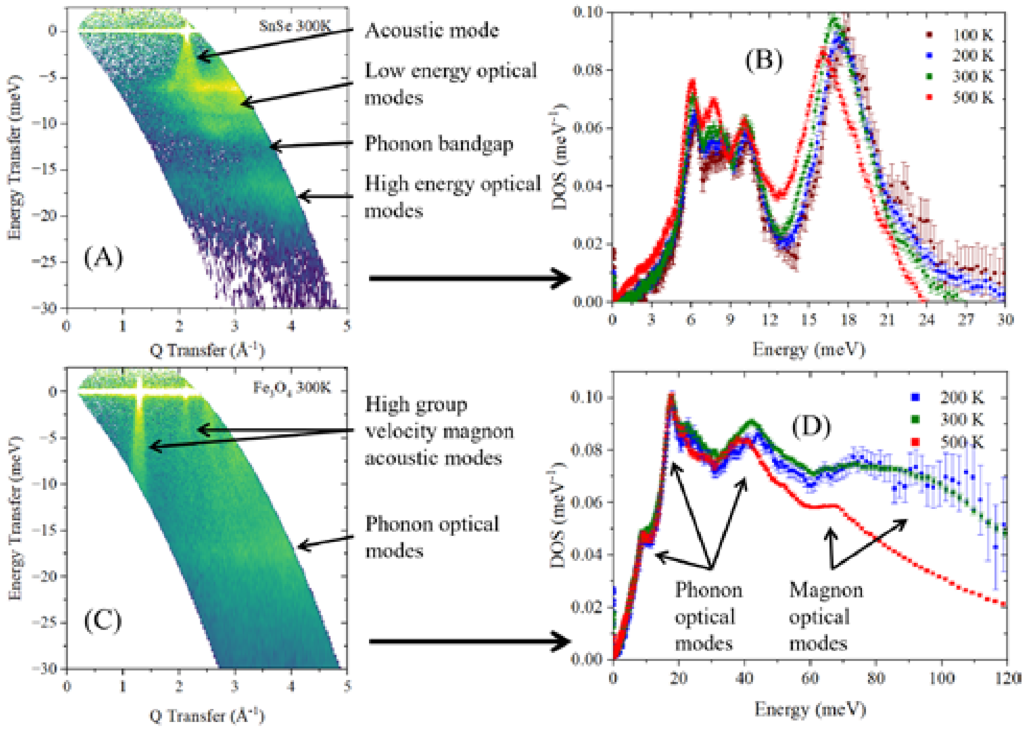


Figure 1: Time-of-flight INS. (A) 2D S(Q,ω) map in energy and reciprocal space, providing a polycrystalline convoluted visual of phonon modes in SnSe, different regions of the spectrum have been labelled. (B) Temperature dependent density of states (DOS), i.e. number of excitations per unit energy, for SnSe from 100 K- 500 K showing softening of high energy modes and broadening of optical phonons. (C) 2D S(Q,ω) map showing phonon and magnons modes in Fe_3O_4 nanoparticles. (D) Temperature dependent DOS for Fe_3O_4 highlighting the phonon and magnon optical modes.

which are indicators of decreasing lifetimes, structural/magnetic transitions, and coupling.

The excitation group velocity can also be directly extracted from the slope of dispersions. This provides valuable insights into the mechanisms that govern thermo-electro-magnetic coupling in these systems.

One of the key materials in my research is tin selenide (SnSe), known for its exceptional thermoelectric properties. SnSe exhibits an ultralow thermal conductivity, making it one of the most efficient thermoelectric materials. In my recently published work (Portwin et al. 2024), I utilise time-of-flight INS and DFT calculations to study the finite-temperature dynamics and role of dispersion interactions in SnSe. Upon heating, time-of-flight INS revealed a significant broadening of phonon modes (decreased phonon lifetimes) and a softening effect where modes are shifted to lower energies, which is indicative of extreme phonon anharmonicity (Fig. 1A-B) and (Fig. 1C-D). We find that the softening and broadening of optical modes results in a decreased phonon group velocity, as acoustic modes are squeezed into a smaller region of phase space.

Magnetite (Fe_3O_4) nanoparticles are promising candidates for integration with thermoelectric materials due to their high magnetic moment, coercivity and Curie temperature. Fe_3O_4 also enters a superparamagnetic state when the nanoparticles are reduced below a threshold diameter. Here, each nanoparticle acts as its own magnetic domain, capable of spontaneous spin flipping. These properties make Fe_3O_4 ideal for inducing different thermo-electro-magnetic effects that can influence electron transport behaviours and enhance phonon scattering. In time-of-flight INS we identified high group velocity magnon modes in Fe_3O_4 nanoparticles along with optical phonons and magnons (Fig. 1(C), Fig. 1 (D)). At higher temperatures, we see a decrease in the intensity of optical magnon modes as the ordered spins become overpowered by thermal fluctuations.

Building on this foundation, composites have been designed by embedding Fe_3O_4 nanoparticles into the SnSe thermoelectric matrix (Fig. 2). Analysis of the S(Q,ω) and density of states (DOS) reveals dramatic changes compared to raw samples of SnSe or Fe_3O_4 alone. Specifically, neutron scattering

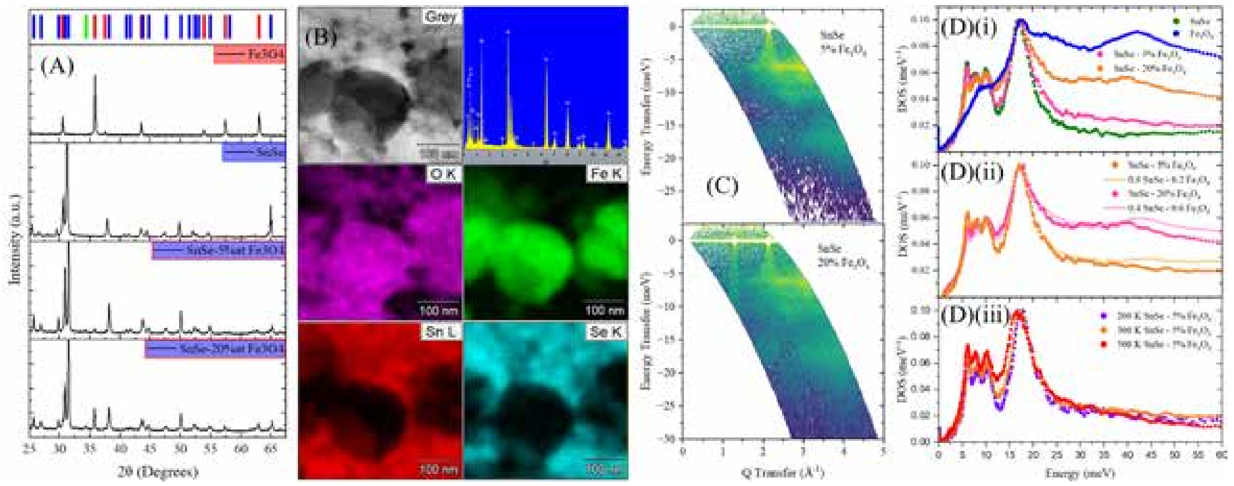


Figure 2: Magnetic thermoelectric composite. (A) X-ray diffraction patterns of the base materials and composites, with the phases SnSe (blue) and Fe_3O_4 (red) shown above. The green phase is SnO. (B) Electron dispersive spectroscopy maps, showing Fe_3O_4 nanoparticles embedded in the SnSe matrix. SnO is also present at the boundaries of the nanoparticles. (C) S(Q,ω) maps of the composite thermoelectrics, with the highly dispersive SnSe phonons, high group velocity Fe_3O_4 magnons and the hybrid optical modes. (D) DOS data for i) the raw materials and composites, showing the intense broadening of the high energy SnSe optical modes, ii) composite DOS plotted with a superposition of SnSe and Fe_3O_4 DOS, note that the amount of Fe_3O_4 needed in the superposition to even come close to matching the data is much higher than the actual concentration, and iii) temperature dependence of the SnSe - 5% Fe_3O_4 composite, where characteristic softening and broadening is still present.

Magnetite (Fe_3O_4) nanoparticles are promising candidates for integration with thermoelectric materials...

data showed that SnSe modes significantly broadened in these composites, especially in the high energy regime—a phenomenon not observed as a simple superposition of the individual components. This suggests that hybrid phonon-magnon modes have likely been created within the composite material. These hybrid modes could have implications for electrical conductivity and thermal transport properties by introducing new pathways for energy transfer, which will be explored by the completion of my PhD.

My research demonstrates how combining magnetic nanoparticles with thermoelectric materials offers a novel approach to optimising waste heat recovery technologies. By unravelling the coupling between electrons, phonons, and magnons in these systems, I aim to develop advanced materials capable of more efficient energy conversion.

This work would not have been possible without the guidance and support from my supervisors Prof. Zhenxiang Cheng (UOW), Prof. Kirrily Rule (ANSTO, UOW), Dr. David Cortie (ANSTO), Dr. Pablo Galaviz (ANSTO) and Prof. Roger Lewis (UOW), as well as other PhD students, Caleb Stamper (UOW) and Rezoan Rahman (UOW), and ANSTO instrument scientists, Dr. Richard Mole (ANSTO) and Dr. Dehong Yu (ANSTO). This work was supported by the Australian Research Council, the Australian Government Research Training Program stipend, and a Postgraduate Research Award (PGRA) from AINSE.

References:

Sun, F-H, Ma, S, Zhao, W, Li, C, Sang, X, Wei, P & Zhang, Q 2021, 'Magnetically enhanced thermoelectrics: a comprehensive review', Reports on Progress in Physics, vol. 84, no. 9, p. 096501.

Zhao, C-C & Xiao, C, 2021, 'When thermoelectric materials come across with magnetism', Rare Metals, vol. 40, no. 4, pp. 752-766.

Yang, G, Sang, L, Zhang, C, Ye, N, Hamilton, A, Fuhrer, MS & Wang, X 2023, 'The role of spin in thermoelectricity', Nature Reviews Physics, vol. 5, no. 8, pp. 466-482.

Liu, S, Chen, M, Fu, C & Zhu, T 2023, 'The Interplay of Magnetism and Thermoelectricity: A Review', Advanced Physics Research, vol. 2, no. 9, p. 2300015.

Portwin, KA, Galaviz, P, Stamper, C, Kutteh, R, Yu, D, Cheng, ZX, Cortie, DL & Rule, K 2024, 'Role of finite-temperature dynamics and dispersion interactions on the phonon bandgap in thermoelectric SnSe', Physical Review B, vol. 110, no. 9, p. 094311.

The role of pyridine-based co-crystals in Titan's chemistry

Larissa Lopes Cavalcante[1], Helen Maynard-Casely[2], Robert Hodyss[3], Morgan Cable[3], Edith Fayolle[3], Tuan Vu[3], Courtney Ennis[1,4].

[1] University of Otago, Dunedin, New Zealand
[2] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia
[3] Jet Propulsion Laboratory, California Institute of Technology, California, United States of America
[4] MacDiarmid Institute for Advanced Materials and Nanotechnology, Wellington, New Zealand.

Exploring the chemistry occurring within different planetary systems provides valuable insights into the origins of life on Earth and beyond. Titan, Saturn's largest moon, has received increased attention due to its complex and dense atmosphere rich in over 20 different organic molecules (Fig.1; Hörst 2017, Nixon 2024, Yu et al. 2024).

These compounds are formed under extreme physical conditions that provides a unique environment for studying chemical pathways that may resemble those on early Earth (Raulin et al. 2012). Among the organic species present, nitrogen-containing compounds are of particular interest due to their potential role in forming prebiotic molecules (He & Smith 2014) that foster the growth of microorganisms.

Recent studies suggest that Titan's unique temperature profile and atmospheric composition create conditions favorable to forming co-crystals, structures composed of two or more compounds in a fixed stoichiometry and arrangement (e.g. Cable et al. 2021 and references therein). The proximity and interaction of the molecules within these structures is thought to play a crucial role in the chemical evolution of organic molecules, potentially acting as reservoirs or intermediates in the formation of biologically-relevant precursors (Gudipati et al. 2013; Couturier-Tamburelli et al. 2015). Using different techniques including neutron and X-ray diffraction, infrared and Raman spectroscopy, mass spectrometry and computational simulations, our group aims to characterize these molecular crystals and uncover pathways to prebiotic molecules that contribute to Titan's chemical complexity.

> *The proximity and interaction of the molecules within these structures is thought to play a crucial role in the chemical evolution of organic molecules...*

Pyridine, a nitrogen-containing aromatic compound, is hypothesized to be present in Titan's atmosphere (Nixon et al. 2020), where it could interact with other molecules to form stable crystalline structures. Its importance as a nucleobase precursor and its known interactions with hydrocarbons like acetylene (Rap et al. 2022) have drawn attention as a favorable co-crystal component (Czaplinski

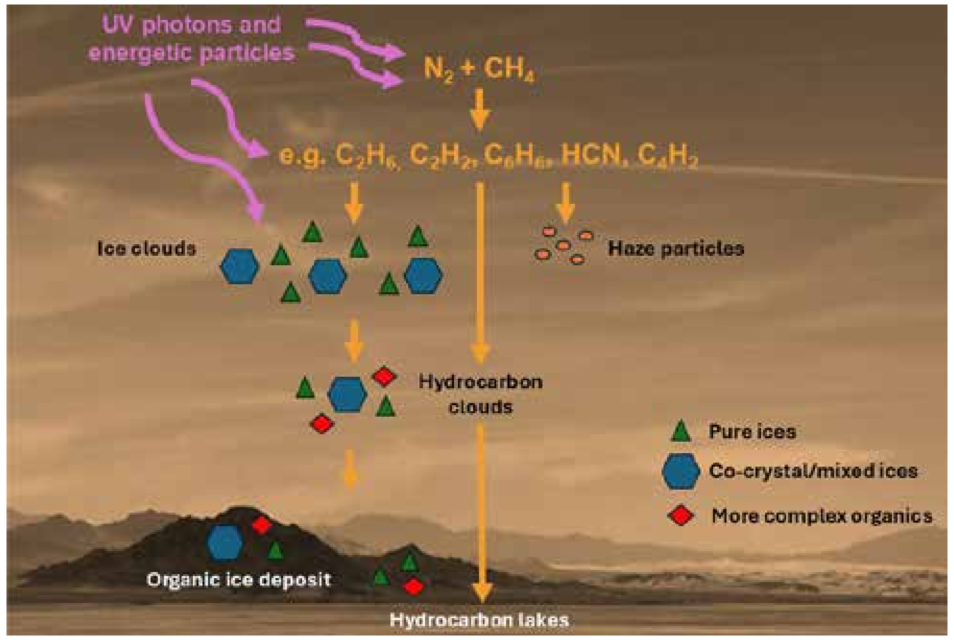


Figure 1: The atmospheric processes on Titan and subsequent deposit of molecular ices and complex organic compounds to the surface. Background image credit: Larissa Lopes Cavalcante.

et al. 2023). In this context, my PhD research focuses on pyridine-based co-crystals, particularly those containing Titan's major atmospheric components, such as acetylene, diacetylene, ethane and acrylonitrile.

The pyridine:acetylene system is particularly noteworthy, where previous experiments have demonstrated that it forms and remains stable under simulated Titan conditions (Czaplinski et al., 2023). Here, to investigate its potential reactivity, we exposed the pyridine:acetylene amorphous and crystalline ices to vacuum-ultraviolet (VUV) irradiation using a high-vacuum chamber at the University of Otago, simulating the exposure to energetic particles in Titan's atmosphere (Lopes Cavalcante et al. 2024). Our experiments revealed the formation of nitrogen-containing polycyclic aromatic hydrocarbons (NPAHs), such as quinolizinium and ethynylpyridines, which might serve as intermediates for more complex organic compounds. Furthermore, when in the stable co-crystal arrangement, this system showed less reactivity, indicating likely preservation of pyridine and acetylene. We conclude that, when stable, both molecules within the co-crystal could be preserved and descend towards Titan's surface, potentially depositing in environments conducive to prebiotic chemistry.

Analogously, the pyridine:diacetylene system has also been explored for its relevance to Titan's chemistry. Diacetylene, a hydrocarbon abundant in Titan's atmosphere, is critical for understanding the formation of higher-order molecules (Zhou et al. 2009). However, studying diacetylene poses significant challenges due to its instability and tendency to polymerize. To address these obstacles, an advanced gas delivery system tailored

> *...when in the stable co-crystal arrangement, this system showed less reactivity, indicating likely preservation of pyridine and acetylene.*

Figure 2: Transfer of synthesised diacetylene to the vanadium can on the WOMBAT neutron diffractometer using the designed gas lines at the Australian Centre for Neutron Scattering (ACNS) in March/2023. Image credit: Helen Maynard-Casely.

for neutron diffraction experiments was developed at ANSTO's Australian Centre for Neutron Scattering (ACNS) by the sample environment team. This innovative setup enabled the precise delivery of hazardous gases such as diacetylene, while protecting them from atmospheric exposure (Fig. 2).

Combining the neutron diffraction patterns taken in the WOMBAT beamline at ANSTO's Australian Centre for Neutron Scattering (ACNS) with X-ray diffraction experiments performed at the University of Sydney and Raman spectra collected at the Jet Propulsion Laboratory (JPL), California Institute of Technology, we were able to resolve the pure diacetylene crystal structure under cryogenic conditions relevant to Titan (Lopes Cavalcante et al. In prep).

The success of this experimental setup established a foundation for future studies on the formation of co-crystals involving flammable, toxic and reactive molecules at Titan-relevant temperatures, including diacetylene and pyridine. Further experiments on pyridine mixed with diacetylene using X-ray diffraction were done at JPL. Our results indicate the formation of a new crystalline phase, which supports previous infrared spectroscopic findings, potentially a new Titan-relevant co-crystal.

In addition to the pyridine:acetylene and pyridine:diacetylene systems, investigations were conducted on mixtures of pyridine with ethane and acrylonitrile. Here, neutron diffraction studies indicated the presence of a new phase in both systems, where complementary investigations using Raman spectroscopy and X-ray diffraction refined these insights. Our data show that the presence of both ethane and acrylonitrile induced an unexpected phase transition in pyridine rather than the formation of a co-crystal (Fig. 3).

Together, these findings not only enhance our comprehension of Titan's unique environment but also contribute to the broader

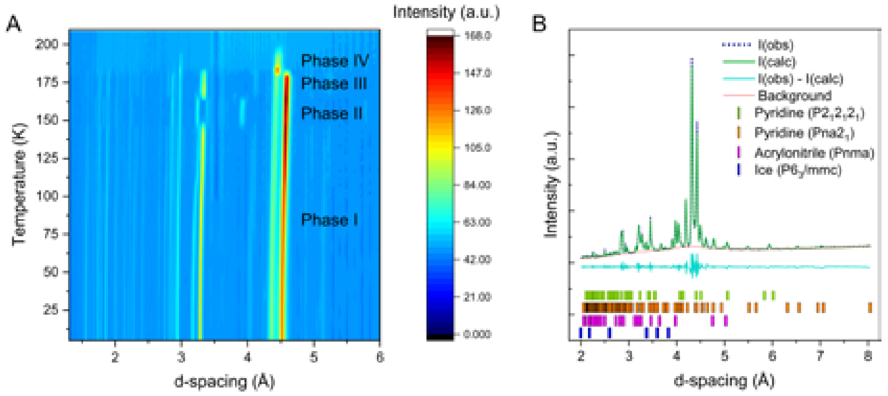


Figure 3: (A) Thermodiffractogram of variable temperature neutron powder diffraction data from 5 to 210 K collected on the pyridine:acrylonitrile (1:1) mixture. Four different phases can be seen in the thermodiffractogram, with phase transitions at 147, 165 and 183 K. (B) Diffraction pattern of a 3:1 mixture of pyridine and acrylonitrile collected at 90 K (blue dot) and its Rietveld refinement with Le Bail intensity extraction (green). The residual fit between the observed and calculated patterns is shown in light blue. The tick marks denote the reflections for the space groups used in the refinement: P212121 (light green) and Pna21 (orange) for pyridine, Pnma (magenta) for the known structure of one of the phases of acrylonitrile, and P63/mmc for water ice. The latter accounts for the small amount of water frost condensed outside the capillary.

understanding of the origins of life across the solar system. In this context, pyridine-based mixed ices, with their potential to form nucleobase precursors and other essential organic molecules, represent a pathway toward understanding how life's building blocks may emerge. Contrastingly, the co-crystal stability under Titan's harsh conditions suggests these structures could preserve organic compounds over geological timescales and facilitate their delivery to environments suitable for prebiotic chemistry. Our results have particular relevance for upcoming missions such as NASA's Dragonfly, which will explore this moon's surface and investigate its chemical and astrobiological potential (Lorenz et al. 2018).

This research is supported by the Marsden Fund Council from Government New Zealand funding, managed by Royal Society Te Apārangi (Proposal: 21-UOO-123), and by an AINSE Ltd. Postgraduate Research Award (PGRA). Dr. Courtney Ennis (University of Otago) is the PI in the project and Larissa's PhD primary supervisor. Dr. Helen Maynard-Casely (ANSTO) is a collaborator in the Marsden project and Larissa's AINSE supervisor. Dr. Robert Hodyss (JPL) and Dr. Morgan Cable (JPL) are collaborators in the Marsden project, and they also acted as mentors in Larissa's JPL Visiting Student Research Programme (JVSRP). During the JVSRP, Dr. Edith Fayolle (JPL) and Dr. Tuan Vu (JPL) were her co-mentors.

We thank Prof. Brendan Kennedy (University of Sydney), Dr. Samuel Duyker (University of Sydney), Dr. Ellen Czaplinski (JPL) and Dr. Naila Chaouche (University of Otago) for their additional contributions to the project. We also thank New Zealand eScience Infrastructure (NeSI) for high-performance computing resources (Project UOO03077). We acknowledge the Australian Centre for Neutron Scattering for provision of instrument through program proposal 13601. Part of this work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (80NM0018D0004). Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.

References:

Cable, ML, Runčevski, T, Maynard-Casely, HE, Vu, TH & Hodyss, R 2021, 'Titan in a Test Tube: Organic Co-crystals and Implications for Titan Mineralogy', Accounts of Chemical Research, vol. 54, pp. 3050-3059.

Couturier-Tamburelli, I, Piétri, N & Gudipati, M 2015, 'Simulation of Titan's atmospheric photochemistry', Astronomy & Astrophysics, vol. 578, pp. 111-119.

Czaplinski, EC, Vu, TH, Cable, ML, Choukroun, M, Malaska, MJ & Hodyss, R 2023, 'Experimental Characterization of the Pyridine:Acetylene Co-crystal and Implications for Titan's Surface', ACS Earth and Space Chemistry, vol. 7, pp. 597-608.

Gudipati, M, Jacovi, R, Couturier-Tamburelli, I, Lignell, A & Allen, M 2013, 'Photochemical activity of Titan's low-altitude condensed haze', Nature Communications, vol. 4, p. 1648.

He, C & Smith, MA 2014, 'Identification of nitrogenous organic species in Titan aerosols analogs: Implication for prebiotic chemistry on Titan and early Earth', Icarus, vol. 238, pp. 86-92.

Hörst, SM 2017, 'Titan's atmosphere and climate', Journal of Geophysical Research: Planets, vol. 122, pp. 432-482.

Cavalcante, LL, Czaplinski, EC, Maynard-Casely, HE, Cable, ML, Chaouche-Mechidal, N, Hodyss, R & Ennis, C 2024, 'Vacuum-ultraviolet irradiation of pyridine:acetylene ices relevant to Titan astrochemistry', Physical Chemistry Chemical Physics, vol. 26, pp. 26842-26856.

Cavalcante, LL, Cable, ML, Duyker, S, Fayolle, E, Hodyss, R, Kennedy, B, Vu, T, Ennis, C, Maynard-Casely, HE, In preparation for submission to International Union of Crystallography Journal, 'Crystal structure of 1,3-butadiyne unveiled by X-ray and neutron diffraction, Raman spectroscopy and periodic-DFT'.

Lorenz, RD, Turtle, EP, Barnes, JW, Trainer, MG, Adams, DS, Hibbard, KE, Sheldon, CZ, Zacny, K, Peplowski, PN, Lawrence, DJ et al. 2018, 'Dragonfly: A rotorcraft lander concept for scientific exploration at Titan', Johns Hopkins APL Technical Digest (Applied Physics Laboratory), vol. 34, pp. 374-387.

Nixon, C, Thelen, A, Cordiner, M, Kisiel, Z, Charnley, S, Molter, E, Serigano, J, Irwin, P, Teanby, N, Kuan, Y-J 2020, 'Detection of Cyclopropenylidene on Titan with ALMA', The Astronomical Journal, vol. 160, pp. 205-222.

Nixon, C 2024, 'The Composition and Chemistry of Titan's Atmosphere'. ACS Earth and Space Chemistry, vol. 8, pp. 406-456.

Rap, D, Schrauwen, J, Marimuthu, A, Redlich, B & Brünken, S 2022, 'Low-temperature nitrogen-bearing polycyclic aromatic hydrocarbon formation routes validated by infrared spectroscopy', Nature Astronomy, vol. 6, pp. 1059-1067.

Raulin, F, Brassé, C, Poch, O & Coll, P 2012, 'Prebiotic-like chemistry on Titan', Chemical Society Reviews, vol. 41, p. 5380.

Yu, X, Yu, Y, Garver, J, Zhang, X & McGuiggan, P 2024, 'The Fate of Simple Organics on Titan's Surface: A Theoretical Perspective', Geophysical Research Letters, vol. 51, no.1, p. e2023GL106156.

Zhou, L, Kaiser, RI & Tokunaga, AT 2009, Infrared spectroscopy of crystalline and amorphous diacetylene (C4H2) and implications for Titan's atmospheric composition. Planetary and Space Science, vol. 57, pp. 830-835.

The effects of doping on the crystal structure and magnetic ordering of the skyrmion hosting material, Cu_2OSeO_3, for future spintronic devices

Marco Vás[1,2], Qinfen Gu[3], Elliot P. Gilbert[4], Clemens Ulrich[5], Samuel Yick[1,2], Tilo Söhnel[1,2].

[1] The University of Auckland, Auckland, New Zealand
[2] MacDiarmid Institute for Advanced Materials and Nanotechnology, Wellington, New Zealand
[3] Nuclear Science and Technology (NST), ANSTO, Clayton, VIC, Australia
[4] Nuclear Science and Technology (NST), ANSTO, Lucas Heights, NSW, Australia
[5] University of New South Wales, Kensington, NSW, Australia

In today's technological world, the need to store vast amounts of data, such as AI learning databases, contributes to the current global energy crisis. It is projected that in 2025, data centres will consume 4.5% of the world's total energy, leading to the emission of millions of metric tonnes of CO_2 (Liu et al. 2020). This amount is expected to rise through technological advances and demands, such as the use of AI tools to solve large complex models.

Silicon-based materials are the foundation for modern semiconductor technology. However, further advancement has been hindered by issues such as leakage current and waste heat management. These factors inhibit efforts for further miniaturisation and lowering of power consumption. To combat this, a new generation of low-energy, high-density data storage devices is required to store increasing amounts of data with lower energy demands. This highlights the need for science to discover and better understand novel materials that could be used in such devices.

The field of spintronics is an emerging field for the next generation of electronic devices with reduced power consumption and increased memory and processing capacities (Hirohata et al. 2020). Rather than using electric current, information is encoded in the angular momentum of electrons (spin) and their long-range magnetic ordering. Spintronic devices are already in use, such as solid-state hard drives which are widely used in electronic devices, but a possible candidate for improved capabilities is the use of skyrmion racetrack memory. Skyrmions are stable quasiparticles (a group of particles that can be treated as if they were a single particle) that form through the interaction of atomic magnetic moments in a vortex-like spin structure under specific temperatures and magnetic fields (Nagaosa & Tokura 2013). The use of skyrmions in a binary system as mobile data carriers could enable low-cost, ultra-dense, and low-power data storage while showing possibilities to overcome limitations such as thermal energy loss and limited scalability.

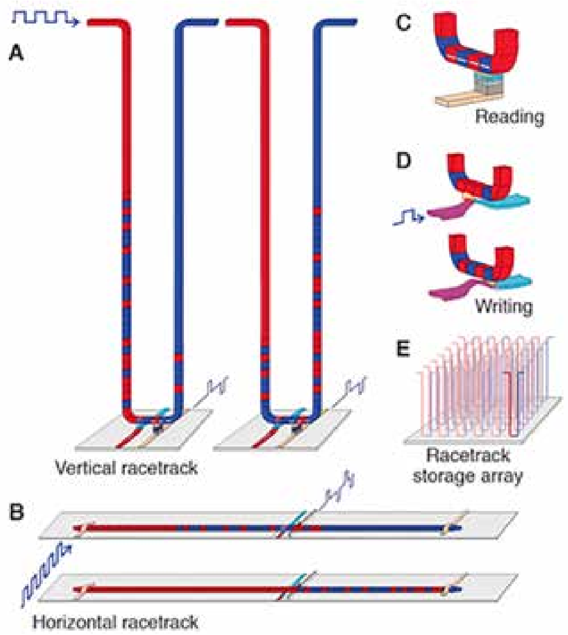


Figure 1: Schematic diagram of different racetrack memory architectures. A) vertical and B) horizontal configurations. C) Reading and D) writing of skyrmions can be carried out electrically under specific temperature and magnetic field conditions. E) A high-density 3D array concept. Figure taken from Hirohata et al. 2020.

Silicon-based materials are the foundation for modern semiconductor technology.

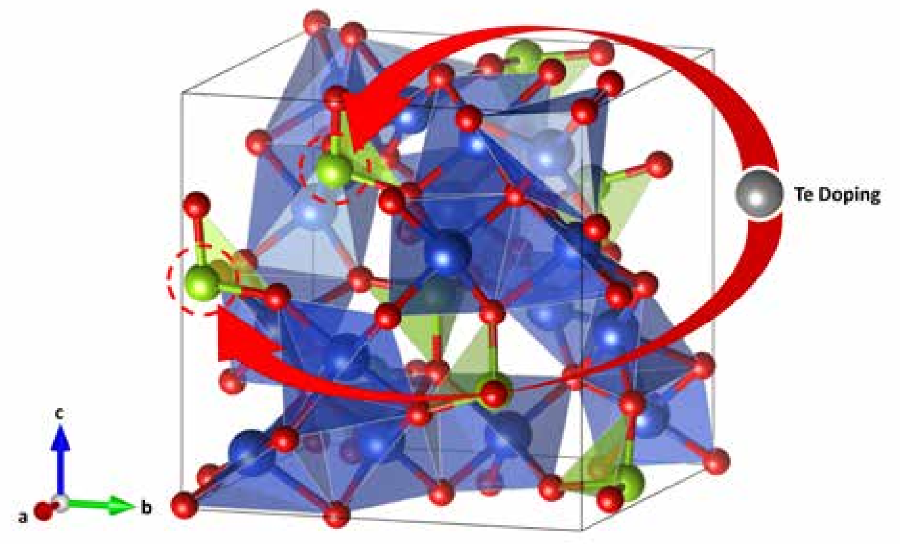


Figure 2: The unit cell of the crystal structure of Cu_2OSeO_3. Blue atoms are copper, lime atoms are selenium, and red atoms are oxygen, while the red arrows show which atomic site tellurium substitutes into.

One promising material for racetrack memory is Copper oxide selenite (Cu_2OSeO_3). It is the only known insulating multiferroic material to host magnetic skyrmions, which is significant as no free electrons are created when writing electrically, which results in low energy loss. In order to try optimise this material for application, having a comprehensive understanding of the underlying quantum-mechanical processes and relationships between the crystal structure and the formation of skyrmions in this material is crucial.

One approach to better understand this material is by replacing atoms within the structure with characteristically different atoms and measure the changes to the structure and the formation of the skyrmions. In my work, the atom that has been investigated is tellurium, which has a larger ionic radius that can be substituted into the selenium site. Due to its larger size, it expands the crystal structure and weakens the interactions between copper pairs in the system, which is essential in the formation of skyrmions.

My work has used various ANSTO instruments across both the Australian Centre for Neutron Scattering (ACNS) and the Australian Synchrotron (AS) to study the effects of doping on both the crystal and magnetic structures in my system. Using the Powder Diffraction beamline at the AS along with the Wombat and Echidna diffractometer beamlines at ACNS, I have been able to accurately characterise my crystal structure under various temperatures and magnetic fields. Tellurium doping was shown to be incorporated into the crystal structure, resulting in the lengthening of copper-copper interaction lengths. To observe this effect on the formation of skyrmions in the system, we used the small angle neutron scattering (SANS) instrument, Quokka at ACNS. Tellurium doping was shown to stabilise the formation of skyrmions to lower temperatures and lower magnetic fields without disrupting the material's intrinsic properties. Despite the unfavourable reduction in formation temperature, less electrical energy is required to apply a sufficient magnetic field to form skyrmions. This is one step forward to paving the way for the chemical design of material optimisation to form skyrmions under lower magnetic fields and higher temperatures, to be used in future racetrack memory devices to tackle the global energy crisis.

Using the Powder Diffraction beamline at the AS along with... diffractometer beamlines at ACNS, I have been able to accurately characterise my crystal structure under various temperatures.

This project is supervised by Professor Tilo Söhnel and Dr Samuel Yick (UoA), along with co-supervision from Professor Elliot Gilbert (ANSTO, ACNS), Dr Qinfen Gu (ANSTO, AS), and Associate Professor Clemens Ulrich (UNSW). I would thank my beamline scientists Elliot Gilbert (ACNS), Helen Maynard-Casely (ACNS), James Hester (ACNS), Qinfen Gu (AS), Anita D'Angelo (AS), and Liam Tan (AS) for ensuring the highest quality data was collected and their invaluable knowledge.

Figure 3: Aligning the cryo-cooler lid on the Powder Diffraction beamline at the Australian Synchrotron for cryogenic temperature X-ray diffraction measurements.

I also would like to thank the ACNS sample environment for technical support with the superconducting magnet for all my magnetic measurements, which wouldn't have been possible without them. This research is financially supported by the University of Auckland Doctoral Scholarship, an AINSE Postgraduate Research Award (PGRA), and the Royal Society Te Aparangi Marsden Fund. The Powder diffraction beamtimes (PDR21589, M20970) were awarded through merit beamtime and funded by the New Zealand Synchrotron Group and the Wombat (P15914), Echidna (MI17485), and Quokka (P15924) merit beamtimes were funded by ANSTO and AINSE.

References:

Liu, Y, Wei, X, Xiao, J, Liu, Z, Xu, Y & Tian, Y 2020, 'Energy consumption and emission mitigation prediction based on data center traffic and PUE for global data centers', Global Energy Interconnection, vol. 3, pp. 272-282.

Hirohata, A, Yamada, K, Nakatani, Y, Prejbeanu, L, Diény, B, Pirro, P & Hillebrands, B 2020, 'Review on Spintronics: Principles and Device Applications', Journal of Magnetism and Magnetic Materials, vol. 509, p. 166711.

Nagaosa, N & Tokura, Y 2013, 'Topological Properties and Dynamics of Magnetic Skyrmions', Nature Nanotechnology, pp. 899-991.

Outreach Activities

January 2024

Indigenous Australian Engineering School | The University of Sydney, NSW, Australia

Michael Rose, Laura Owen and Rebecca Duncan met with 25 Indigenous students attending the 2024 Indigenous Australian Engineering School (IAES). Representatives from ANSTO and other engineering organisations were also in attendance.

Meeting with Prof Masatoshi Takeda (Nagaoka University of Technology) | AINSE, Lucas Heights, NSW, Australia

Michael Rose met with Prof. Masatoshi Takeda, Vice President of Nagaoka University of Technology, Japan, along with 2 Japanese postgraduate students and ANSTO's Gordon Thorogood.

February 2024

Meeting with The Australian National University Delegates | Online

Michelle Durant hosted a online meeting with university contacts at the ANU.

Meeting with The University of Sydney Delegates | AINSE, Lucas Heights, NSW, Australia

Michelle Durant met with delegates from The University of Sydney.

RMIT University Visit | RMIT University, Melbourne, VIC, Australia

Michelle Durant visited RMIT University to connect with AINSE Member Representatives and staff.

Victoria University Visit | Victoria University, Melbourne, VIC, Australia

Michelle Durant visited Victoria University to connect with AINSE Member Representatives and staff.

The University of Melbourne Visit | The University of Melbourne, Melbourne, VIC, Australia

Michelle Durant visited The University of Melbourne to connect with AINSE Member Representatives and staff.

La Trobe University Visit | La Trobe University, Melbourne, VIC, Australia

Michelle Durant visited La Trobe University to connect with AINSE Member Representatives, staff and students.

Launch of the Nuclear Innovation Centre at UNSW | The University of New South Wales, NSW, Australia

Michelle Durant attended the launch of the Nuclear Innovation Centre at The University of New South Wales.

March 2024

Science Meets Parliament | Parliament House, Canberra, ACT, Australia

2 AINSE staff, 4 AINSE Member Representatives and 1 AINSE Member University student attended on behalf of AINSE. The event was organised by Science and Technology Australia (STA).

Meeting with The University of Southern Queensland | Online

Michelle Durant hosted a online meeting with university contacts at the University of Southern Queensland.

AINSE staff members Rebecca Duncan (left) and Michael Rose (right) alongside ANSTO's Brett Rowling (centre) at the Indigenous Australian Engineering School, hosted at The University of Sydney in January 2024.

May 2024

ANSTO Powder Diffraction Workshop | ANSTO, Lucas Heights, NSW, Australia

Michelle Durant spoke to attending student participants of ANSTO's Powder Diffraction Workshop.

ShireBiz CEO Breakfast | Cronulla, NSW, Australia

Michelle Durant attended on behalf of AINSE to discuss issues of importance to economic development in the region.

AINSE Award Ceremony | Hybrid event hosted from AINSE, Lucas Heights, NSW, Australia

Michelle Durant hosted a hybrid event at which Dr. Yangxiang Meng and Dr. Oliver Paull were presented with AINSE Gold Medals.

AINSE Annual Networking Dinner | Sydney Masonic Centre, Sydney, NSW, Australia

AINSE hosted a networking dinner for the Australian nuclear industry, with representatives from AINSE member universities, ANSTO, the ANA, ARWA, ARPANSA, nandin, WiN Australia and AusYGN in attendance.

AINSE Annual General Meeting | Hybrid meeting hosted from AINSE, Lucas Heights, NSW, Australia

Attended by Australian and New Zealand University Representatives, in addition to representatives from ANSTO, CSIRO and AINSE.

Meeting with Swinburne University of Technology | Online

Michelle Durant hosted a online meeting with the AINSE Member Representative at Swinburne University of Technology.

ARPS Regional Meeting | Online

Michelle Durant attended the regional meeting of the Australasian Radiation Protection Society on behalf of AINSE.

44th International Symposium on Archaeometry | Melbourne, VIC, Australia

Michelle Durant ran an information booth promoting AINSE to attendees of the 44th International Symposium on Archaeometry, Melbourne.

Outreach Activities

June 2024

ACNS Clip Day | ANSTO, Lucas Heights, NSW, Australia

Michael Rose spoke to student participants of the annual ACNS Clip Day regarding opportunities to engage with AINSE programs.

RNA-NET Steering Committee Meeting | Online

Michelle Durant attended as an industry representative.

ARWA Meeting | ARWA Head Office, Adelaide, SA, Australia

Michelle Durant met with Australian Radioactive Waste Agency CEO Sam Usher.

July 2024

ANSTO Awards | Sydney, NSW, Australia

Michelle Durant attended the ANSTO Award ceremony on behalf of AINSE.

STA Meeting | AINSE, Lucas Heights, NSW, Australia

Michelle Durant met with Science and Technology Australia CEO Ryan Winn.

August 2024

Edith Cowan University Research Partner Forum | Perth, WA, Australia

Michelle Durant attended the forum as a keynote panellist.

Murdoch University Roundtable | Perth, WA, Australia

Michelle Durant met with senior academic leaders to discuss opportunities for collaboration with AINSE.

University of Western Australia "Coffee and Connect" Session | Perth, WA, Australia

Michelle Durant hosted a drop-in session for researchers and students regarding opportunities with AINSE, attended by students and researchers.

Curtin University Visit | Perth, WA, Australia

Michelle Durant presented to an audience of students and researchers from Curtin University to provide an overview of AINSE programs and opportunities.

Western Sydney University Research Seminar | Online

Michael Rose presented to an audience of students and researchers from Western Sydney University about contemporary research projects supported by AINSE and opportunities for collaboration with AINSE.

Parliamentary Friends of Science | Parliament House, Canberra, ACT, Australia

Michelle Durant attended a briefing on Synthetic Biology with politicians and STEM leaders.

September 2024

Meeting with Western Sydney University students| ANSTO, Lucas Heights, NSW, Australia

Michelle Durant and Michael Rose met with visiting undergraduate students from Western Sydney University and provided an overview of AINSE programs and activities.

University of the Sunshine Coast Research Conference | Gold Coast, QLD, Australia

Michelle Durant spoke to an audience of students and senior STEM staff from the University of the Sunshine Coast regarding AINSE collaboration and funding opportunities.

AINSE staff members Georgia Barrington-Smith (left) and Michael Rose (right) at ANSTO's Australian Synchrotron Open Day, October 2024.

October 2024

16th Australian Nuclear Association (ANA) Conference | Sydney, NSW, Australia

Michelle Durant gave a presentation to delegates entitled:'Building the Pipeline of Scholars in Nuclear Science and Engineering'.

EmpowerHER Women in STEM event at Swinburne University of Technology | Melbourne, VIC, Australia

Michael Rose and Georgia Barrington-Smith gave a presentation to students at Swinburne University of Technology alongside guest speakers from the technology industry.

ANSTO Synchrotron Open Day 2024 | ANSTO, Clayton, VIC, Australia

Michael Rose and Georgia Barrington-Smith participated in the ANSTO Synchrotron Open Day in Clayton Victoria.

3rd ANSTO-HZB Neutron Training Course | ANSTO, Lucas Heights, NSW, Australia

Michael Rose provided an overview of AINSE programs and opportunities to course attendees.

November 2024

Women in Nuclear (WiN) Australia Day | Sydney, NSW, Australia

Georgia Barrington-Smith and Rebecca Duncan attended the WiN Australia Inaugural Women in Nuclear Day at The University of New South Wales, Kensington Sydney.

AANSS2024 | ANBUG-AINSE Neutron Scattering Symposium 2024 | ANSTO, Lucas Heights, NSW, Australia

Michelle Durant presented an overview of AINSE scholarships and programs to attendees, and delivered a speech at the symposium dinner.

December 2024

RACI Inorganic Chemistry Division Conference | Sydney, NSW, Australia

Georgia Barrington-Smith attended the Royal Australian Chemical Institute (RACI) conference, Parramatta, Sydney, sponsored by AINSE.

Meetings and Committees

AINSE Council

Member Organisations and Their Representatives

Two Member Meetings were held in 2024. There was an Annual General Meeting held on 22 May and a General Meeting held on 20 November.

AINSE MEMBER CODE	ORGANISATION	MEMBERSHIP COMMENCED	MEMBER REPRESENTATIVE	MEETINGS ATTENDED
ADE	The University of Adelaide	1958	Professor Christopher Sumby	2
AKL	The University of Auckland	1995	Professor Duncan McGillivray	1
ANS	ANSTO	1958	Professor Andrew Peele (b)	2
ANS	ANSTO	1958	Mrs Roslyn Hatton (b)	2
ANS	ANSTO	1958	Mr David Filipetto (b)	2
ANU	The Australian National University	1958	Dr Edward Simpson	2
CAN	University of Canterbury	2005	Dr Vladimir Golovko	2
CBR	University of Canberra	1996	Dr Duanne White	0
CDU	Charles Darwin University	1995	A/Professor Krishnan Kannoorpatti	1
CQU	CQ University	1991	Dr Nathan Brooks-English	2
CSI	CSIRO	2010	Professor Aaron Seeber	2
CSU	Charles Sturt University	1995	Dr Celia Barril	1
CUR	Curtin University	1989	Dr Craig Buckley	1
DEA	Deakin University	1997	Professor Peter Enticott	0
ECU	Edith Cowan University	1996-2019 (rejoined 2023)	Professor Pere Masque Barri	0
FLI	Flinders University	1966	Professor Claire Lenehan	1
GRI	Griffith University	1975	A/Professor William Bennett	0
JAM	James Cook University	1970	A/Professor Scott Smithers	2
LAT	La Trobe University	1966	Dr Grant van Riessen	2
MAC	Macquarie University	1966	A/Professor Tracy Rushmer	2
MEL	The University of Melbourne	1958	Dr Amy Prendergast	2
MON	Monash University	1961	Professor Christopher McNeill	2
MUR	Murdoch University	1985-1997 (rejoined 1998)	A/Professor David Henry	2
NCT	The University of Newcastle	1965	A/Professor Grant Webber	1
NSW	The University of New South Wales	1958	A/Professor John Stride	1
OTA	University of Otago	2007	Professor Christopher Moy	1
QLD	The University of Queensland	1958	Professor Ian Gentle (b)	2
QUT	Queensland University of Technology	1992	Professor Godwin Ayoko	2
RMI	RMIT University	1988	Professor Gary Bryant	2
SCU	Southern Cross University	1994	Dr Renaud Joannes-Boyau	0
SWI	Swinburne University of Technology	1991	A/Professor Jeremy Brown	0
SYD	The University of Sydney	1958-2015 (rejoined 2017)	Professor Chris Ling	1
TAS	University of Tasmania	1958	A/Professor Zanna Chase	1
UNE	The University of New England	1958	Dr Ali Bagheri	1
USA	University of South Australia	1991	A/Professor Ivan Kempson	2
USC	University of the Sunshine Coast	2010	Dr Rezwanul Haque	2
USQ	University of Southern Queensland	1996-2015 (rejoined 2021)	Dr Gudrun Seynsche	1
USQ	University of Southern Queensland	1996-2015 (rejoined 2021)	Professor John Bell (b)	0
UTS	University of Technology Sydney	1988	A/Professor Cuong Ton-That	2
UWA	The University of Western Australia	1958	Professor Rob Atkin	0
VIC	Victoria University	2019	Professor Thomas Yeager	1
VUW	Victoria University of Wellington	2010	Professor Emily Parker	0
WAI	The University of Waikato	2011	A/Professor Graham Saunders	2
WOL	University of Wollongong	1975-2014 (rejoined 2016)	Dr Paul Di Pietro	0
WSU	Western Sydney University	1993-2016 (rejoined 2020)	A/Professor Freya MacMillan	1
			Professor Janice Adrich-Wright (b)	1
	Independent Director		Dr Diana Day (b)	1
	Independent Director		Dr. Leonie Walsh (b)	1

Alternate Representatives and Other Attendees

AINSE MEMBER CODE	ORGANISATION	REPRESENTATIVE	MEETINGS ATTENDED
CSU	Charles Sturt University	Dr Danielle Ryan	1
DEA	Deakin University	Professor Lingxue Kong	1
USQ	University of Southern Queensland	Dr Joanna Turner	1
WSU	Western Sydney University	Dr Feng Li	1
CUR	Curtin University	A/Professor Mark Hackett	1
NCT	The University of Newcastle	A/Professor Karen Livesey	1
SWI	Swinburne University of Technology	Dr Rohan Shah	1

ORGANISATION	REPRESENTATIVE	MEETINGS ATTENDED
AINSE	Ms Kim Shields (Minutes Secretary)	2
AINSE	Dr Michael Rose (Zoom Monitor)	2
AINSE	Ms Georgia Barrington-Smith (Zoom Monitor)	1
Delante Accountants & Business Advisors Pty Ltd	Mr David Aston (AINSE Auditor)	1

Six individual members were invited to attend.

AINSE Board Meetings

Board Meetings attended in 2024:

DIRECTOR	REPRESENTATIVE ROLE	ORGANISATION	MEETINGS ELIGIBLE TO ATTEND	MEETINGS ATTENDED
Ian Gentle	President, University Representative	The University of Queensland	5	5
Michelle Durant	Managing Director	AINSE	4	4
Diana Day	Independent Director	Independent	5	4
Leonie Walsh	Independent Director	Independent	5	5
Dave Filipetto	ANSTO Representative	ANSTO	5	5
Rosyln Hatton	ANSTO Representative	ANSTO	5	5
Andrew Peele	ANSTO Representative	ANSTO	5	4
Janice Aldrich-Wright	University Representative	Western Sydney University	5	5
John Bell	University Representative	University of Southern Queensland	5	4

AINSE Winter School Planning Committee

Dhriti Bhattacharyya	ANSTO
Helen Brand	ANSTO
Paul Callaghan	ANSTO
Ryan Drury	ANSTO
Patricia Gadd	ANSTO
Pablo Mota-Santiago	ANSTO
Anton Stampfl	ANSTO
Gordon Thorogood	ANSTO
Alan Xu	ANSTO
Rosie Young	ANSTO
Rebecca Duncan	AINSE
Michelle Durant	AINSE
Michael Rose	AINSE

Students visiting ANSTO's Lucas Heights campus during the on-site Winter School in September.

AINSE Specialist Committees

The AINSE Managing Director is an ex-officio (non-voting) member of all Committees. Committees met in April, June, August and October. Committee members are listed, (r) indicates 'AINSE Member Representative'.

Archaeology, Geosciences and Environmental Sciences Committee (AGES)

Alan Williams (Convenor)	CSIRO
Silvia Frisia	The University of Newcastle
Pere Masqué Barri (r)	Edith Cowan University
Karina Meredith	ANSTO
Pauline Treble	ANSTO
Reka Fulop	ANSTO

Biomedical Science and Biotechnology Committee (BBS)

Elena Ivanova (Convenor)	RMIT University
Benjamin Blyth	Peter MacCallum Cancer Centre
Lawrence Gahan	The University of Queensland
Mark Hackett	Curtin University
Lidia Matesic	ANSTO
Michael Hay	The University of Auckland
Ingo Köeper	Flinders University
Adele Williamson	University of Waikato

Materials Science and Engineering Committee (MSE)

Graham Saunders (r) (Convenor)	The University of Waikato
Tamar Greaves	RMIT University
Kirrily Rule	ANSTO
Anna Sokolova	ANSTO
Manickam Minakshi Sundaram	Murdoch University
John Stride	The University of New South Wales
Weiyao Zhao	Monash University

Scholarships and Medals Committee

Richard Garrett (Convenor)	ANSTO
Alan Williams	CSIRO
Elena Ivanova	RMIT University
Graham Saunders (r)	The University of Waikato
Ian Gentle (r)	The University of Queensland

Scholar Gold Medals

AINSE Scholar Gold Medals are awarded by the AINSE Members for excellence and impact in research by postgraduate and early career researchers supported by AINSE. On Tuesday 21st May 2024, AINSE Scholar Gold Medals for excellence and impact in research were formally awarded to: Dr. Yanxiang Meng, former AINSE PGRA scholar from 2020 until the completion of his PhD in 2022 at the University of Melbourne; and Dr. Oliver Paull, former AINSE Honours Scholar in 2016 at the University of Wollongong, AINSE PGRA Scholar from 2017 to until the completion of his PhD in 2021 at The University of New South Wales, and 2019 SAAFE Scholar.

The Gold Medal ceremony was hosted from the AINSE Theatre and livestreamed via Zoom, with Dr. Paull and his family present in the Theatre and Dr. Meng joining remotely from Switzerland. Dr. Meng and Dr. Paull were presented with their medals by AINSE Managing Director Michelle Durant in front of an audience of AINSE member representatives and ANSTO researchers.

Dr. Meng's Research: New insights to combat inflammatory disease

Dr Yanxiang Meng's research investigated the molecular mechanisms of cell signalling during necroptosis. Necroptosis is a pro-inflammatory form of programmed cell death, which has been linked to inflammatory bowel disease, ischaemia-reperfusion injuries, and other inflammatory diseases. RIPK1 is a small molecule that inhibits necroptosis by targeting the apical kinase in the pathway. This molecule has shown promising results in mouse models of non-infectious disease and is in phase II human clinical trials, triggering over $USD1billion in investment into the emerging class of necroptosis inhibiting drugs. However, therapeutically targeting the downstream effectors of necroptosis, RIPK3 kinase and MLKL pseudokinase, has been hindered by a lack of structural and mechanistic knowledge of these proteins. In addition, human and mouse necroptosis effectors are regulated differently, meaning interpreting the data generated in mouse disease models, for human drug development, is complicated.

Dr Meng's research revealed the mechanisms by which the terminal effector of necroptosis, MLKL, is activated by RIPK3. By characterizing the interactions and structures of RIPK3 and MLKL using the SAXS/WAXS and MX2 beamlines at the Australian Synchrotron in a series of high impact research papers, Dr Meng has revealed the structural basis by which RIPK3 and MLKL are regulated in human cells for the first time. This knowledge is necessary to design novel therapeutic agents to inhibit RIPK3 and MLKL, which have enormous potential to generate positive clinical outcomes for patients worldwide who are suffer with inflammatory diseases, as well as the strong potential commercial value in a billion-dollar drug market.

Dr. Paull's Research: A revolution in information storage

Dr. Oliver Paull's research focused on the development of a new class of functional materials called multiferroics. These materials harbour both magnetic and dipolar charge properties and directly address these challenges associated with our consumption of energy. Whilst significant emphasis has already been placed on researching energy generation, the consumption demands of energy is one of the defining challenges of the 21st century. Information and Communications Technology (ICT) currently consumes approximately 10% of the world's energy supply, and this is expected to double every ~10 years. If this goes unchecked, it will create an untenable situation where a large fraction of our primary energy is used simply for ICT functions. Dr. Oliver Paull's research, published across numerous high impact journals, addresses these issues through developing our understanding of multiferroic materials.

Specifically, Dr. Paull worked on bismuth ferrite, a materials system offering attractive functional properties including robust multiferroicity, lead-free chemical nature and high temperature stability. Dr. Paull demonstrated a special crystal growth technique that identified a new low symmetry phase of bismuth ferrite which required significantly lower input bias for operation. This new phase showed an electromechanical response 500% of the traditionally used form. Following that, he outlined the interdependence between the lattice strain state and magnetic spin textures. He also visited the Centrale Supélec, Paris as a SAAFE awardee, to develop bismuth ferrite based thin films as lead-free environmentally friendly sensor materials. Finally, Dr. Paull's research also contributed to designing new multiferroic phases of bismuth ferrite with topological properties, and these have the potential to revolutionise how information is sorted and read.

AINSE wishes to congratulate Dr. Meng and Dr. Paull on their outstanding accomplishments, and eagerly anticipates the outcomes of their next research endeavours.

AINSE Managing Director Michelle Durant (left) presented the AINSE Scholar Gold Medals to Dr. Oliver Paull (right) and Dr. Yanxiang Meng (on-screen).

AINSE Networking Dinner

Following the Gold Medal Ceremony, AINSE's hosted its annual networking dinner to bring together representatives from the Australasian nuclear science and technology sector. AINSE member representatives from across Australia and New Zealand met with members of the AINSE and ANSTO Boards, representatives from ARWA, ARPANSA, the ANA, ATSE, and AusYGN, alongside AINSE alumni and ANSTO researchers, at the Sydney Masonic Centre.

AINSE President Prof. Ian Gentle and Managing Director Michelle Durant welcomed the distinguished guests to the evening, noting the unique networking opportunities afforded by this unique gathering of representatives from across the vast majority of the Australasian nuclear science and technology sector, and speaking to recent developments over the past 12 months.

Gold Medal recipient Dr. Oliver Paull shared his AINSE-supported research into multiferroic materials with the assembled guests over dinner, in an extended conversation with Prof. Ian Gentle. Dr. Paull also detailed his experience with the Scholarship AINSE ANSTO French Embassies (SAAFE) research exchange internship, and his associated visit to the Centrale Supélec, Paris, during his Ph.D. research.

Throughout the evening, select AINSE Member Representatives and ANSTO staff were acknowledged for their outstanding service to AINSE over the past 12 months. AINSE staff member Nerissa Phillips received special acknowledgement for her 30 years of service to AINSE, over which time she has provided assistance and support to many hundreds of undergraduate and postgraduate students and researchers on AINSE scholarships and awards.

AINSE Managing Director Michelle Durant celebrated the success of the second annual AINSE Networking dinner and looked forward to future opportunities for AINSE to foster further connections within the Australasian nuclear science and technology sector.

AINSE President Professor Ian Gentle welcoming guests to the 2024 AINSE Networking Dinner following the AINSE Gold Medal Award Ceremony

Finances

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Financial Statements
For the Financial Year Ended 31 December 2024

Contents

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Directors' Report
For the Financial Year Ended 31 December 2024

Your Directors present their report on AINSE Limited (AINSE) for the financial year ended 31 December 2024.

Directors

The names of Directors in office at any time during or since the end of the financial year are:

Professor Ian Gentle
Ms Michelle Durant
Professor Janice Aldrich-Wright
Professor John Bell
Dr Diana Day (commenced 1 January 2024)
Mr David Filipetto
Ms Roslyn Hatton
Ms Helen Liossis (ceased 1 January 2024)
Professor Andrew Peele
Dr Leonie Walsh

Directors have been in office since the start of the financial year to the date of this report unless otherwise stated.

Principal Activities

The principal activities of AINSE during the financial year was to advance research, education and training in the field of nuclear science and engineering and related fields within Australasia by being, in particular, the key link between universities, ANSTO, other member organisations and major nuclear science and associated facilities.

AINSE's short-term objectives are to:

- Offer Honours, Masters, PhD top up Scholarships, Early Career Grants to students and Researchers from AINSE Institutional members for the conduct of research principally at ANSTO.
- Organise educational schools and workshops in nuclear science and engineering for AINSE members.
- Organise conference travel support in specific areas relating to nuclear science and engineering and in related fields that utilise nuclear techniques and analysis.
- Support travel and accommodation for students and academics to present their AINSE supported research at conferences both within Australia and overseas.

AINSE's long-term objectives are to:

- Be an effective link between all stakeholders of nuclear science and engineering
- Play a key role in enhancing collaborations for the Australasian nuclear community
- Play a leading role in nuclear education and training
- Facilitate the development of international strategic research initiatives
- Utilise new streams of funding

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Directors' Report
For the Financial Year Ended 31 December 2024

STRATEGIC PLAN (2024 – 2028)

AINSE's Vision

To enhance the capability of Australia and New Zealand in nuclear science, engineering and related research fields by facilitating world-class research and education.

AINSE's Mission

AINSE provides pathways and networks for collaboration within nuclear science, engineering and related industry, and research nationally and internationally and builds capability and diversity through training and education.

STRATEGIC PRIORITIES

AINSE has defined the following five strategic priorities for its Strategic Plan. These will drive our focus, resource allocation and how we monitor our success over the life of the Strategic Plan.

1 Be the vital link between universities and knowledge in the nuclear industry by exploring targeted opportunities for the next generation of students and researchers with an interest in nuclear science and engineering.

- Support the next generation of students and researchers by exploring new opportunities for collaboration and knowledge transfer nationally and internationally.
- Work with AINSE members for continued improvement of existing programs aligned with current trends in the tertiary sector.
- Expand the reach and accessibility of existing programs to AINSE member students and researchers.

2. Be a visible and respected brand with strong connections that reaches a wider audience beyond nuclear scientists and engineers.

- Promote AINSE's value proposition and align it with the priorities of Government, ANSTO, Universities, Industry, and other interested parties.
- Effectively communicate AINSE's vision and mission to a wide range of different stakeholders through outreach and marketing campaigns.

3. Facilitate research collaboration through networking and expanding opportunities nationally and internationally.

- Play a key role in supporting research collaboration and networking opportunities between ANSTO, Universities, Industry, and other experts in nuclear science and engineering.
- Explore targeted national and international opportunities to support the expansion of the nuclear industry.

4. Have resources available to provide agility and responsiveness to opportunities aligned with stakeholders needs in a changing environment.

- Liaise through networking and targeted meetings with local, national and international policy makers to influence and communicate future priorities that relate to emerging trends and opportunities as identified by members.
- Seek new collaborative opportunities to expand member benefits in nuclear science and engineering and other related research areas in line with member priorities.
- Efficiently manage and protect AINSE's information assets.

5. Provide a sustainable and growing business that increases the value of AINSE membership.

- Diversify AINSE's revenue streams, while recognising the importance of existing members and maintaining/increasing membership value.
- Identify gaps in the AINSE pipeline to address emerging trends through member consultation to develop targeted programs when required.

Information on Directors

The Directors in office at the date of this report are listed below with particulars of qualifications, experience and special responsibilities (if any).

Ian Gentle – University Representative Director, President
Board Member since August 2014.
Over 40 years' experience in academia and scientific research and research management.
BSc (Hons), PhD, MRACI.

Michelle Durant – Managing Director
Board Member since April 2016.
Over 30 years' experience in scientific and business administration and management.
BSc, BFinAdmin, GradDipAppCorpGov, FGIA, FCG, GAICD.

Janice Aldrich-Wright – University Representative Director
Board Member since January 2023.
Over 35 years' experience in academia and scientific research and research management.
Professor of Chemistry at Western Sydney University
BSc (Hons), PhD, FRACI, FRSC.

John Bell – University Representative Director
Board Member since January 2022.
Over 35 years' experience in academia, scientific research and senior academic management. Previous Board experience with Cooperative Research Centre for Railway Technologies, Cooperative Research Centre for Integrated Engineering Asset Management, and the Business Council for Sustainable Energy. Currently a Director of the Queensland Cyber Infrastructure Foundation.
Deputy Vice-Chancellor (Research and Innovation), University of Southern Queensland.
BSc (Hons), PhD, GAICD, FAIP.

Diana Day - Independent Director
Board Member since January 2024
Over 35 years' experience in academic research and leadership, public administration and as non-executive director and chair of national and state boards, research authorities, councils and companies.
Previous board experience includes Atlas of Living Australia; CRC Irrigation Futures; Sydney Water Corporation; Murray-Darling Basin Authority.
Board member of the NSW Smart Sensing Network; Chair QLD Ministerial Advisory Committee for Flood Mitigation Manuals; Australian Institute of Company Directors, NSW Advisory Council; STEM Mentor Australian Academy of Technology and Engineering IMNIS Network; and, the Australian Water Association.
BA(Hons), Dip Ed, PhD, FAICD.

David Filipetto – ANSTO Representative Director
Board member since November 2023.
Over 40 years' experience in the public and private sectors, predominantly in transport – air and rail, in engineering leadership, continuous improvement and quality roles.
Group Executive ANSTO Maintenance and Engineering.
Bachelor Engineering (Hons), Masters Engineering Management, Lean Six Sigma Master Black Belt, GAICD.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Directors' Report
For the Financial Year Ended 31 December 2024

Information on Directors continued

Roslyn Hatton – ANSTO Representative Director
Board Member representing ANSTO since December 2014.
Independent Board Member from August 2012 until September 2014.
Over 30 years' experience in public and private sector audit and financial accounting roles.
Deputy Chief Financial Officer at ANSTO.
BComm (Accounting, finance and information systems) UNSW, FCA.

Andrew Peele – ANSTO Representative Director
Board member since February 2018.
Over 30 years' experience in academia, scientific research and science management in Australia and USA.
Previous legal experience as a practicing solicitor in Victoria.
BSc (Hons), PhD, LLB, Grad Dip (Intellectual Property), FAIP, FTSE.

Leonie Walsh – Independent Director
Board Member since January 2020.
Over 35 years' experience in industrial technology development with over 15 years of Board experience across broad sectors including health, energy, manufacturing, clean technology, and education.
BSc, MSc, MBA (Exec), GAICD, FTSE, HonDUni (Swin)

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Directors' Report
For the Financial Year Ended 31 December 2024

Meetings of Directors

During the financial year, 5 meetings of directors were held. Attendances by each director were as follows:

	Number eligible to attend	Number attended
Professor Ian Gentle	5	5
Ms Michelle Durant	4	4
Professor Janice Aldrich-Wright	5	5
Professor John Bell	5	4
Dr Diana Day	5	4
Mr David Filipetto	5	5
Ms Roslyn Hatton	5	5
Professor Andrew Peele	5	4
Dr Leonie Walsh	5	5

AINSE is incorporated under the *Corporations Act 2001* and is a company limited by guarantee. If AINSE is wound up, the constitution states that each member is required to contribute a maximum of $10 each towards meeting any outstanding obligations of AINSE. At 31 December 2024, the total amount that members of AINSE are liable to contribute if AINSE was wound up would be $450 (2023: $480).

Auditors Independence Declaration

The lead auditor's independence declaration for the year ended 31 December 2024 has been received and can be found on page 95 of the report.

Signed in accordance with a resolution of the Board of Directors.

Director MICHELLE DURANT

Director D. FILIPETTO

Dated this 19th day of March 2025

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Auditor's Independence Declaration to the Directors
For the Financial Year Ended 31 December 2024

In accordance with the requirements of section 60-40 of the *Australian Charities and Not-for-profits Commission Act 2012*, I declare that, to the best of my knowledge and belief, during the year ended 31 December 2024 there have been no contraventions of:

i. The auditor independence requirements as set out in the *Australian Charities and Not-for-profits Commission Act 2012* in relation to the audit; and

ii. Any applicable code of professional conduct in relation to the audit.

Delante Accountants and Business Advisers Pty Ltd
Chartered Accountants

David G Aston
Director

TAREN POINT NSW 2229

Dated 19 March 2025

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Statement of Comprehensive Income – By Nature
For the Financial Year Ended 31 December 2024

	Note	2024 $	2023 $
Revenue	2	1,725,487	1,651,418
External grants	2	234,392	359,006
Other income	2	193,293	164,921
Total income		2,153,172	2,175,345
Employee benefits expense		(738,508)	(685,643)
Depreciation expense	3	(12,606)	(13,294)
Audit, legal and consultancy expense		(26,817)	(34,003)
AINSE Awards		(1,238,954)	(1,339,852)
Other expenses		(158,322)	(156,214)
Total Expenses		(2,175,207)	(2,229,006)
Surplus/(deficit) before income tax		**(22,035)**	**(53,661)**
Income tax expense		-	-
Surplus/(deficit) for the year		**(22,035)**	**(53,661)**

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Statement of Financial Position
As At 31 December 2024

	Note	2024 $	2023 $
ASSETS			
CURRENT ASSETS			
Cash and cash equivalents	4	3,580,072	3,733,150
Trade and other receivables	5	136,464	149,759
Other	6	68,792	51,065
TOTAL CURRENT ASSETS		3,785,328	3,933,974
NON-CURRENT ASSETS			
Property, plant & equipment	7	16,803	25,809
TOTAL NON-CURRENT ASSETS		16,803	25,809
TOTAL ASSETS		3,802,131	3,959,783
LIABILITIES			
CURRENT LIABILITIES			
Trade and other payables	8	452,865	576,792
Employees provisions	9	141,835	156,088
TOTAL CURRENT LIABILITIES		594,700	732,880
NON-CURRENT LIABILITIES			
Employees provisions	9	15,236	12,673
TOTAL NON-CURRENT LIABILITIES		15,236	12,673
TOTAL LIABILITIES		609,936	745,553
NET ASSETS		3,192,195	3,214,230
EQUITY			
Awards reserve	12	868,092	674,408
Accumulated surplus		2,324,103	2,539,822
TOTAL EQUITY		3,192,195	3,214,230

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Statement of Changes in Equity
For the Financial Year Ended 31 December 2024

	Awards Reserve $	Accumulated Surplus $	Total $
Balance at 1 January 2023	767,394	2,500,497	3,267,891
Net surplus/(deficit) attributable to AINSE	-	(53,661)	(53,661)
Transfers to and from awards reserve	(92,986)	92,986	-
Balance at 31 December 2023	674,408	2,539,822	3,214,230
Net surplus/(deficit) attributable to AINSE	-	(22,035)	(22,035)
Transfers to and from awards reserve	193,684	(193,684)	-
Balance at 31 December 2024	868,092	2,324,103	3,192,195

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Cash Flow Statement
For the Financial Year Ended 31 December 2024

	2024 $	2023 $
CASH FLOWS FROM OPERATING ACTIVITIES		
Receipts from operations	1,901,272	1,804,813
Receipts from grants	115,496	166,932
Interest received	204,997	159,672
Award related payments	(1,385,773)	(1,490,949)
Payments to suppliers and employees	(985,470)	(912,725)
Net cash generated from operating activities	(149,478)	(272,257)
CASH FLOWS FROM INVESTING ACTIVITIES		
Proceeds from sale of property, plant and equipment	-	-
Payment for property, plant and equipment	(3,600)	(5,466)
Net cash used in investing activities	(3,600)	(5,466)
Net increase / decrease in cash held	(153,078)	(277,723)
Cash and cash equivalents at beginning of financial year	3,733,150	4,010,873
Cash and cash equivalents at end of financial year	3,580,072	3,733,150

The accompanying notes form part of these financial statements

Note 1 – Statement of Significant Accounting Policies

The financial statements cover AINSE Limited (AINSE) as an individual entity. AINSE is a Company limited by guarantee, incorporated and domiciled in Australia.

Basis of Preparation

The financial statements are general purpose financial statements that have been prepared in accordance with Australian Accounting Standards – Simplified Disclosure Requirements of the Australian Accounting Standards Board and the Australian Charities and Not-for-profits Commission Act 2012. AINSE is a not-for-profit entity for financial reporting purposes under Australian Accounting Standards.

AINSE does not have 'public accountability' as defined in AASB 1053 Application of Tiers of Australian Accounting Standards and is therefore eligible to apply the 'Tier 2' reporting framework under Australian Accounting Standards.

The financial statements comply with the recognition and measurement requirements of Australian Accounting Standards, the presentation requirements in those Standards as modified by AASB 1060 General Purpose Financial Statements – Simplified Disclosures for For-Profit and Not-for-Profit Tier 2 Entities (AASB 1060) and the disclosure requirements in AASB 1060. Accordingly, the financial statements comply with Australian Accounting Standards – Simplified Disclosures.

Australian Accounting Standards set out accounting policies that the AASB has concluded would result in financial statements containing relevant and reliable information about transactions, events and conditions. Material accounting policies adopted in the preparation of these financial statements are presented below and have been consistently applied unless stated otherwise.

The financial statements, except for the cash flow information, have been prepared on an accruals basis and are based on historical costs, modified, where applicable, by the measurement at fair value of selected non-current assets, financial assets and financial liabilities. The amounts presented in the financial statements have been rounded to the nearest dollar.

The financial statements were authorised for issue on 14 March 2025 by the directors of AINSE.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

Significant Accounting Policies

Revenue and Other Income

Revenue arises mainly from membership subscriptions, promotion fees, and grants. Revenue is recognised either at a point in time or over time, when (or as) performance obligations are satisfied by transferring the promised goods or services to its customers.

Revenues are recognised when the following steps have been satisfied:

1. Identify contract with customer
2. Identify the performance obligations in the contract
3. Determine the transaction price
4. Allocate the transaction price to each performance obligation
5. Recognise revenue when (or as) performance obligations are satisfied

Membership Subscriptions
The membership subscription year for institutional members, industry members and individual members is 1 January to 31 December with fees paid annually in advance. Only those membership subscription receipts that are attributable to the current financial year are recognised as revenue.

Grants
When AINSE receives operating grant revenue it assesses whether the contract is enforceable and has sufficiently specific performance obligations in accordance with AASB15. When both of these conditions are satisfied, AINSE:

- Identifies each performance obligation relating to the grant;
- Recognises a contract liability for its obligations under the agreement; and
- Recognises revenue as it satisfies its performance obligations.

Where the contract is not enforceable or does not have sufficiently specific performance obligations. AINSE:

- Recognises the asset received in accordance with the recognition requirements of other applicable accounting standards;
- Recognises related amounts (being lease liability, provisions, revenue or contract liability arising from a contract with a customer); and
- Recognises income immediately in profit or loss as the difference between the initial carrying amount of the asset and the related amount.

If a contract liability is recognised as a related amount above, AINSE recognises income in profit or loss when or as it satisfies its obligations under the contract.

Other Income
Interest Income is recognised using the effective interest rate method.

All revenue is stated net of the amount of goods and services tax.

Property, Plant and Equipment

Each class of property, plant and equipment is carried at cost or fair value as indicated less, where applicable, any accumulated depreciation and impairment losses.

Plant and Equipment

Plant and equipment are measured on the cost basis and are therefore carried at cost less accumulated depreciation and any accumulated impairment losses. In the event the carrying amount of plant and equipment is greater than its estimated recoverable amount, the carrying amount is written down immediately to its estimated recoverable amount and impairment losses are recognised either in profit or loss or as a revaluation decrease if the impairment losses relate to a revalued asset. A formal assessment of recoverable amount is made when impairment indicators are present.

Plant and equipment that have been contributed at no cost, or for nominal cost, are valued and recognised at the fair value of the asset at the date it is acquired.

Depreciation

The depreciable amount of all fixed assets including buildings and capitalised leased assets, but excluding freehold lands, are depreciated on a straight line or diminishing value basis over their useful lives to AINSE commencing from the time the asset is held ready for use. Leasehold improvements are depreciated over the shorter of either the unexpired period of the lease or the estimated useful life of the improvement.

The depreciation rates used for each class of depreciable asset are:

Plant & equipment	15-35%
Motor vehicles	25%
Furniture and fittings	10-25%

The asset's residual values and useful lives are reviewed, and adjusted if appropriate, at the end of each reporting period.

Gains and losses on disposals are determined by comparing proceeds with the carrying amount. These gains or losses are included in the statement of comprehensive income. When revalued assets are sold, amounts included in the revaluation reserve relating to that asset are transferred to retained earnings.

Financial Instruments

AINSE's financial instruments consist mainly of deposits with banks, local money market instruments, short-term investments and accounts receivable and payable.

Initial Recognition & Measurement
Financial assets and financial liabilities are recognised when AINSE becomes a party to the contractual provisions to the instrument. Financial instruments are initially measured at fair value plus transaction costs, except where the instrument is classified "at fair value through profit or loss" in which case transaction costs are recognized immediately as expenses in profit or loss. Subsequent to initial recognition these instruments are measured as set out below.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

Classification and Subsequent Measurement
Financial instruments are subsequently measured at either fair value, amortised cost using the effective interest method, or cost. Where available, quoted prices in an active market are used to determine fair value. In other circumstances, valuation techniques are adopted.

Amortised cost is calculated as the amount at which the financial asset or financial liability is measured at initial recognition less principal payments and any reduction for impairment and adjusted for any cumulative amortisation of the difference between that initial amount and the maturity amount calculated using the effective interest method.

Fair Value
Fair value is determined based on current bid prices for all quoted investments. Valuation techniques are applied to determine the fair value for all unlisted securities, including recent arm's length transactions, reference to similar instruments and option pricing models.

Loans and Receivables
Loans and receivables are non-derivative financial assets with fixed or determinable payments that are not quoted in an active market and are subsequently measured at amortised cost. Gains or losses are recognized in profit or loss through the amortization process and when the financial asset is derecognized.

Held-to-Maturity Investments
Held-to-maturity investments are non-derivative financial assets that have fixed maturities and fixed or determinable payments, and it is the AINSE's intention to hold these investments to maturity. They are subsequently measured at cost. Gains and losses are recognised in profit and loss through the amortisation process and when the financial asset is derecognised.

Financial Liabilities
Non-derivative financial liabilities (excluding financial guarantees) are subsequently measured at amortised cost. Gains or losses are recognised in profit or loss through the amortization process and when the financial liability is derecognised.

Impairment of Assets

At the end of each reporting period, AINSE assesses whether there is objective evidence that a financial asset has been impaired. A financial asset (or a group of financial assets) is deemed to be impaired if, and only if, there is objective evidence of impairment as a result of one or more events (a "loss event") having occurred, which has an impact on the estimated future cash flows of the financial asset(s).

In the case of financial assets carried at amortised cost, loss events may include: indications that the debtors or a group of debtors are experiencing significant financial difficulty, default or delinquency in interest or principal payments; indications that they will enter bankruptcy or other financial reogranisation; and changes in arrears or economic conditions that correlate with defaults.

For financial assets carried at amortised cost (including loans and receivables), a separate allowance account is used to reduce the carrying amount of financial assets impaired by credit losses. After having taken all possible measures of recovery, if management establishes that the carrying amount cannot be recovered by any means, at that point the written off amounts are charged to the allowance account or the carrying amount of impaired financial assets is reduced directly if no impairment amount was previously recognized in the allowance account.

When the terms of financial assets that would otherwise have been past due or impaired have been renegotiated, AINSE recognises the impairment for such financial assets by taking into account the original terms as if the terms have not been renegotiated so that the loss events that have occurred are duly considered.

Employee Benefits

Provision is made for AINSE's liability for employee benefits arising from services rendered by employees at the end of the reporting period. Employee benefits that are expected to be settled within one year have been measured at the amounts expected to be paid when the liability is settled. Other employee benefits payable later than one year have been measured at the present value of the estimated future cash outflows to be made for those benefits.

Cash and Cash Equivalents

Cash and cash equivalents include cash on hand, deposits held at-call with banks, other short-term highly liquid investments with original maturities of three months or less, and bank overdrafts. Bank overdrafts are shown within short term borrowings in current liabilities on the statement of financial position.

Goods and Services Tax (GST)

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST incurred is not recoverable from the Australian Taxation Office (ATO).

Receivables and payables are stated inclusive of the amount of GST receivable or payable. The net amount of GST recoverable from, or payable to, the ATO is included with other receivables or payables in the statement of financial position.

Cash flows are presented on a gross basis. The GST components of cash flows arising from investing or financing activities which are recoverable from, or payable to, the ATO are presented as operating cash flows included in receipts from customers or payments to suppliers.

Income Tax

AINSE Limited is exempt from income tax under section 50-5 of the *Income Tax Assessment Act 1997 as AINSE is established for the purpose of enabling scientific research to be conducted in Australia.*

Trade and Other Payables

Trade and other payables represent the liabilities for goods and services received by AINSE during the reporting period that remain unpaid at the end of the reporting period. The balance is recognised as a current liability with the amounts normally paid within 30 days of recognition of the liability.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

Awards Reserve

The awards reserve represents the future commitments for funding to scientists for research in three programs. These programs are the Postgraduate Research Awards (PGRA), the Scholarship AINSE, ANSTO and the French Embassy (SAAFE) and the AINSE Supported Facility awards (ASF). The PGRA program provides support to post graduate students at an entry point in their qualification and last for the duration of their underlying primary scholarship. The SAAFE scholarship is a 6 month program as an internship to increase mobility and collaborations between Australia and France. The ASF awards provide travel and accommodation opportunities for researchers to access equipment that complements the facilities at ANSTO and are available for a period of 12 months. Interest earned on unspent New Fund monies forms part of this reserve.

Comparative Figures

When required by Accounting Standards, comparative figures have been adjusted to conform to changes in presentation for the current financial year.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

	Note	2024 $	2023 $
Note 2 – Revenue and Other Income			
Revenue			
Payments from members		1,315,187	1,240,818
ANSTO promotion fee		410,300	410,600
		1,725,487	1,651,418
External grants	13	234,392	359,006
		1,959,879	2,010,424
Other income			
Interest received		193,293	164,875
Sundry income		-	46
		193,293	164,921
Total revenue and other income		2,153,172	2,175,345
Note 3 – Surplus for the Year			
The surplus for the year has been determined after charging as expenses:			
Depreciation of property, plant and equipment		12,606	13,294
Bad and doubtful debts		-	-
Note 4 – Cash and Cash Equivalents			
Cash at bank		3,580,072	3,733,150
Total cash and cash equivalents		3,580,072	3,733,150
Note 5 – Trade and Other Receivables			
Trade receivables		12,836	24,307
Less: Provision for impairment		-	-
		12,836	24,307
Other receivables		123,628	125,452
Total trade and other receivables		136,464	149,759
Note 6 – Other Current Assets			
Accrued interest		18,723	30,427
Prepayments		50,069	20,638
Total other current assets		68,792	51,065

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

	Note	2024 $	2023 $
Note 7 – Property, Plant and Equipment			
Plant and equipment – cost		16,530	16,530
Less: Accumulated depreciation		(13,705)	(13,340)
		2,825	3,190
Furniture and fittings – cost		62,753	59,153
Less: Accumulated depreciation		(48,775)	(40,659)
		13,978	18,494
Motor vehicles – cost		22,500	22,500
Less: Accumulated depreciation		(22,500)	(18,375)
		-	4,125
Total property, plant and equipment		16,803	25,809

a. Movements in Carrying Amounts

Movements in the carrying amounts for each class or property, plant and equipment between the beginning and the end of the current financial year.

	Plant & Equipment $	Furniture & Fittings $	Motor Vehicles $	Total $
Balance at 1 January 2024	3,190	18,494	4,125	25,809
Additions	-	3,600	-	3,600
Disposals	-	-	-	-
Depreciation	(365)	(8,116)	(4,125)	(12,606)
Balance at 31 December 2024	2,825	13,978	-	16,803

	Note	2024 $	2023 $
Note 8 – Trade and Other Payables			
Trade and other payables		18,888	16,111
Contract liabilities	13	409,456	541,323
Employees – accrued salary and wages		24,521	19,358
Total trade and other payables		452,865	576,792

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

	2024 $	2023 $
Note 9 – Employee Provisions		
CURRENT		
Annual leave	42,675	65,117
Long service leave	99,160	90,971
	141,835	156,088
NON-CURRENT		
Long service leave	15,236	12,673
	15,236	12,673
Total employee provisions	157,071	168,761

Note 10 – Key Management Personnel Compensation

Any person(s) having authority and responsibility for planning, directing and controlling the activities of AINSE, directly or indirectly, including any director (whether executive or otherwise) of AINSE is considered key management personnel.

The totals of remuneration paid to key management personnel of AINSE during the years are as follows:

	2024 $	2023 $
Key management personnel compensation	231,254	233,562

Compensation includes salary and wages, superannuation and fringe benefits.

Key management personnel compensation includes a rate of $1,000 per meeting provided to Independent Board Members.

Note 11 – Other Related Party Transactions

There were no related party transactions during the financial year.

	2024 $	2023 $
Note 12 – Awards Reserve		
Opening balance at 1 January	674,408	767,394
Transfer to and (from) awards reserve	193,684	(92,986)
Balance as at 31 December	868,092	674,408

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

	2024 $	2023 $
Note 13 – External Grants		
GRANTS REVENUE		
ANSTO - Residential Student Scholarship Continuing (Year 2 onwards)	83,434	105,132
New Fund - Residential Student Scholarship New (Year 1)	34,754	46,638
New Fund - Early Career Research Grant	112,362	193,698
Scholarship AINSE ANSTO French Embassy (SAAFE)	3,842	13,538
	234,392	359,006
Contract Liabilities		
New Fund	363,689	510,805
Scholarship AINSE ANSTO French Embassy (SAAFE)	45,767	30,518
	409,456	541,323
Note 14 – Remuneration of Auditors		
AINSE Limited – Financial Statements	4,980	4,650
AINSE Limited – Audit	16,800	15,700
AINSE Limited – Consulting	530	1,410
AINSE Trust Fund – Financial Statements	1,430	1,340
AINSE Trust Fund – Audit	2,240	2,090
	25,980	25,190

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Notes to and Forming Part of the Financial Statements
For the Financial Year Ended 31 December 2024

Note 15 – Financial Risk Management

AINSE's financial instruments consist mainly of deposits with banks, local money market Instruments, short-term investments, accounts receivable and payable, and leases.

The carrying amounts of each category of financial instruments, measured in accordance with AASB 139 as detailed in the accounting policies to these financial statements, are as follows:

	2024 $	2023 $
Financial Assets		
Cash and cash equivalents	3,580,072	3,733,150
Trade and other receivables	136,464	149,759
Total financial assets	3,716,536	3,882,909
Financial Liabilities		
Trade & other payables	452,865	576,792
Total financial liabilities	452,865	576,792

Note 16 – Events after the Reporting Date

The Directors are not aware of any significant events since the end of the reporting period.

Note 17 – Company Details

AINSE's principal place of business is:

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
New Illawarra Road
LUCAS HEIGHTS NSW

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Directors' Declaration
For the Financial Year Ended 31 December 2024

The Directors of AINSE Limited (AINSE) declare that:

1. The financial statements and notes, as set out on pages 96 to 110 satisfy the requirements of the *Australian Charities and Not-for-profits Commission Act 2012* and *Not-for-profits Commission Regulation 2013*, and;

   (a) comply with Australian Accounting Standards – Simplified Disclosure Requirements, and

   (b) give a true and fair view of the financial position as at 31 December 2024 and of its performance for the year ended on that date.

2. In the directors' opinion there are reasonable grounds to believe that AINSE will be able to pay its debts as and when they become due and payable.

This declaration is made in accordance with a resolution of the Board of Directors.

Director MICHELLE DURANT

Director D. FILIPETTO

Dated this 19th day of March 2025

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Independent Auditor's Report to the Members of
AINSE Limited
For the Financial Year Ended 31 December 2024

Audit Opinion

Opinion

We have audited the financial report of AINSE Limited (AINSE), which comprises the statement of financial position as at 31 December 2024, and the statement of comprehensive income, statement of changes in equity and cash flow statement for the year then ended, and notes to the financial statements, including a summary of significant accounting policies, and the declaration by those charged with governance.

In our opinion, the accompanying financial report of AINSE is prepared, in all material respects, in accordance with *the Australian Charities and Not-for-profits Commission Act 2012, the Not-for-profits Commission Regulation 2013, including:*

(i) giving a true and fair view of AINSE's financial position as at 31 December 2024 and of its financial performance for the year then ended; and

(ii) complying with Australian Accounting Standards – AASB1060: *General Purpose Financial Statements - Simplified Disclosures for For-Profit and Not-For-Profit Tier 2 Entities* and *Australian Charities and Not-for-profits Commission Regulation 2013.*

Basis for Opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the *Auditor's Responsibilities for the Audit of the Financial Report* section of our report. We are independent of AINSE in accordance with the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 *Code of Ethics for Professional Accountants* (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other responsibilities in accordance with the Code. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Information Other than the Financial Report and Auditor's Report Thereon

Those charged with governance are responsible for the other information. The other information comprises the information included in AINSE's annual report for the year ended 31 December 2024 but does not include the financial report and our auditor's report thereon.

Our opinion on the financial report does not cover the other information and accordingly we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial report, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial report or our knowledge obtained in the audit or otherwise appears to be materially misstated.

If, based on the work we have performed, we conclude that there is a material misstatement of this other information; we are required to report that fact. We have nothing to report in this regard.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Independent Auditor's Report to the Members of
AINSE Limited
For the Financial Year Ended 31 December 2024

Responsibilities of Management and Those Charged with Governance for the Financial Report

Management is responsible for the preparation of the financial report in accordance with *the Australian Charities and Not-for-profits Commission Act 2012, the Not-for-profits Commission Regulation 2013*, and for such internal control as management determines is necessary to enable the preparation of the financial report that is free from material misstatement, whether due to fraud or error.

In preparing the financial report, management is responsible for assessing AINSE's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate AINSE or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing AINSE's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of the financial report.

A further description of our responsibilities for the audit of the financial report is detailed in Appendix A to the Auditor's Report.

Delante Accountants and Business Advisers Pty Ltd
Chartered Accountants

David G Aston
Director

TAREN POINT NSW 2229

Dated 19 March 2025

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Independent Auditor's Report to the Members of
AINSE Limited
For the Financial Year Ended 31 December 2024

APPENDIX A to the Auditor's Report

As part of an audit in accordance with Australian Auditing Standards, we exercise professional judgement and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial report, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of AINSE's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the directors.
- Conclude on the appropriateness of the directors' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on AINSE's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial report or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause AINSE to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial report, including the disclosures, and whether the financial report represents the underlying transactions and events in a manner that achieves fair presentation.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Auditor's Disclaimer
For the Financial Year Ended 31 December 2024

The additional data presented in the Detailed Profit & Loss Statement is in accordance with the books and records of AINSE Limited (AINSE), which have been subjected to the auditing procedures applied in the statutory audit of AINSE for the year ended 31 December 2024.

It will be appreciated that the statutory audit did not cover all details of the financial data and no warranty of accuracy or reliability is given. Neither the firm nor any member or employee of the firm undertakes responsibility in any way whatsoever to any person (other than AINSE) in respect of such data, including any errors or omissions therein however caused.

Delante Accountants and Business Advisers Pty Ltd
Chartered Accountants

David G Aston
Director

TAREN POINT NSW 2229

Dated 19 March 2025

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Detailed Profit & Loss Statement
For the Financial Year Ended 31 December 2024

		2024 $		2023 $
Operating Revenue				
Payments from Members		1,315,187		1,240,818
ANSTO Promotion Fee		410,300		410,600
External Grants		234,392		359,006
Interest Received		193,293		164,875
Other Income		-		46
Total Operating Revenue		2,153,172		2,175,345
Operating Expenses				
Wages & Salaries		638,677		593,165
Superannuation		99,831		92,478
AINSE Awards				
Postgraduate Awards				
ANSTO Facility Consumables	4,272		-	
Professional Development	5,506		1,009	
Stipends	936,108		953,505	
Thesis Publications	12,769		19,730	
Travel & Accommodation	87,149		118,166	
		1,045,804		1,092,410
Research Awards				
Early Career Researcher Grant	144,050		225,374	
Return of Unspent Funds	(39,688)		(39,676)	
		104,362		185,698
Conference Support		20,840		15,556
Events and Schools		88,788		61,744
Publication & Promotions		14,633		10,570
Meetings & Committees		43,658		43,911
AINSE Secretariat				
Administration & Staff Training	11,160		12,866	
Audit Fees	26,817		26,003	
Bank Charges	211		210	
Books & Software	7,770		13,496	
Consultant Fees	-		8,000	
Credit Card Expense	-		64	
Depreciation	12,606		13,294	
Entertainment	549		992	
FBT Expense & Payments	1,280		3,906	
Insurance	19,922		19,270	
Miscellaneous	14,154		14,240	

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Detailed Profit & Loss Statement
For the Financial Year Ended 31 December 2024

		2024 $		2023 $
Office Supplies	1,455		3,492	
Postage & Telephone	1,690		1,533	
Staff Recruitment	4,400		2,019	
Travel & Accommodation	11,904		8,924	
Vehicle Expenses	4,696		5,165	
		118,614		133,474
Total Operating Expenses		2,175,207		2,229,006
Surplus/(deficit) for the Year		(22,035)		(53,661)

Facilitating world-class research and education across Australia and New Zealand

Student funding opportunities:

AINSE Pathway Scholarships

A stipend of A$5,000 to support Honours or Masters students who are undertaking research at ANSTO, or processing data collected from ANSTO facilities.

Applications open: 1 December – 15 March annually.

AINSE Postgraduate Research Awards (PGRA)

Up to A$9,000 per annum awarded as a top-up stipend for PhD students undertaking research associated with nuclear science, engineering, and related research fields. Also includes fully-funded travel and accommodation to access ANSTO's research facilities.

Applications open: 1 February – 15 April annually.

AINSE Residential Student Scholarship (RSS)

A top-up scholarship for students spending an extensive amount of their PhD research time at ANSTO facilities. Up to A$9,000 stipend and A$5,000 travel support per annum.

Applications open: 1 February - 15 April annually.

AINSE Early Career Researcher Grant (ECRG)

A grant of up to A$10,000 to support Early-Career Researchers who are in the first five years (FTE) of their postdoctoral career and are working in collaboration with ANSTO.

Applications open: 1 May - 31 July annually.

Scholarship AINSE ANSTO French Embassies (SAAFE)

Funding to support Early Career Researchers at PhD and postdoctoral levels to travel from Australia or New Zealand to France - or from France to Australia - to foster research collaborations between France and Australia / New Zealand in nuclear science and engineering.

Overseas Conference Scholarship

For student travel or online registration to domestic or international conferences to present AINSE-supported research..

Technical Skills Scholarship

Students who have a current AINSE postgraduate award can apply to receive up to A$1,000 towards technical skills training at a Registered Training Provider.

Annual Events Calendar:

AINSE Winter School

July (online) + September (on-site)

For senior undergraduate STEM students.

Go behind the scenes with Australian landmark research facilities, guided by leading ANSTO researchers, at an intensive week-long online Winter School. Meet future research collaborators and explore potential research projects. Participants can apply to visit facilities at ANSTO's Sydney campus over two days in September.

Applications open: 1 March – 15 May.

AINSE Postgraduate Orientation Week

Nuclear Science Week, October (online event)

For new AINSE postgraduate scholarship recipients, and students interested in applying for future scholarship rounds.

Network with fellow early-career researchers from across Australia and New Zealand and take general and site-specific tours of the facilities at ANSTO's Sydney campus. Includes social activities, professional development opportunities, and a scholarship applications workshop.

Open to all new AINSE Pathway, PGRA and RSS recipients.
EOIs for future scholarship applicants open 1 August.

AINSE Women in STEM and Entrepreneurship (WISE) School

First week of December (hybrid event)

For first-year undergraduate women in STEM

Meet established researchers, entrepreneurs and STEM leaders, network with fellow first-year students from across Australia and New Zealand, and engage in a year-long mentorship program with AINSE and ANSTO professionals. This hybrid online/in-person event allows select students to visit ANSTO's Sydney campus for the final two days of the program.

Applications open: 1 August – 30 September.

Visit ainse.edu.au to learn more about AINSE-supported events and conferences.

AINSE

The Australian Institute of Nuclear Science and Engineering
New Illawarra Road, Lucas Heights NSW 2234 Australia
+61 2 9717 3376 | enquiries@ainse.edu.au | ainse.edu.au
ABN 18 133 225 331
AINSE Ltd.

8th WISE School

Women in STEM and Entrepreneurship

Inspiring and supporting the next generation of female leaders in STEM and Entrepreneurship

From 2 December to 6 December, AINSE held its 8th annual Women in STEM and Entrepreneurship (WISE) School. A total of 70 students from 21 AINSE member institutions across Australia and New Zealand participated in the hybrid program. As part of this hybrid program, 43 select students were invited to attend the final two days of the program on-site at ANSTO Lucas Heights Campus, with the other 27 students simultaneously joining the event virtually. This was the largest cohort AINSE has brought on-site for the AINSE WISE School, with hopes to continue growing the number in future years.

pay respects to the original scientists of the land ANSTO campuses are situated on. AINSE Managing Director, Michelle Durant, officially opened the 2024 WISE school and provided an overview of the various event and scholarship opportunities that AINSE offers to students and early career researchers of member institutions.

Through the first three days of the program, students heard from guest speakers, including Cherry Augustin (Radiation Therapist Educator, Westmead Hospital), Associate Professor Caroline Tiddy (Associate Professor in Geosciences,

“I got to learn so much about the industry and ANSTO that I never knew about before! It was so valuable to hear about others' journeys and experiences and to be able to see such a wide variety of careers and career paths!”

- 2024 WISE Student

Over the five days, the 2024 WISE cohort engaged and networked with other students and a diverse group of inspiring professionals from across STEM, business and policy, each offering a unique insight into their fields and career paths. Through engaging presentations and thoughtful discussions, the WISE speakers provided invaluable advice to undergraduate students on how to overcome challenges and establish a successful career in STEM.

The program began with a thoughtful Understanding of Country by Wannungine/Guringai man and ANSTO research chemist Brett Rowling to recognise and

University of South Australia), Kellie-Anne Farrawell (Tritium Facility Officer, ANSTO), Annie Chayko (Senior Safety Engineer, Thales Australia), Amanda Bovis (Chief Engineer, ANSTO), Kali Goldstone (Strategic Engagement and Advocacy Officer, Human Rights Commission), Dr Kelsi Dodds (Neurophysiologist, The University of Adelaide), Dr Emma Camp (Marine Biologist, University of Technology Sydney), Associate Professor Sarah Cresswell (Associate Professor of Forensic Chemistry, Griffith University), Dr Rebecca Duncan (Polar Marine Biologist, UNIS Svalbard and University of Technology Sydney), Associate Professor Natasha

p.119, top: WISE students visiting ANSTO's Lucas Heights campus on 5–6 December, while the remainder of the cohort joined online from around Australia and New Zealand; bottom: on-site students engaging with mentors and guests at the WISE Networking Dinner.

Hurley-Walker (Associate Professor in Radio Astronomy, Curtin University), Dr Laura Driessen (Radio Astronomer, The University of Sydney) and Chloe Rout (Research Agronomist, Living Farm).

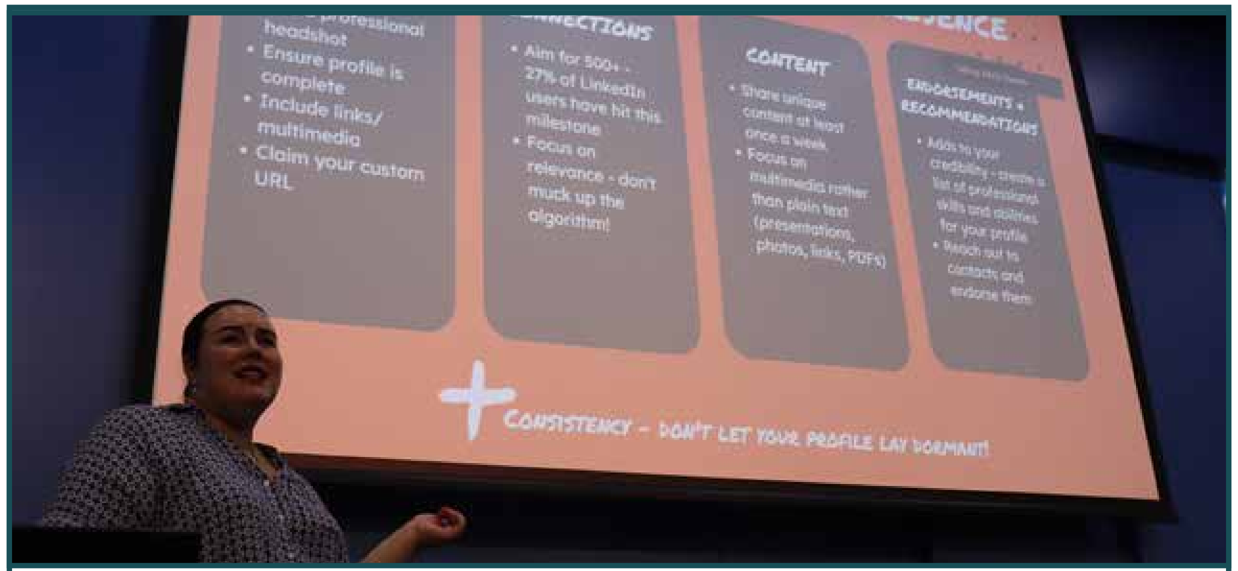
The cohort also heard from AINSE’s partner organisations, including the Women in Nuclear (WiN) Australia Chapter through Oceania Representative, Jasmin Diab, the Australian Young Generation in Nuclear (AusYGN) through President Shakila Fernando, and the ANSTO Ignite Network through AINSE Communications and STEM Manager, Dr. Michael Rose. Students also participated in a ‘Design Workshop’ with nandin Associate, Carol Azzam Mackay.

On day four of the program, all students took part in a tour of ANSTO’s key research infrastructure, hosted by the ANSTO Discovery Centre. This tour offered a unique behind-the-scenes look at the OPAL Multipurpose Reactor, Australian Centre for Neutron Scattering and Centre for Accelerator Science. The 43 students participating onsite visited these facilities in-person, whilst the students joining online took part in a virtual tour. Students then engaged in an Early Career Industry Panel with AINSE WISE Alumnae, Jennifer Tinker, Ingrid Ronnfeldt and Alex Bastick, who shared their career developments

following their WISE School experiences and provided advice for the new WISE cohort.

The 2024-2025 WISE Mentorship program officially commenced that afternoon, with all students having the opportunity to meet their ANSTO mentors at a hybrid networking event. The WISE Mentorship Program is a 12-month program aiming to provide students with guidance and support from their mentors through regular communication and moderated bi-monthly videoconference sessions focusing on pertinent topics for women in STEM. That evening, the on-site students were invited to a dinner in Circular Quay, followed by a networking breakfast at ANSTO on Friday morning, where students had further opportunities to network with mentors and connect with mentors from the ANSTO Board. AINSE are grateful to the 24 ANSTO staff members who generously volunteered their time to mentor the WISE students throughout 2024-2025.

On the final day of the program, students heard from Amanda Fortanier (General Manager, Safety and Technical, ARWA), Katrina Van De Ven (CEO and Co-Founder, Lükbook) and Professor Ania Paradowska (Industrial Liaison Manager & Senior Research Scientist, ANSTO and The University of Sydney) before



Katrina Van De Ven, CEO and Co-Founder of Lükbook, presenting to the WISE students.

undertaking a thought-provoking Science Communication Workshop with Dr. Michael Rose. Throughout the week, AINSE hosted a range of social activities, such as a virtual trivia competition, offering students the chance to connect with like-minded peers and establish a supportive network that could benefit them for years.

After five inspiring days, the 2024 AINSE WISE School was officially closed on Friday 6 December by AINSE Managing Director Michelle Durant, AINSE President Professor Ian Gentle and ANSTO Group Executive, Nuclear Operations and Nuclear Medicine, Pamela Naidoo-Ameglio.

AINSE would like to express our immense gratitude to all the guest speakers and mentors of the WISE School for their invaluable contributions to the success of the 8th Annual WISE School. We are excited to witness the ongoing growth and career trajectories of the 2024 WISE students as they stay connected with ANSTO and the WISE mentorship program.

2024 AINSE WISE School Students

Abigail McPhan	WOL	Khusnil Deo	WSU
Alexis Au	SYD	Lara Nikolovski	UTS
Aliyah Bakhitah	UWA	Lucinda Fien	NCT
Amber Soo	WOL	Lucy Scholten	ADE
Anais Holowacz	CAN	Madeleine Daley	CUR
Anna Jago	CAN	Madeline Amos	MUR
Ariana Mellor	CAN	Madelyn Rudgley	UTS
Ashika Hira	CAN	Manpreet Pandher	ADE
Bethany Conner	CAN	Masoome Alikhani	ECU
Breanna Conille Solomon	ADE	Melanie Leatherland	CAN
Cassandra Cameron	CAN	Muthuthanthrige Cooray	RMI
Charlotte Hardy	VUW	Nabiha Suha	RMI
Charlotte McCaughan	CSU	Naomi Dana	CAN
Chelsea Tse	SYD	Natalie Liow	RMI
Cleo Kent	ADE	Olive Kipping	MEL
Courtney Sidwell	RMI	Rachel Denholm-Hall	CUR
Danielle White	CDU	Samantha Vallance	FLI
Daphne Lan	SYD	Sandra Bui	RMI
Elizabeth Leo	CUR	Sarah Collins	CAN
Eloise Savry	CAN	Sarah Koschny	WOL
Emma Comerford	CAN	Sarah Manickam	UTS
Fidelis Athieno	ECU	Sienna Robinson	CAN
Fiona Wambugu	USA	Sierra Bell	ADE
Genevieve Vo	UWA	Sophie van den Eijkhoff	CAN
Gunkeerat Kaur	ADE	Soraya Machlaoui	VIC
Hamida Rezai	FLI	Sritanvi Mandapaka	FLI
Harriet van der Westhuizen	CAN	Sunny Davis	CAN
India Bellhouse	WOL	Susannah Priest	CSU
Indigo Lang	RMI	Tali Fishpool	UTS
Isabella Ferguson	MON	Tia Sharma	VIC
Jehaan Gydien	CAN	Tushti Chaturvedi	SYD
Jennifer Wales	NCT	Tyler Klinger	SYD
Jordan Selby	VUW	Vivian Duong	SYD
Judy Ferguson	VIC	Yulun Ali	NSW
Kelsey Smit	SYD	Zarlee Corolla	WOL

Student Disciplines / Areas of Study

Students attending the Women in STEM and Entrepreneurship School came from a diverse background of disciplines and areas of study, including the following:

Astrophysics	2
Biological Science	3
Biomedical Engineering	1
Biotechnology	1
Chemical Engineering	3
Chemistry	7
Law	1
Molecular Biology	1
Data Science	1
Computing	4
Earth Science and Geography	1
Electrical Engineering	1
Engineering	17
Commerce	1
Environmental Science	1
Forensic Chemistry	1
Genetics	1
Geospatial Science	1
Health/Medical/Biomedical Science	6
Marine Science	3
Maritime Engineering	1
Mathematics	4
Mechatronics Engineering	1
Medical Radiation Science	2
Mechanical Engineering	3
Nuclear and Space Radiation Science	1
Nuclear Medicine and Molecular imaging	1
Petroleum Engineering	1
Pharmaceutical Science	1
Physics	6
Physiology and Immunopharmacology	1
Space Science	1

28th Winter School

Building networks across Australia and New Zealand, and between scientific generations

The annual AINSE Winter School has provided senior undergraduate students across Australia and New Zealand with a connection to ANSTO researchers, research facilities, and postgraduate research opportunities at ANSTO since 1997.

The 28th AINSE Winter School provided 74 students from 25 member institutions with the opportunity to gain unique insights into the landmark research facilities at ANSTO. The 2024 Winter School was a hybrid structure, which was first implemented in 2022, consisting of an entirely-online event from 1-8 July, followed by small group visits to ANSTO's Lucas Heights campus for 42 selected students. The on-site visits took place from 2-17 September, with students visiting ANSTO for two days, allowing them to visit two ANSTO facilities during their time.

The online week was opened by Michelle Durant, AINSE Managing Director, who gave a warm welcome to students, and Brett Rowling, ANSTO experimental officer and Wannungine/Guringai man, who gave an engaging Understanding of Country and acknowledged the extensive history of Australian science over 60,000 years. This was followed by an overview of ANSTO's Nuclear Science and Technology (NST) infrastructure and research activities by Dr Jamie Schulz, Director of the Australian Centre for Neutron Scattering at ANSTO, and an introduction into Nuclear Science by Dr Ed Simpson from Australian National University.

Students were then taken on a virtual tour of the key ANSTO facilities by the ANSTO Discovery Centre, including the OPAL Multipurpose Reactor, where students gained a thorough understanding of OPAL's operation including explanations of how the neutrons produced in OPAL are used to create medical radioisotopes, produce high-quality doped silicon, and deliver neutron beams for use in research across various scientific disciplines.

Students engaged with a series of presentations and panel discussions from ANSTO researchers and research leaders, offering a comprehensive summary of the key research areas at ANSTO and the primary scientific infrastructure that underpins this research.

“It gave me a great opportunity to speak with scientists that I would absolutely love to collaborate with in the future."

- 2024 Winter School Student

p.125, top: Winter School students networking with ANSTO CEO Shaun Jenkinson during their on-site visit in September; bottom: selected students visiting ANSTO's Lucas Heights Campus during September after attending the online week held in July.

The interactive ANSTO Facility Sessions – the central activities of the Winter School – ran throughout the week. These sessions, delivered by ANSTO researchers working within each facility, gave students a behind-the-scenes look at research facilities including the Australian Synchrotron, Australian Centre for Neutron Scattering, Centre for Accelerator Science, Environmental Radioactivity Measurement Centre, Nuclear Materials and Characterisation, and the Heavy Ion Accelerator.

Students also had the opportunity to hear from representatives from Women in Nuclear (WiN) Australia, Australian Young Generation in Nuclear (AusYGN), Ignite Network and the Australian Radioactive Waste Agency (ARWA).

The final afternoon of the Winter School was dedicated to the online Research Roundup Networking Event and Facility Session Roundtable, where students connected with ANSTO researchers in small-group virtual meetings to ask detailed questions about ongoing research at ANSTO. AINSE is excited to see the collaborations initiated throughout the program develop as Winter School participants move forward to apply for AINSE scholarships to support their future Honours and postgraduate research. The Winter School concluded with closing remarks from AINSE President Prof. Ian Gentle, ANSTO CEO Shaun Jenkinson, and AINSE Managing Director Michelle Durant.

Through the first three weeks of September, AINSE brought 42 final-year undergraduate students from 20 AINSE-member institutions, on-site to ANSTO's Lucas Heights Campus. After gaining deeper understanding of each of the ANSTO facilities during the online week in July, students could nominate which facilities they would like to visit. Within these small-group visits, students visited the following facilities: Australian Centre

for Neutron Scattering, and Nuclear Materials and Characterisation (2nd – 3rd September), Australian Centre for Neutron Scattering, and Centre for Accelerator Science (9th – 10th September), Natural Radioactivity in Environmental Studies, and Centre for Accelerator Science (16th – 17th September). On the second day of each visit, AINSE hosted networking breakfasts to enable students to meet and interact with ANSTO staff, and discuss potential collaborations with future Honours, Masters and/or Ph.D. research projects.

AINSE would like to express its gratitude to all the ANSTO speakers, Facility Session organisers, and Research Roundup participants for their essential contributions in ensuring the success of the 28th Annual Winter School. We look forward to welcoming the participating students back to ANSTO as they undertake collaborations and research projects in the future.

The 2024 Winter School was a hybrid structure, with seventy four students joining online in July (as seen in above image), followed by smaller group visits to ANSTO's Lucas Heights campus in September.

Student Disciplines / Areas of Study

Students attending the Winter School came from a diverse background of disciplines and areas of study, including the following:

Archaeology	1	Information Science and Technology	2
Arts	1	Marine Science and Ecology	2
Astronomy	1	Material Engineering	1
Biochemistry	1	Mathematics	4
Biology	2	Mechatronics Engineering	1
Biomedical Science	5	Medical Science	3
Chemical Engineering	5	Medicinal Chemistry	2
Chemistry	18	Microbiology	1
Civil Engineering	2	Mining Engineering	2
Earth Science	2	Music	1
Electrical Engineering	2	Nanotechnology	1
Engineering	4	Physics	10
Environmental Science	4	Science	5
Forensic Science	1	Space Science	1
Geography	1	Statistics	1
Geology	1		

(duplicates represent students enrolled in combined degrees)

2024 AINSE Winter School Students

Abbie Watson	CAN	Jennifer Mulder	QLD
Adele McRae	MAC	Jennifer Lee Tinker	RMI
Alexandra Ritter	RMI	Jerry Yan	MEL
Alicia Celine Werlen	SYD	Jessica Goodwin	QLD
Alissa Reinke	USQ	Kerry Zheng	MEL
Annie Grace Kraehe	ANU	Kirti Giridhar	UWA
Bethany Anne Frankis	GRI	Krysta-Leigh Douglass	RMI
Breeanah Hope Borsi	RMI	Lachlan Hoffman	NCT
Callum Clausen	CAN	Lachlan Murphy	SWI
Candice Mitchell	QLD	Lucas Berry	SWI
Chantelle Rose Falanga	ADE	Luke Trounce	USC
Chundu Gyem Tamang	USQ	Luke Steven Clifford	SYD
Claire Morey	MON	Mackayla Fletchere-Davies	RMI
Conrad Livingstone	SWI	Matthew Olzard	JAM
Copernicus Fung	MON	Matthieu Cobby Gagnon	UWA
Courtney Monica Green	CAN	Mikayla Gallina	MON
David Michael Whiteside	USA	Narasimha Reddy Mamilla	ADE
Edward Pitt	QLD	Olivia Jane Connolly	CAN
Elizabeth Cook	SYD	Oscar Goodwin Keats	JAM
Ella Cross	RMI	Patjaree Aukarasereenont	CSI
Emily Myers	QLD	Peter David Spencer	USC
Emma Faraone	MON	Rose Wilkens	LAT
Emma Lila Cooney	QLD	Rosette Wanis	ANU
Erick Rolando Canessa Lau	QLD	Rubi McLennan	QLD
Fareeha Alma	QLD	Rufus Mart Ceasar Ramos	DEA
Gabrielle Margot Grace Hancox	USA	Salman Al-Saeedi	DEA
Garvit Madan	MON	Samuel Lee	TAS
Georgia Mary Baillie	QLD	Shafia Husna	SWI
Hanny Chua	UNE	Sophie Bennet	CAN
Hayley Wagner	USQ	Taylor Manouge	USQ
Imaad Abdul Hafeez	RMI	Therese Masele Tui Samoa	AKL
Imogen Bell-Butler	CAN	Timothy John Harrison	RMI
Isabel Bradley	CAN	Veda Patel	AKL
Isabella Jajjo	WSU	Virginia Baird	CAN
Isabelle Kameron	FLI	Xavier Gambetta	ADE
Jack Hitching	ANU	Xinnian Li	DEA
Jasmine Hutchinson	CSU	Yu Chen	DEA

Pathway Scholarships

In 2024, AINSE expanded its Honours program, that first commenced in 2011, into a new Pathway Scholarship program that also encompassed students enrolled in any Masters degree at an AINSE-member institution. The new Pathway program provides scholarships to a small number of excellent Honours or Masters students who have a project that utilises the research facilities at ANSTO.

AINSE Pathway Scholarships provide a stipend of A$5,000. Their purpose is to provide a link between the AINSE Winter School and other AINSE programs, such as the AINSE Postgraduate Research Award (PGRA).

AINSE wishes to congratulate the thirty successful students representing sixteen universities who were awarded a Pathway Scholarship in 2024.

Images taken by Lottie Stevenson, an AINSE Pathway scholar who conducted field work in Eastern Antarctica. p130: Field tent setup. p.131: Image 1: (top) Lottie and research team at Byrd Glacier Antarctica. Image 2: (left) Lottie extracting isotope at ANSTO's CAS facility. Image 3: (right) Lottie's teammate on fieldwork in Antarctica. Image 4: (bottom) Eratic rock with Byrd Glacier in the background.

Honours/Masters students supported in 2024: **30**

Students supported through an AINSE Pathway or Honours Scholarship since 2011: **313**

Lottie Stevenson, an AINSE Pathway scholar, and her collaborators conducting field work in Eastern Antarctica, alongside Byrd Glacier.

Pathway Scholars, and Their Projects, supported in 2024:

Effect of mechanochemical activation on the hydrometallurgical recycling of spent $LiCoO_2||Li_4Ti_5O_{12}$ batteries.
Lilian Andrew, The University of New South Wales.

Characterising Local Disorder in alpha-$Ba_4Nb_2O_9$.
Eugene Bakker, The University of Sydney.

Quantifying impacts of external radiation to Australian marine organisms.
Alexandra Bastick, Charles Sturt University.

Mapping the hidden fluid pathways in Earth's ductile crust.
Nikki Bishop, Queensland University of Technology.

Using self-consistent local mean field theory to generate magnetic moment structures in a low dimensional quantum magnet.
Anna Carpenter, The University of Newcastle.

Control and kinetics of functional amyloid assembly: Investigating the role of disordered regions.
Sienna Clarke, The University of Sydney.

IONSIV Waste Immobilisation in Hot Isostatically Pressed Glass-Ceramic Waste Forms.
Jessica Degeling, The University of New South Wales.

Characterisation of $CD4^+$ and $CD8^+$ T cell responses to a nested influenza-derived peptide.
Georgia Dow, La Trobe University.

Compositional Diversity of Titan's Surface: Unveiling New Mineral Assemblages.
Sonya Emmett, The University of Western Australia.

Manipulation of the Skyrmion Phase in Cu_2OSeO_3 Single Crystals by Light.
Louise Flint, The University of New South Wales.

Developing biomimetic drug delivery vehicles through the investigation of lipid-coated silicon nanoparticles.
Lauren Giles, RMIT University.

Exploring the Use of Lipidic Mesophases as a Platform for On-site Detectors for Sulfate Pollution.
Yang Guo, Monash University.

Investigating internal structure in biomolecular condensates: effects on molecular interactions and material properties.
Jacob Hartshorn, University of Canterbury.

Toxicokinetic and Trophic Accumulation Dynamics of Mercury and Selenium in a Tropical Marine Predatory Fish.
Holly Hollomon, The University of New South Wales.

Estimating shallow magma body depths from volatiles dissolved in glass recovered during drilling at the Puna Geothermal Venture wellfield, Hawaii.
Brianna Kirkham, University of Canterbury.

Exploring the protein dynamics of human IgG allelic variants.
Marina Kuplich Barcellos, The University of Waikato.

Low-Valent Boron Catalysts for Hydrogen Activation.
Rebecca Majchrzak, The Australian National University.

Developing new osmium probes for lipid detection in brain tissues.
Breah Milford, Curtin University.

Exploiting the Potential of Neutron Capture Enhanced Particle Therapy (NCEPT) for Glioblastoma Treatment.
Joshua Morris, Queensland University of Technology.

Expression and characterisation of the Atypical Dark Kinase RIOK3.
Jacqueline Ormsby, University of Canterbury.

Converting Environmental Pollutants into Fine Chemicals using 'Trapped' Main Group Anions.
Jessica Porter, The Australian National University.

Exposing past marine environments in Antarctica using Beryllium isotope signatures
Selma Richter, University of Canberra.

Cluster-based catalysts for catalytic conversion of CO_2.
Angelo Santos, University of Canterbury.

Nanomaterial Interactions with Model Cell Membranes.
Tilly Shepherd, RMIT University.

Engineering resistance against *Magnaporthe oryzae* using nanobodies.
Benjamin Silke, The Australian National University.

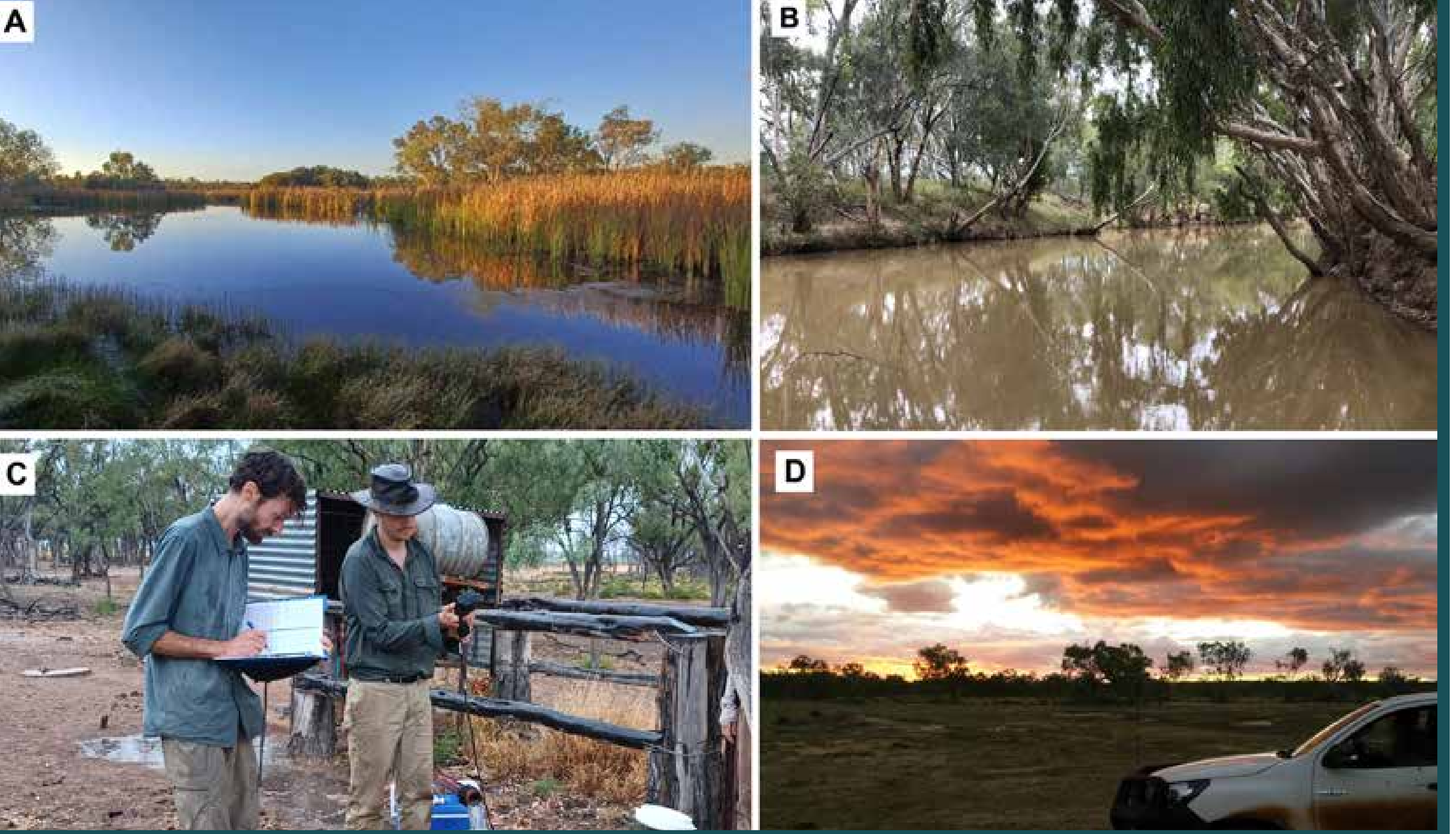
Gas Sequestration in Polymethylpentene (TPX).
Lachlan Souter, University of Wollongong.

Reconstructing the deglacial thinning history of Byrd Glacier, East Antarctica, using surface exposure dating.
Lottie Stevenson, Victoria University of Wellington.

Chlorine-36 in magnetite: A new capability for studying the links between chemical weathering and the global carbon cycle.
Angus Walton, University of Wollongong.

Correlation of Single Event Upset cross section in commercial SRAM integrated circuits between charged particle microbeam irradiation and pulsed laser energy deposition methods.
Jacob Wright, University of Wollongong.

Towards rapid inhibitor development against RNA-binding proteins.
Esther Zhang, The University of Sydney.



Top: AINSE PGRA Scholar Angus Campbell at: (A) the Doongmabulla springs. Photo credit: Matthew Currell. (B) the Carmichael River. Photo Credit: Angus Campbell. (C) Angus Campbell (right) and Matthew Currell (left) collecting groundwater samples. Photo credit: Matthew Currell. (D) Sunset over the Doongmabulla springs. Photo credit: Matthew Currell (see p.9 for further details).

Bottom: AINSE PGRA scholar Larissa Lopes Cavalcante transferring synthesised diacetylene to the vanadium can on the WOMBAT neutron diffractometer at the Australian Centre for Neutron Scattering (ACNS). Photo credit: Helen Maynard-Casely (see p.69 for further details).

PGRA Scholarships

Postgraduate Research Award

PGRA students supported in 2024: **113**

New PGRA students in 2024: **34**

Students trained in nuclear science and related fields under an AINSE PGRA: **632**

An AINSE Postgraduate Research Award (PGRA) is a top-up scholarship.To be eligible for one of these awards, an applicant must hold an Australian Government Research Training Program scholarship (RTP) or equivalent primary scholarship. The PGRA may be held until the expiry of the recipient's primary scholarship.

In addition to providing a student with a stipend of A$9,000 per annum, the award provides access to ANSTO's world-class facilities and expertise. An allowance for travel expenses for two visits and a total of twenty-eight nights of accommodation to Lucas Heights per annum is also awarded.

Thirty-four new AINSE postgraduate research projects were supported by a PGRA in 2024. The total number of scholars supported in 2024 was one hundred and thirteen. AINSE received notifications of thirty three theses (thirty one PGRA and two RSS) this year and, through its PGRA program, has now helped train six hundred and thirty-two students in aspects of nuclear science and associated techniques of analysis. Many more students have been assisted with their research by gaining access to ANSTO facilities through AINSE Awards granted to their supervisors.

The Members believe that one of the most valuable roles fulfilled by AINSE is the provision of these scholarships.

AINSE PGRA Scholar Casey Ryan recording his collegues on fieldwork in Western Australia, sampling speleothem caves.

PhD Theses of Postgraduate Scholars Notified during 2024:

Gloria Diaz-Arenas
Diaz-Arenas, G 2024, 'Membrane separation and characterisation of bio-sourced xylooligosaccharides', Ph.D. Thesis, Monash University.

Carin Basirun
Basirun, C 2024, 'Investigating Cardiovascular Mechanotransduction: Insights from Cardiac Models Under Simulated Microgravity and Radiation', Ph.D. Thesis, University of Technology Sydney.

Matthew Large
Large, M 2024, 'Advanced Methods for Radiation Protection in Medical and Space Applications', Ph.D. Thesis, University of Wollongong.

Harrison Stevens
Stevens, H 2024, 'Investigating the Recent Depositional History of Nutrients, Heavy Metals, and Fire Markersin Tasmanian Highland Lakes', Ph.D. Thesis, University of Tasmania.

Yeping Ji
Ji, Y 2024, 'Minimising multiple scattering and experimental artefacts for simulated in-situ conditions of (Ultra)-Small Angle Neutron Scattering experiments', Ph.D. Thesis, The University of New South Wales.

Yangfan Wang
Wang, Y 2024, 'Development and performance investigation of low activation medium entropy alloy FeCr2VWx via arc melting for fusion applications', Ph.D. Thesis, University of Wollongong.

Hayden Robertson
Robertson, H 2024, 'Decoding Specific Ion Effects: Polymer Brushes in Complex Electrolytes', Ph.D. Thesis, The University of Newcastle.

Calum Butler
Butler, C 2022, 'Exploring the effects of molecular structure on surfactant behaviour, micelle morphology and formulation properties', Ph.D. Thesis, Monash University.

Stuart Brown
Brown, S 2023, 'Designer Solvents for Understanding Protein Stability', Ph.D. Thesis, RMIT University.

Carl McCombe
McCombe, C 2023, 'Functional characterisation of Nudix hydrolase effectors from phytopathogenic fungi ', Ph.D. Thesis, The Australian National University.

Tara Oliver
Oliver, T 2023, 'Bismuth-NSAIDs as colorectal cancer chemopreventives', Ph.D. Thesis, University of Wollongong.

Daniel Yu
Yu, D 2023, 'Structural investigation of the interaction between SIX effectors and resistance proteins', Ph.D. Thesis, The Australian National University.

Abuduliken Bake
Bake, A 2023, 'Engineering order-disorder transitions at the surface of topological insulators to manipulate electronic transport', Ph.D. Thesis, University of Wollongong.

Sarah Otto
Otto, S 2023, 'Development of Thermoresponsive Polysaccharides as Tunable Delivery Systems', Ph.D. Thesis, University of South Australia.

Andrew Braz
Braz, A 2024, 'Spin Crossover in Chalcogen-Containing Heterocyclic Metal–Organic Frameworks', Ph.D. Thesis, The University of Sydney.

Felicia Haase
Haase, F 2023, 'Unravelling the Early Diagenesis of Vanadium in Anoxic Marine Environments', Ph.D. Thesis, Griffith University.

Thulya Chakkumpulakkal Puthan Veettil
Veettil, T C P 2023, 'Vibrational Spectroscopic Approaches for Disease and Metabolic Diagnosis', Ph.D. Thesis, Monash University.

Thomas Sanders
Sanders, T 2024, 'Understanding the Terahertz Spectra of Amino Acid Molecular Crystals: Experiment and Theory', Ph.D. Thesis, University of Wollongong.

Nisal Wanasingha
Wanasingha, N 2024, 'Resilin-mimetic Polypeptides: Biosynthesis and Structure-Function Correlation', Ph.D. Thesis, RMIT University.

Lucinda Duxbury
Duxbury, L 2022, 'Holocene climate, fire and ecosystem change on Kangaroo Island (Karti), South Australia', Ph.D. Thesis, The University of Adelaide.

Daniel Doherty
Doherty, D 2024, 'Evolution and inhibition of cholesterol catabolising P450 enzymes in pathogenic mycobacteria', Ph.D. Thesis, The University of Adelaide.

Alice Tiong
Tiong, A 2024, 'Legume Protein Isolate Properties and the Implications for Meat Analogue Production ', Ph.D. Thesis, Monash University.

Cintya Dharmayanti
Dharmayanti, C 2024, 'Development of pH-responsive polymer homopolypeptide micelles for drug delivery', Ph.D. Thesis, University of South Australia.

Xuemei Li
Li, X 2024, 'Metal-Organic Framework Crystal Glass Composites', Ph.D. Thesis, The University of Queensland.

Rebecca Duncan
Duncan, R J 2024, 'Climate change induced shifts in polar microalgae nutritional content: species, community and trophic implications', Ph.D. Thesis, University of Technology Sydney.

Harley Rutherford
Rutherford, H 2024, 'Development of Novel Dose Quantification Methods for Heavy Ion Radiotherapy Using In-Beam Positron Emission Tomography Imaging', Ph.D. Thesis, University of Wollongong

Libei Yuan
Yuan, L 2024, 'Designing advanced Zn-based batteries with highly reversible Zn anodes', Ph.D. Thesis, University of Wollongong.

Vladimir Pan
Pan, V 2024, 'Radiobiological Effectiveness of Charged Particle Therapeutic Beams: Experimental Derivation, Application for Treatment Optimization and Radiation Protection of Astronauts', Ph.D. Thesis, University of Wollongong.

Kia Matley
Matley, K 2024, 'Pollen and macrofossil-based reconstructions of southeast Australian vegetation, and their implications for Late Pleistocene palaeoclimate reconstructions ', Ph.D. Thesis, The University of Melbourne.

Zo Shaw
Shaw, Z L 2024, 'Low-Dimensional Materials forAntimicrobial Treatment', Ph.D. Thesis, RMIT University.

Michelle Croughan
Croughan, M K 2024, 'Single-exposure directional dark-field x-ray imaging', Ph.D. Thesis, Monash University.

Samantha Alloo
Alloo, S 2024, 'Multimodal Intrinsic Speckle-Tracking: Complementary, Rapid, and High-Resolution X-ray Imaging', Ph.D. Thesis, University of Canterbury.

Shankar Dutt
Dutt, S 2024, 'Fundamentals and Applications of Ion Tracks and Nanopores in Solid State Membranes', Ph.D. Thesis, The Australian National University.

Postgraduate Scholars, and Their Projects, supported in 2024:

Dual-energy propagation-based dark-field imaging on the Imaging and Medical Beamline
Jannis Ahlers, Faculty of Science; School of Physics and Astronomy, Monash University.
Commenced 01/07/2024.

Investigating severe COVID-19 and its genetic link: the role of HLA-C molecule
You Min Ahn, Agriculture, Biomedicine and Environment, La Trobe University.
Commenced 01/07/2023.

Understanding the complex magnetic interactions in magnetic low-dimensional materials for future spintronic devices.
Jackson Allen, Physics, University of Wollongong.
Commenced 01/07/2021.

Developing speckle-based X-ray imaging as a multimodal technique.
Samantha Alloo, School of Physical and Chemical Sciences, University of Canterbury.
Commenced 01/07/2022.

Does nutrient enrichment enhance the loss of old stored carbon in seagrass beds?
Mona Abouhaidar Andskog, Science and Engineering, Southern Cross University.
Commenced 01/07/2023.

Structure and mechanism of TRAP-associated extra-cytoplasmic immunogenic transporter in Thermus thermophilus
Irene Antony, Biomolecular Interaction Center, School of Biological sciences, University of Canterbury.
Commenced 01/07/2024.

Development of Methodologies and Strategies for Radiation Protection of Astronauts in Long Term Space Missions
Jay Archer, Physics, University of Wollongong.
Commenced 01/07/2023.

Investigation of the oxymercuration reaction for mercury-203 radiolabelling of alkenes for radiopharmaceutical applications.
Meaghan Ashton, School of Physical Sciences , The University of Adelaide.
Commenced 01/07/2022.

Treatment optimisation for synchrotron radiotherapy.
Micah Barnes, Centre for Medical Radiation Physics, University of Wollongong.
Commenced 01/07/2021.

Decreasing rainfall and its impact on water resources in southwest Australia.
Rose-Anne Bell, School of Agriculture and Environment, The University of Western Australia.
Commenced 01/07/2021.

Realizing new intrinsic magnetic topological insulators and heterostructures for lossless transport applications at high temperature.
Md Tofajjol Hossen Bhuiyan, School of Physics and Astronomy, Monash University.
Commenced 01/07/2023.

Top-down synthesis of metal oxide nanoparticles using metal-organic-frameworks.
Rebecca Blake, School of Molecular Sciences, The University of Western Australia.
Commenced 01/07/2024.

Understanding the electron and magnetic properties of 2D Kagome metals via ARPES and STM.
James Blyth, School of Physics and Astronomy, Monash University.
Commenced 01/07/2022.

A holistic investigation of materials for use in all-solid-state batteries: from local structure to device scale interactions.
Michael Brennan, School of Chemistry, The University of Sydney.
Commenced 01/07/2022.

Ascertaining the optimal lipid packing parameters and lipid headgroup selection for the phospholipase A2 tethered bilayer lipid membrane sensor.
Samara Bridge, School of Life Sciences, University of Technology Sydney.
Commenced 01/07/2024.

Using geochemical indicators to assess the vulnerability of springs to mining impacts: Doongmabulla Springs and the Carmichael Coal mine (Queensland).
Angus Campbell, School of Engineering, RMIT University.
Commenced 01/07/2022.

Dosimetry and Diagnostics for ultra-high dose-rate very high-energy electron radiotherapy at PEER.
James Cayley, Engineering and Information Sciences - School of Physics, University of Wollongong.
Commenced 01/07/2024.

New insights into colloidal phase transitions using neutron scattering techniques.
Katherine Chea, School of Science, Physics, RMIT University.
Commenced 01/07/2020.

Thin-wall effects and residual stress of additively manufactured Cu-10Sn.
Kangwei Chen, Faculty of Engineering, School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney.
Commenced 01/07/2024.

Travertine and speleothems as recorders of magmatic processes and volcanic eruptions from Mount Taranaki.
Nathan Collins, School of Environment, The University of Auckland.
Commenced 01/07/2022.

Using radiometric approaches to quantify blue carbon in Australian mangrove carbonate settings.
Brooke Conroy, School of Earth, Atmospheric and Life Sciences, University of Wollongong.
Commenced 01/07/2022.

Response, resilience and recovery of Tasmania's endangered Pencil Pine using a multi-archive palaeoenvironmental record.
Sarah Cooley, School of Geography, Earth and Atmospheric Sciences, The University of Melbourne.
Commenced 01/07/2022.

Phase-Contrast Computed Tomography (PC-CT) for Clinical Lung Cancer Diagnostics.
Lucy Costello, Faculty of Science, School of Physics and Astronomy, Monash University.
Commenced 01/07/2024.

Application of directional dark-field x-ray imaging to biological samples for low-dose super-resolution imaging.
Michelle Croughan, School of Physics and Astronomy, Monash University.
Commenced 01/07/2023.

Cosmogenic constraint on Holocene glacier retreat.
Aylin de Campo, Antarctic Research Centre, Victoria University of Wellington.
Commenced 01/07/2024.

Optimising treatment delivery for large field size synchrotron based spatially fractionated radiotherapy.
Vincent de Rover, Faculty of Engineering and Information Sciences, School of Physics, University of Wollongong.
Commenced 01/07/2024.

Research Highlights:

Angus Campbell - p.09

Using geochemical indicators to assess the vulnerability of springs to mining impacts Doongmabulla springs and the Carmichael Coal Mine (Queensland)

Jay Archer - p.43

Nanodosimetric studies and characterisation of silicon detectors for the assessment of radiation on the Moon

Development of pH-responsive, receptor-targeted polymeric micelles for precision delivery of chemotherapeutics.
Cintya Dharmayanti, Clinical and Health Sciences, University of South Australia.
Commenced 01/07/2022.

Probing the structure and properties of novel silicon-containing polymer brushes in non-aqueous environments.
Zachary Di Pietro, College of Engineering, Science and Environment/School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2024.

Resolving Ghost Forest tree methane flux rates, origin, and age using a novel 14C-CH4 approach.
Johannes Dittmann, Faculty of Science and Engineering, Southern Cross University.
Commenced 01/07/2024.

Unlocking the environmental archives of the Kimberley's past.
Teresa Dixon, School of Earth and Environmental Sciences, The University of Queensland.
Commenced 01/07/2022.

A novel characterisation of the platy morphology of talc in a copper ore flotation using neutron computed tomography.
Daniel Dodoo, Engineering, Information and Technology, The University of Melbourne.
Commenced 01/07/2024.

Investigating P450 enzymes found in pathogenic mycobacteria as potential drug targets for new-line antibiotics.
Daniel Doherty, School of Physical Sciences, The University of Adelaide.
Commenced 01/07/2021.

Trace metal geochemistry in urban mangrove sediments: a new view using gel-based samplers and high-resolution X-ray imaging
Mark Donaldson, School of Environment and Science, Griffith University.
Commenced 01/07/2024.

Measurement of concurrent interphase precipitation and phase transformation in Ti-Mo steels by Small Angle Neutron Scattering (SANS).
Baoqi Dong, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2022.

Using giant clam shell geochemistry to understand past environmental change and human-environment interaction in the South Pacific.
Bohao Dong, School of Geography, The University of Melbourne.
Commenced 01/07/2021.

Using Automation to Decipher Ion Specificity in Complex Electrolyte.
Geran Dunlop, Faculty of Chemistry, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2024.

Assessing climate resilience in a subtropical groundwater-dependent ecosystem.
Madeleine Dyring, School of Earth and Environment, The University of Queensland.
Commenced 01/07/2021.

Bioaccumulation and biomagnification of toxic metals in the Finniss River food web.
Isabel Ely, College of Engineering, IT & Environment, Charles Darwin University.
Commenced 01/07/2022.

Chronicles of the Southern Alps: Unravelling mechanisms of Holocene climate change using sedimentary timekeepers.
Julian Eschenroeder, Department of Geology, University of Otago.
Commenced 01/07/2023.

Using a multi-tracer approach to assess vulnerability of culturally and ecologically significant springs in the eastern Great Artesian Basin.
Monica Esmond, School of Engineering and Built Environment, Griffith University.
Commenced 01/07/2024.

Improving the permeability and selectivity of glycosylation inhibitors to enhance tumour radiosensitivity.
Rebecca Farrell, School of Chemistry and Molecular Bioscience, University of Wollongong.
Commenced 01/07/2022.

Using a dual carbon isotope approach (14C and 13C) to differentiate transport and transformation of aged carbon in intermittent streams.
Ryan Felton, Faculty of Science and Engineering, Southern Cross University.
Commenced 01/07/2023.

Neutron and X-ray characterisation of lunar and martian minerals.
Nicholas Florent, Physics, RMIT University.
Commenced 01/07/2021.

Interfacial crystallization of lipids in food formulations in the presence of sugar-based emulsifiers.
Jessica Frahn, Future Industries Institute, University of South Australia.
Commenced 01/07/2023.

Short-range order, structure evolution and diffusion behaviour of liquid metals under an external magnetic field.
Rong Fu, School of Mathematical and Physical Sciences, University of Technology Sydney.
Commenced 01/07/2022.

Developing Biomimetic Nanoparticle Drug Delivery Vehicles.
Soroosh Gharehgozlo, STEM College, RMIT University.
Commenced 01/07/2024.

Unravelling the drivers of orbital- and millennial-scale hydroclimate change in Australia's southern arid margin through the last glacial period.
Calla Gould-Whaley, School of Geography, The University of Melbourne.
Commenced 01/07/2021.

Localizing monomers within hexagonal lyotropic liquid crystal template for the fabrication of nanofiltration membranes.
Senlin Gu, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2021.

Investigation of Cubosomes for Enhanced Delivery of Drugs and Neuroprotective Compound to the Brain as Multitarget Treatment for Alzheimer's Disease.
Lucrezia Guarneri, Chemical and Biological Engineering, Monash University.
Commenced 01/07/2024.

Investigating the synergy of a Lactoferrin-derived peptide Lactofungin and the anti-fungal drug Amphotericin B.
Lissy Hartmann, School of Life Sciences, University of Technology Sydney.
Commenced 01/07/2023.

Development of scalable x-ray nanofabrication fabrication technology.
Blair Haydon, School of Computing, Engineering and Mathematical Sciences, La Trobe University.
Commenced 01/07/2024.

Synthesising exotic carbon phases from molecular carbon and hydrocarbon precursors.
Hendrik Heimes, Research School of Physics, The Australian National University.
Commenced 01/07/2024.

Shedding light, and electrons, on MLKL oligomerisation within native cell membranes
Hanadi Hoblos, Faculty of Medicine, Dentistry and Health Sciences, Department of Medical Biology, The University of Melbourne.
Commenced 01/07/2024.

Research Highlights:

Calla Gould-Whaley - p.14

Groundwater recharge on Australia's southern arid margin

Teresa Dixon - p.31

Exploring 65,000 years of monsoonal history: hydroclimatic insights from Kimberley floodplain sediments

Lissy Hartmann - p.52

Finding synergy: Understanding the effect of the peptide Lactofungin on the antifungal drug Amphotericin B

Rebecca Farrell - p.61

Development of non-toxic glycosylation inhibitors to enhance cancer radiotherapy

Developing next-generation anti-microbial surfaces: metal doped and hydrothermally-etched substrates.
Louisa Huang, School of Science (Applied Chemistry), RMIT University.
Commenced 01/07/2021.

Towards More Enzyme-like MOF-based Catalysts.
Tyla Jones, Faculty of SET, School of Physics, Chemistry; Earth Sciences, The University of Adelaide.
Commenced 01/07/2024.

Targeting tRNA charging as a novel anti-infective strategy.
Nutpakal Ketprasit, Department of Biochemistry and Pharmacology, The University of Melbourne.
Commenced 01/07/2023.

Investigation of novel fluorine-free firefighting foams based on hydroxysultaine surfactants: A molecular approach.
Ramya Khandika, Energy and Resources Institute, Charles Darwin University.
Commenced 01/07/2024.

Coherent Wavefront Metrology for Extreme Ultraviolet Lithography.
Jerome Knappett, Department of Mathematical and Physical Sciences, La Trobe University.
Commenced 01/07/2023.

High Frequency MHz Acoustic modulation of polymers using THz-IR; WAXS.
Robert Komljenovic, Department of Chemical Engineering, RMIT University.
Commenced 01/07/2024.

Deriving the functional mechanism of Ni-rich layered oxides as high-performance cathodes for Li-ion batteries.
Jingxi Li, School of Chemical Engineering, The University of Adelaide.
Commenced 01/07/2023.

Lead halide perovskite metal-organic framework glass composites for photoluminescence.
Xuemei Li, School of Chemical Engineering, The University of Queensland.
Commenced 01/07/2022.

Correlating morphology and performance in optoelectronic devices.
Oliver Lindsay, Faculty of Science, School of Chemistry and Molecular Biosciences, The University of Queensland.
Commenced 01/07/2024.

Advancing cardiovascular disease therapies through vaccine-inspired mRNA-loaded lipid nanoparticles.
Haikun Liu, Baker Department of Cardiometabolic Health, The University of Melbourne.
Commenced 01/07/2023.

Titan nitrogen chemistry: organic building blocks for the origin of life.
Larissa Lopes Cavalcante, Department of Chemistry, University of Otago.
Commenced 01/07/2023.

Cosmogenic Dating Doctoral Research Assistance.
Karsten Lorentz, Earth Sciences, Antarctic Research, Victoria University of Wellington.
Commenced 01/07/2020.

Investigating Magnetoelectric Effects of a BiFeO3 Resonant Tunnelling Diode.
King Luo, School of Materials Science & Engineering, The University of New South Wales.
Commenced 01/07/2023.

Severe plastic deformation processing of bioresorbable metals.
Kurt Mills, School of Science, Technology and Engineering, University of the Sunshine Coast.
Commenced 01/07/2024.

Hydrophobicity driven nanoparticle transfer across oil-water interface in the absence of emulsifiers
Amalie Moller, Future Industries Institute, University of South Australia.
Commenced 01/07/2024.

Unravelling the complex compounds of bromine and antimony in chemical recycling of plastics from electrical and electronic equipment.
Angel Alberto Aguilar Morones, Faculty of Science and Technology, Charles Darwin University.
Commenced 01/07/2023.

Linking structure and dynamics of ionic liquid systems to rationalise solvent effects on organic processes.
Daniel Morris, School of Chemical Engineering, The University of New South Wales.
Commenced 01/07/2022.

Cellular and molecular mechanisms behind T cell activation to SARS-CoV-2.
Lawton Murdolo, School of Agriculture, Biomedicine and Environment, La Trobe University. Commenced 01/07/2023.

When you are an a la carte eater in a buffet world: Understanding selective bacterial nutrient uptake through structural and functional analysis.
Michael Newton-Vesty, School of Biological Sciences, University of Canterbury.
Commenced 01/07/2021.

Reconstructing palaeotemperature in Australia's arid interior using clumped isotopes.
Fletcher Nixon, Department of Earth Sciences, The University of Adelaide.
Commenced 01/07/2022.

Investigation of the membrane disulfide reductases DsbD and ScsB in *Klebsiella pneumoniae.*
Callum O'Flaherty, ANU College of Science, Research School of Biology, The Australian National University.
Commenced 01/07/2024.

Shedding light on groundwater-driven influxes of nutrients and dissolved gasses into the Hawkesbury Tidal River System: a multi-tracer approach.
James Padilla Montalvo, Faculty of Science and Engineering, Southern Cross University.
Commenced 01/07/2023.

Reconstructing past climate using subfossil New Zealand kauri (*Agathis australis*).
Priyadarshini Parsons O'Brien, School of Biological, Earth and Environmental Sciences (BEES), The University of New South Wales.
Commenced 01/07/2021.

Age constraints on polar ice-sheet meltwater pulses during the Last Interglacial period.
Maddalena Passelergue, Faculty of Science - School of Geography, Earth and Atmospheric Sciences, The University of Melbourne.
Commenced 01/07/2024.

Probing the Interactions of Metal Nanomaterials with Synthetic Cell Membranes.
Rowan Penman, School of Science, RMIT University.
Commenced 01/07/2023.

Converting cytochrome P450s into efficient peroxygenases for the synthesis of drug metabolites.
Matthew Podgorski, Department of Chemistry, The University of Adelaide.
Commenced 01/07/2021.

Thermo-electro-magnetic coupling through nano doping engineering for enhanced thermoelectricity.
Kyle Portwin, Institute of Semiconducting and Electronic Materials (ISEM), University of Wollongong.
Commenced 01/07/2022.

Research Highlights:

Michael Newton-Vesty - p.57

Understanding selective bacterial nutrient uptake through structural and functional analysis

Kyle Portwin - p.65

Thermo-electro-magnetic coupling for enhanced thermoelectricity

Larissa Lopes Cavalcante - p.69

The role of pyridine-based co-crystals in Titan's chemistry

Regional distribution of antiepileptic drugs in the developing brain during pregnancy and early postnatal period.
Fiona Qiu, Department of Neuroscience, Monash University.
Commenced 01/07/2022.

Using in-situ Neutron Powder Diffraction to Advance Technology Readiness Levels of High-Density Nuclear Fuels.
Melody Ranger, School of Mechanical and Manufacturing Engineering, The University of New South Wales.
Commenced 01/07/2023.

Treating thrombosis using responsive radiotheranostic porous silicon nanoparticles.
Peije Russell, Faculty of Pharmacy and Pharmaceutical Sciences, Monash University.
Commenced 01/07/2021.

Elucidating fire histories from speleothems and tree ring records in the Margaret River-Augusta region of southwest WA.
Casey Ryan, School of Biological Sciences, The University of Western Australia.
Commenced 01/07/2023.

Pollution history and transport of toxic metals from Australia to the Southern Ocean islands.
Margot Schneider, College of Asia Pacific, School of Culture History and Language, The Australian National University.
Commenced 01/07/2024.

The interaction of small molecules with biomembranes.
Dilek Sezer, RMIT School of Science, Applied Chemistry Department, RMIT University.
Commenced 01/07/2024.

Investigating membrane interactions of low dimensional materials and microbial cells using synchrotron ATR-FTIR microspectroscopy.
Zo Shaw, School of Engineering, RMIT University.
Commenced 01/07/2022.

Managing soil microbiomes to boost resilience and productivity of plantation pine seedlings.
Romika Shrestha, Hawkesbury Institute for the Environment, Western Sydney University.
Commenced 01/07/2024.

Examining the role of iron in non-alcoholic fatty pancreas disease.
Keea Smith, Curtin Medical School, Curtin University.
Commenced 01/07/2022.

Probing the electronic and magnetic properties of Rare-Earth Kagome metals and superconductors.
Sadhana Sridhar, Faculty of Science and School of Physics, Monash University.
Commenced 01/07/2024.

Slowing down the heat - phonon engineering in thermoelectrics using carbon allotropes.
Caleb Stamper, Institute for Superconducting and Electronic Materials, University of Wollongong.
Commenced 01/07/2022.

Extending Titan mineralogy.
Nicholas Stapleton, School of Molecular Sciences, The University of Western Australia.
Commenced 01/07/2021.

Enhancing tumour radiosensitivity using small-molecule glycosylation inhibitors.
Harrison Steele, School of Chemistry and Molecular Bioscience, University of Wollongong.
Commenced 01/07/2021.

Reconstructing atmospheric deposition, nutrient cycling and history of Tasmanian Central Highland lakes.
Harrison Stevens, School of Biological Sciences, University of Tasmania.
Commenced 01/07/2021.

Late Quaternary environmental change and seasonal resource use along the Central Murray River using freshwater shell midden sclerochronology.
Chloe Stringer, Geography, The University of Melbourne.
Commenced 01/07/2021.

Characterising effector proteins expressed during the early stages of myrtle rust infection by Austropuccinia psidii.
Jovarn Sullivan, School of Biological Sciences, University of Canterbury.
Commenced 01/07/2023.

A variable temperature and high-pressure structural study of valence tautomeric complexes.
Aston Summers, School of Molecular Sciences, The University of Western Australia.
Commenced 01/07/2022.

Developing phage depolymerase enzymes to disarm Klebsiella pneumoniae.
Daniel Williams, Department of Microbiology, Monash University.
Commenced 01/07/2021.

Poly(3-hexylthiophene)-graft-gelatin based transient organic electronics: Study of the polymer chain conformation in solution and film morphology
Xin Sun, School of Chemical Science, The University of Auckland.
Commenced 01/07/2023.

Understanding the pea protein gelling behaviour from molecular to macro-scale for the development of dairy and meat analogues.
Alice Tiong, Chemical Engineering, Monash University.
Commenced 01/07/2021.

Surface properties optimisation of parts fabricated by additive/ subtractive manufcturing.
Ikram Ul Hassan, School of Engineering, RMIT University.
Commenced 01/07/2023.

A Magnetic and Structural Investigation of Magnetic and Non-Magnetic Doping in the Skyrmion Hosting Material, Cu2OSeO3.
Marco Vás, School of Chemical Sciences, The University of Auckland.
Commenced 01/07/2023.

Powder arc additive manufacturing of a WCrV based refractory high entropy alloy.
Yangfan Wang, School of Mechanical, Materials, Mechatronic and Biomedical Engineering, University of Wollongong.
Commenced 01/07/2021.

In situ investigation of the lithium-mediated nitrogen electroreduction to ammonia.
Callum Weir-Lavelle, School of Chemistry, Monash University.
Commenced 01/07/2023.

Fundamental investigation on the influence of the crystal structure on swift heavy ion tracks
Jessica Wierbik, Research School of Physics, The Australian National University.
Commenced 01/07/2024.

Developing XANES-spectroscopic protocols for imaging changes in metal ion speciation in plant leaves during crop disease.
Meg Willans, School of Molecular and Life Sciences, Curtin University.
Commenced 01/07/2023.

Reconstructing timings of coral reef turn on events since the mid Pleistocene climate transition on both the North West and North East Australian Margins.
Carra Williams, School of Geosciences, The University of Sydney.
Commenced 01/07/2022.

Research Highlights:

Casey Ryan - p.18

Building fire histories for the Capes region of southwest Western Australia

Harrison Stevens - p.22

Investigating the recent depositional History of nutrients, heavy metals, and fire markers in Tasmanian highland lakes

Daniel Williams - p.39

Developing phage depolymerase enzymes to disarm *Klebsiella pneumoniae*

Marco Vás - p.74

The effects of doping on the crystal structure and magnetic ordering of the skyrmion hosting material, Cu_2OSeO_3, for future spintronic devices

Bulk liquid nanostructure studies of polymeric ionic liquids, surfactant/water in salt electrolytes, and interfacial nanostructure studies of surface-active ionic liquids.
Lucas Wong, School of Molecular Sciences, The University of Western Australia.
Commenced 01/07/2022.

UV-absorbing compounds and metals along ancient mosses as bioindicators of past Antarctic microclimates.
Hao Yin, School of Earth, Atmospheric and Life Sciences, University of Wollongong.
Commenced 01/07/2023.

Dead Heart Beating: Palaeoenvironmental History & Geochronology of the Coongie Lakes (Strzelecki Desert, South Australia).
Marc Young, College of Humanities, Arts and Social Sciences, Flinders University.
Commenced 01/07/2023.

How do climate stressors impact essential metal regulation in the holobiont?
Caitlin Younis, Climate Change Cluster, University of Technology Sydney.
Commenced 01/07/2023.

Studying the working mechanism of Cu^{2+} based cathodes to broaden the options in aqueous Zn-ion batteries.
Libei Yuan, Institute for Superconducting and Electronic Materials (ISEM), University of Wollongong.
Commenced 01/07/2022.

High-resolution Holocene hydroclimate reconstruction for the South Pacific using trace elements analyses of Tongan stalagmites and non-linear data series analysis
Hesam Zareh Parvar Ghoochani Nejad, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2024.

Residential Student Scholarships

In 2024 AINSE continued to offer the Residential Student Scholarship (RSS), which is a top-up residential postgraduate scholarship awarded to high-quality students who are enrolled in a Research Higher Degree at an AINSE Member University. The RSS differs from a Postgraduate Research Award (PGRA) in that a RSS student must be onsite at an ANSTO facility (at Lucas Heights and/or Clayton) for an average of six months per year, which can be a single block of time or separate visitations. The award was developed as AINSE recognised an opportunity to support students whose project topics closely aligned with ANSTO's research programmes in the areas of Environment, Health, Nuclear Technologies, Defence Industry, and Fusion.

AINSE wishes to congratulate the two successful RSS applicants for 2024 (listed below), who have secured an A$9,000 (pro rata where applicable) stipend per annum with up to A$5,000 travel and accommodation allowance per annum, plus an annual allowance for laboratory consumables used at ANSTO facilities.

Residential Scholars, and Their Projects, awarded in 2024:

Hydrogeological controls on Australian alpine water and the potential impacts of climate change on streamflow generation.
Celine Anderson, The Australian National University.

Land-to-sea connectivity – the importance of natural nutrient enrichment sites for adjacent marine ecosystems.
Jakob Quade, The University of Sydney.

Postgraduate Orientation Week

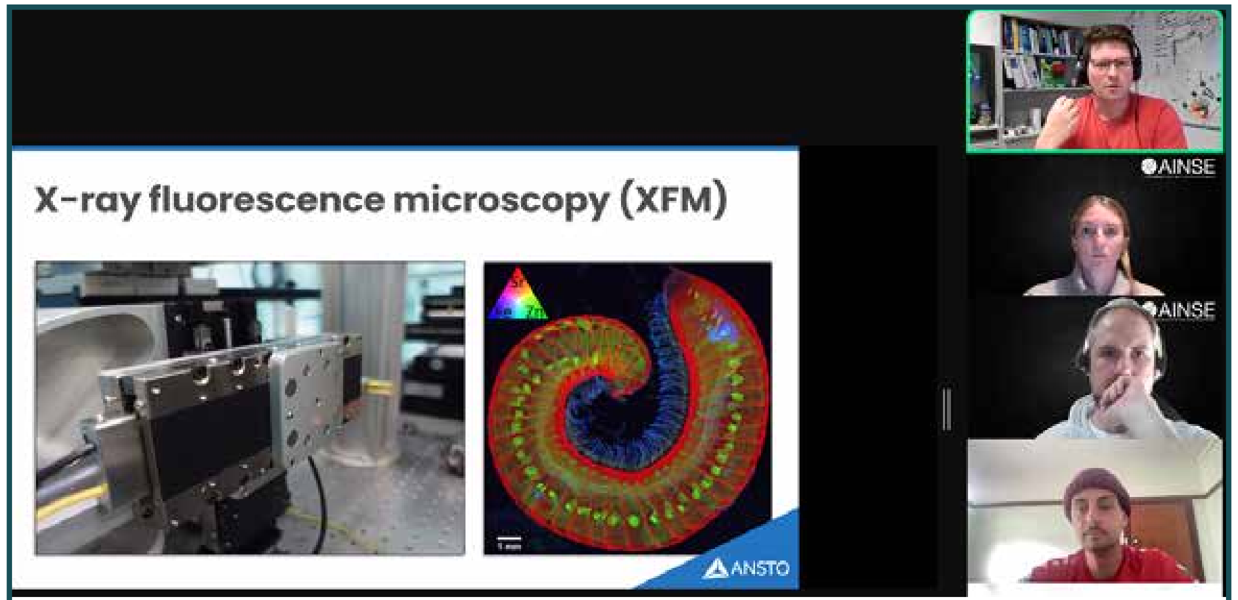
AINSE's Postgraduate Orientation Week (O'Week), held in conjunction with the annual international celebrations of Nuclear Science Week, welcomed both the new 2024 AINSE-supported scholars and students interested in applying for the future rounds of AINSE scholarships. This event aims to support students in achieving their goal of a postgraduate qualification at ANSTO by offering insights into research infrastructure and projects, and facilitating their application process. Furthermore, this event offers valuable opportunities for students to connect with ANSTO researchers and fellow AINSE-supported postgraduate students to help them build professional networks and inspire potential research collaborations.

From 21 – 25 October, AINSE was delighted to welcome 9 new postgraduate scholars and 21 future scholarship applicants to the five-day online event. The event began with an Acknowledgement of Country and welcome by AINSE Managing Director, Michelle Durant, before an informative overview of ANSTO's Nuclear Science and Technology by Dr Ceri Brenner, the leader of the Centre for Accelerator Science.

On day one, students engaged in presentations and panels from leaders across ANSTO's three Research Groups: Environment Research and Technology Group, Health Research and Technology Group and Nuclear Materials Research and Technology Group. After these insightful presentations, students were treated to a virtual tour of ANSTO's Lucas Heights and Clayton facilities courtesy of the ANSTO Discovery Centre. This included a behind-the-scenes look at the OPAL Multipurpose Reactor, the Australian Centre for Neutron Scattering, the Australian Synchrotron, and the Centre for Accelerator Science. For the 2024 program, AINSE was fortunate to hear from an inspiring guest speaker, Cherry Augustin, a Radiation Therapist Educator at Westmead Hospital about her career in radiation therapy.

> *"The scholarship application information was incredibly helpful and connecting with experts has boosted my confidence for future applications. It highlights the importance of science in Australia and the friendly, supportive nature of AINSE's scientific community."*
>
> *- 2024 Postgraduate O'Week attendee*

Over the next three days, students attended a series of virtual panel discussions with ANSTO researchers and research leaders to ask questions and gain insights into the ongoing research projects within ANSTO'S landmark research infrastructure, including the Centre for Accelerator Science, Australian Synchrotron, Australian Centre for Neutron Scattering, Health Research and Technology Group, National Deuteration Facility, Nuclear Materials Development and Characterisation, and Nuclear Stewardship and Environmental Applications of Natural Radioactivity.



Dr. Simon James, Beamline Scientist at ANSTO's Australian Synchrotron explains XFM techniques to students at AINSE Postgraduate O'Week 2024.

Students also heard from representatives of Australian nuclear organisations, including the Women in Nuclear (WiN) Australian Chapter, the Australian Young Generation in Nuclear (AusYGN), the ANSTO Ignite Early Careers Network, the Australian-American Fulbright Commission, and the National Museum of Nuclear Science and History in Albuquerque.

All attendees were also able to access an online science communication workshop to assist them in promoting their ongoing work through AINSE, and hear from AINSE PGRA recipients Cintya Dharmayanti and Rebecca Duncan about their experiences working with AINSE and ANSTO.

As part of AINSE's Professional Development Program for new postgraduate scholars, new PGRA and RSS recipients had the opportunity to attend a workshop on "The Ph.D. Experience" from internationally-renowned educator and author Hugh Kearns, which provided a wealth of practical knowledge on navigating the challenges of postgraduate research. Simultaneously, students interested in applying for 2025 AINSE scholarships met with AINSE

AINSE Managing Director Michelle Durant (left) and AINSE President Prof. Ian Gentle (right) address the attendees of the online Postgraduate Orientation Week.

Managing Director Michelle Durant and Dr. Rebecca Duncan for a scholarships workshop, which provided an overview of AINSE's support and delivered useful tips and tricks on creating successful scholarship applications.

In celebration of Nuclear Science Week, AINSE hosted various social activities throughout the event. These activities included an online trivia session, a "Great Debate" and the return of AINSE's annual "2 Minute Thesis"-style competition. This activity was a great way for new postgraduate students to share their research topic with their peers and an audience of AINSE and ANSTO staff, while being challenged to summarise their research in under 2 minutes with only the help of simple graphical tools such as MS Paint. This was followed by the official close of the O'Week by Michelle Durant and AINSE President, Prof. Ian Gentle.

AINSE would like to thank ANSTO, WiN Australia, AusYGN, the Ignite Network, the Australian-American Fulbright Commission, Hugh Kearns, Cherry Augustin and the many guest speakers from ANSTO who contributed to another successful AINSE O'Week. We wish our new AINSE scholars all the best for their research endeavours throughout 2025 and beyond, and look forward to following their PGRA/RSS-supported research journeys.

2024 AINSE Postgraduate Orientation Week Attendees

AINSE PGRA/RSS/Pathway Scholars:

Celine Anderson	ANU
Alexandra Bastick	CSU
Samara Bridge	UTS
Vincent de Rover	WOL
Johannes Dittmann	SCU
Tyla Jones	ADE
Kurt Mills	USC
Callum O'Flaherty	ANU
Margot Schneider	ANU

Additional Student Attendees:

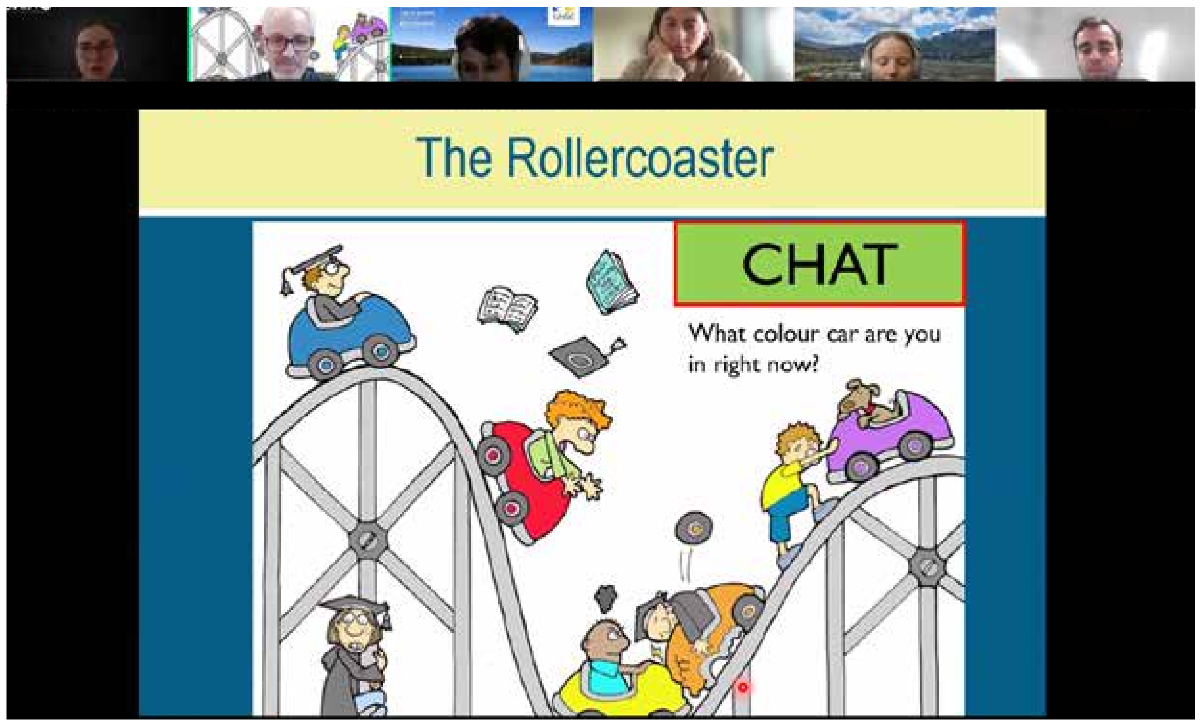
Jarvis Ashcroft	WOL
Zachary Candiloro	RMI
Holly Ceapa	UTS
Kaylee Clark	SYD
Candy Duff	CDU
Ido Fridberg	JAM
Irene Ganzevles	JAM
Tasman Harvey	SWI
Natinael Kokeb Koyra	RMI
Sedigheh Mohammadi	SCU
Zahra Parhizi	USQ
Dulanjalee Rajapaksha	TAS
Luke Roeger	USA
Pallavi Saini	RMI
Maria Sanchez	SYD
Sowbarnika Senthilkumar	USA
Peter Spencer	USC
Chundu Gyem Tamang	USQ
Mahima Tawal	CUR
Jennifer Tinker	RMI
Ita Wulandari	MAC

Professional Development Program

In 2024, AINSE continued its Professional Development Program, which was first launched in 2021 to support postgraduate students (PGRA and RSS scholars) in building essential skills for their post-Ph.D. careers. The program focuses on academic writing, job search strategies, and other key competencies to enhance career readiness.

For the newest cohort of postgraduate students, the program kicked off during the 2024 Postgraduate Orientation Week with a workshop led by internationally acclaimed author Hugh Kearns from iThinkWell. In this engaging session, Kearns took students through the highs and lows of "The Ph.D. Experience," providing valuable insights for navigating their academic journey and helping them set a positive foundation for their studies.

AINSE looks forward to continuring the Professional Development Program and supporting the growth of its postgraduate scholars throughout this program.



Educator and author Hugh Kearns delivers a workshop on "The Ph.D. Experience" to 2024 AINSE Postgraduate scholars during the Postgraduate Orientation Week.

Technical Skills Scholarship

In 2024, AINSE continued offering the Technical Skills Scholarship that was first launched in 2021 to support current postgraduate students (PGRA and RSS scholars) in receiving additional technical skills training relevant to their postgraduate research project.

The scholarship provides up to A$1,000 towards the cost of technical skills training undertaken with a Registered Training Provider, covering any technical skills relevant to the scholar's AINSE-supported postgraduate research. This includes, but is not limited to, coding, data analysis, project management, and a broad range of other technical skills.

AINSE wishes to congratulate the seven postgraduate scholars who were awarded a Technical Skills Scholarship in 2024.

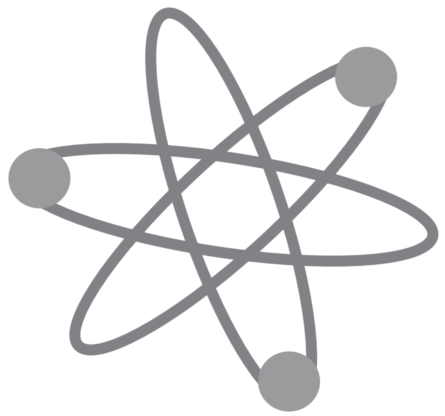
Technical Skills Scholarships awarded in 2024:

STUDENT	AINSE MEMBER CODE	COURSE ATTENDED	COURSE PROVIDER
Kangwei Chen	SYD	Additive Manufacturing or 3D Printing Abaqus simulation	CAE Assistant
		3DEXPERIENCE ENGINEER for Students	Dassault Systèmes
Brooke Conroy	WOL	One-Day Online Workshop: Introduction to Mixed Modelling	University of Wollongong Statistical Consulting Centre
Daniel Dodoo	MEL	Predictive Analytics	Minitab Pty Ltd
Isabel Ely	CDU	R Software for Data Science	ACSPRI (Australian Consortium for Social and Political Research Incorporated)
James Padilla Montalvo	SCU	Remote Pilot's Licence (RePL) / Aeronautical Radio Operators Certificate (AROC)	The Ripper Aviation Training Academy
Caitlin Selfe	QUT	R Programming Course: Intermediate	University of Sydney
Chloe Stringer	MEL	STAA0002 - Simple Linear Regression and ANOVA	Swinburne University of Technology

Early Career Researcher Grant (ECRG)

An AINSE Early Career Researcher Grant (ECRG) is a grant of up to A$10,000 to support early-career researchers working in collaboration with ANSTO. To be eligible for one of these grants, an applicant must be in their first five years (full-time equivalent) of employment in a postdoctoral Early Career Research position at an AINSE Member Institution. Allowances are made for career breaks when assessing the five-year FTE eligibility requirement.

The inaugural round of the Early Career Researcher Grant was launched in 2019. In 2024, AINSE continued the ECRG into its sixth consecutive year. AINSE wishes to congratulate the seventeen successful applicants for the 2024 round of the ECRG, who are listed below.



Research Highlights:

(by continuing ECRG scholars)

Niloofar Karimian - p.26

Environmental co-behavior and mechanisms of arsenic and antimony sorption onto jarosite: Insights from multi-edge synchrotron X-ray absorption spectroscopy

Andrew Marshall - p.35

Uncovering molecular structures of disordered proteins that form liquid droplets inside cells

Jessie Posar - p.48

Enhanced detection of synchrotron X-rays with a flexible organic X-ray sensor

Early Career Research Grants Awarded in 2024:

Fokker-Planck Dark-field: A new kind of X-ray Imaging.
Samantha Alloo
Monash University

Hearing in invertebrates: first radiography and tomography of sound-induced motion in the statocyst organ.
Lucille Chapuis
La Trobe University

Probe nontrivial phonons in quantum materials.
Lei Chen
University of Southern Queensland

Directional dark-field imaging of small animal bones and teeth to characterize structural changes caused by cystic fibrosis.
Michelle Croughan
Monash University

IMPACT (Implementation of x-ray PhAse-Contrast Tomography to transform cancer diagnosis).
Lorenzo D'Amico
Monash University

Self-assembled Surface-Active Ionic Liquids (SAILs) in ionic liquids (ILs).
Elise Guerinoni
The University of Sydney

Discovering inhibitors of tripartite ATP-independent periplasmic (TRAP) transporters.
Kelsi Hall
University of Canterbury

For how long have warm waters been interacting with the grounding line of Shackleton Ice Shelf?
Matthew Jeromson
University of Canberra

Modification of closed porosity in tight shale rocks due to mechanical stress.
Yeping Ji
CSIRO

Understanding the structural dynamics of liquid metals using neutron scattering.
Vaishnavi Krishnamurthi
RMIT University

Developing methods to enhance the detection and quantification of cobalt in iron rich geological samples using X-ray fluorescence.
Maximilian Mann
Monash University

Investigating atmospheric inputs to the remote Southern Indian Ocean using deep sea marine sediment cores.
George Rowland
University of Tasmania

Development and optimisation of detector suite for real-time neutron dosimetry in clinical BNCT treatment.
James Vohradsky
University of Wollongong

Tracking the mobilisation and speciation of cobalt (Co) during enhanced leaching of mine tailings: Implications for metal enrichment and extraction from artificial laterites.
Zhen Wang
Monash University

Melting metal–organic frameworks (MOFs) with piezoelectric responsive materials for molecular sensors and sieving.
Zixi Xie
The University of Queensland

Stainless-steel structures for nuclear applications manufactured via additive friction stir deposition.
Vladislav Yakubov
The University of Sydney

Investigating the structural evolution of Cu-Zn conductive MOF catalysts in electrosynthesis of urea from CO_2 via X-ray absorption spectroscopy.
Jinshuo Zou
The University of Adelaide

Scholarship AINSE/ANSTO/ French Embassies (SAAFE)

As a result of the MoU signed between AINSE, ANSTO and the Embassy of France in Australia in 2017, and the MoU signed between AINSE, ANSTO and the Embassy of France in New Zealand in March 2022, seven early-career researchers at the Ph.D. student or postdoctoral researcher level were approved to travel either from Australia or New Zealand to France, or from France to Australia, as part of the Scholarship AINSE ANSTO French Embassies (SAAFE) research internship program in 2024.

The SAAFE Program facilitates research collaborations between France, Australia and New Zealand in nuclear science and engineering. The program supports early careers researchers at the Ph.D. or postdoctoral level to expand research and innovation activities within the research areas of Health, the Environment and Nuclear Technologies, and to initiate sustainable research networks and linkages to support Australia, New Zealand and France in research and innovation.

AINSE is thankful for the support offered by the Embassies of France in Australia and New Zealand, and ANSTO, to enable this overseas internship opportunity.

SAAFE Scholars awarded in 2024:

STUDENT	UNIVERSITY OF ENROLMENT	HOST INSTITUTION(S)
Abhijith Aswathy Gopakumar	The Australian National University	Institut Laue–Langevin
Samara Bridge	University of Technology Sydney	Université Grenoble Alpes
Melissa McIntyre	University of South Australia	Centre Léon Bérard
Candice Milewski	University Grenoble-Alpes	ANSTO - Australian Synchrotron
Ngoc Huu Nguyen	The University of Sydney	Centre de Référence des Infections Ostéo-Articulaires Complexes correspondant (CRIOAC)
Maria Nicholas	The University of Sydney	Université Paris-Saclay, Centralesupélec, SPMS Lab
Maria Sanchez	The University of Sydney	Institute Laue Langevin

Conferences and Workshops

AINSE conferences play a major role in the information exchange process for science and technology, providing forums for robust intellectual debate and opportunities for young researchers to present their work to the established research community.

In 2024, AINSE supported the following conferences and events through the provision of sponsorship funding, travel & accommodation assistance, and online registration fee provisions for students to attend AINSE-supported conferences.

As part of these sponsorship packages, AINSE representatives attended events in order to network with delegates and promote ongoing AINSE programs.

NAME OF EVENT	TYPE OF EVENT	DATE	VENUE	STUDENTS SUPPORTED	STUDENT UNIVERSITIES / ORGANISATION
ANSTO Powder Diffraction Workshop	Workshop	30 April – 2 May 2024	Clayton, VIC	10	The University of Adelaide
					The University of Auckland
					University of Canterbury
					Griffith University
					The University of New South Wales
					The University of Queensland
					The University of Sydney
					The University of Western Australia
					Victoria University of Wellington
					University of Wollongong
44th International Symposium on Archaeometry	Symposium	27 - 31 May 2024	Melbourne, VIC	3	The Australian National University
					Flinders University
Australasian Quaternary Association Conference (AQUA)	Conference	24 – 28 June 2024	Moreton Bay, QLD	6	The University of Adelaide
					The University of Auckland
					Monash University
					The University of Melbourne
3rd ANSTO - HZB Neutron Training Course	School	27 October - 1 November 2024	Lucas Heights, NSW	7	Deakin University
					The University of Melbourne
					Monash University
					RMIT University
					The University of Western Australia
					Victoria University of Wellington
ANBUG-AINSE Neutron Scattering Symposium (AANSS)	Symposium	4 - 6 November 2024	Lucas Heights, NSW	3	Charles Darwin University
					Monash University

Conferences and Workshops

NAME OF EVENT	TYPE OF EVENT	DATE	VENUE	STUDENTS SUPPORTED	STUDENT UNIVERSITIES / ORGANISATION
8th Heavy Ion Accelerator Symposium	Symposium	11-13 November 2024	Canberra, ACT	3	The Australian National University
					The University of Melbourne
30th International Conference on Atomic Collisions in Solids & 12th International Symposium on Swift Heavy Ions in Matter	Conference	24 – 29 November 2024	Canberra, ACT	1	The University of Melbourne
2024 RACI R&D Topics Conference in Analytical and Environmental Chemistry	Conference	1 – 4 December 2024	Hobart, TAS	12	CSIRO
					Curtin University
					Deakin University
					Flinders University
					Griffith University
					James Cook University
					The University of Queensland
					University of Tasmania
RACI Inorganic Division National Conference	Conference	8 – 12 December 2024	Parramatta, NSW	5	Curtin University
					University of Otago
					The University of Western Australia

Overseas Conference Scholarships

Throughout the year, students from AINSE-member organisations who are presenting research conducted with an ANSTO collaborator are invited to apply for support to attend international conferences. AINSE Overseas Conference Scholarships encourage students to participate in conferences in order to network and exchange ideas with the worldwide nuclear science and engineering community.

AINSE Overseas Conference Scholarships offer up to A$1,000 towards the costs of online or in-person registration fees, or towards the costs of direct flights to and from an international conference to support in-person presentations.

In 2024, AINSE awarded scholarships to 20 students to present at numerous high-profile international conferences.

ANSTO's OPAL Multipurpose Reactor at Lucas Heights, Sydney. Photo credit: ANSTO.

AINSE Overseas Conference Scholarships Awarded in 2024:

NAME	AINSE MEMBER CODE	CONFERENCE ATTENDED	CONFERENCE LOCATION
Meaghan Ashton	ADE	Metals in Medicine - Gordon Research Seminar (Inorganic Chemistry and its Impact on Disease Diagnosis and Treatment)\ Metals in Medicine - Gordon Research Conference (Fostering Collaborations to Diagnose and Treat Diseases with Metal-Based Agents)	New Hampshire, USA
Ani Baker	ADE	Metals in Medicine - Gordon Research Seminar (Inorganic Chemistry and its Impact on Disease Diagnosis and Treatment) Metals in Medicine - Gordon Research Conference (Fostering Collaborations to Diagnose and Treat Diseases with Metal-Based Agents)	New Hampshire, USA
Javeria Bashir	QLD	Materials Oceania 2024	Phuket, Thailand
Julian Eschenroeder	OTA	European Geoscience Union General Assembly 2024	Vienna, Austria
Matthew Goodwin	NCT	Australia-New Zealand Tree Ring Science Conference	Auckland, New Zealand
Calla Gould-Whaley	MEL	IBS Conference on Climate and Human Evolution	Busan, South Korea
Lissy Hartmann	UTS	21st IUPAB (International Union of Pure and Applied Biophysics)	Kyoto, Japan
Ashleigh Johns	CAN	RapiData 2024	California, USA
Nutpakal Ketprasit	MEL	56th Annual Meeting of the Japan Association for Clinical Laboratory Science	Kagoshima, Japan
Haikun Liu	MEL	15th International Conference on Nanotechnology: Fundamentals and Applications (ICNFA 2024)	Barcelona, Spain
Larissa Lopes Cavalcante	OTA	Astrobiology Science Conference (AbSciCon)	Rhode Island, USA
Paul Michalski	MON	Neutrons & Food 7	Delaware, USA
Kyle Portwin	WOL	MDanse School 2024	Grenoble, France
Peije Russell	MON	Asia Pacific Delivery Science Conference	Kuala Lumpur, Malaysia
Caleb Stamper	WOL	36th International Thermal Conductivity Conference (ITCC) and the International Thermal Expansion Symposium (ITES)	Charlottesville, USA
Marco Vas	AKL	ANSTO Australian Synchrotron User Meeting - UM2024	Melbourne, Australia
Meg Willans	CUR	16th International Conference on X-Ray Microscopy	Lund, Sweden
Caitlin Younis	UTS	European Coral Reef Symposium – ECRS 2024	Naples, Italy

Travel and Accommodation Support

Support for travel and accommodation is provided by ANSTO to AINSE Member Institutions who are awarded access through the ANSTO Research Portal. Throughout 2024, a total of 117 researchers from the following AINSE members received support to attend ANSTO's Lucas Heights NSW campus.

ANSTO-Funded Travel and Accommodation Support in 2024:

ADE	The University of Adelaide
AKL	The University of Auckland
ANU	The Australian National University
CAN	University of Canterbury
CBR	University of Canberra
CDU	Charles Darwin University
CSI	CSIRO
CUR	Curtin University
DEA	Deakin University
FLI	Flinders University
GRI	Griffith University
MEL	The University of Melbourne
MON	Monash University
MUR	Murdoch University
NCT	The University of Newcastle
NSW	The University of New South Wales
QLD	The University of Queensland
QUT	Queensland University of Technology
RMI	RMIT University
SWI	Swinburne University of Technology
SYD	The University of Sydney
USC	University of Southern Queensland
UWA	The University of Western Australia
VUW	Victoria University of Wellington
WOL	University of Wollongong

The exterior of ANSTO's OPAL Multipurpose Reactor at the Lucas Heights campus. Photo credit: ANSTO.

Supported Publications and Presentations

During 2024, AINSE received notification of the following publications and presentations by AINSE scholars that acknowledge AINSE support.

The University of Adelaide

Meaghan Louise Ashton

Ashton, M, Burgess, L, Mansour, F, Walker, A, Pellegrini, P A, Tondl, E M, McDonald, A, Roberts, M P, Fraser, B H, Harris, H H 2024, 'The Development of Radiomercury Theranostics', Poster presented at the Gordon Research Conference Metals in Medicine: Fostering Collaborations to Diagnose and Treat Diseases with Metal-Based Agents, Andover, New Hampshire, USA, 23-28 June 2024.

Ashton, M, Burgess, L, Mansour, F, Walker, A, Pellegrini, P A, Tondl, E M, McDonald, A, Roberts, M P, Fraser, B H, Harris, H H 2024, 'The Development of Radiomercury Theranostics', Oral presentation delivered at the Gordon Research Seminar: Metals in Medicine Inorganic Chemistry and its Impact on Disease Diagnosis and Treatment, Andover, New Hampshire, USA, 22-23 June 2024.

Ashton, M, Fraser, B, Harris, H 2023, 'The Development of Radiomercury Theranostics', Oral presentation delivered at the RACI SA Synthesis Symposium, Adelaide, South Australia, Australia, 4 December 2023.

Ashton, M, Burgess, L, Mansour, F, Walker, A, Pellegrini, P A, Tondl, E M, McDonald, A, Roberts, M P, Fraser, B H, Harris, H H 2023, 'The Development of Radiomercury Theranostics', Poster presented at the International Conference on Biological Inorganic Chemistry, Adelaide, South Australia, Australia, 16-21 July 2023.

Lucinda Duxbury

Duxbury, L 2022, 'Holocene climate, fire and ecosystem change on Kangaroo Island (Karti), South Australia', Ph.D. Thesis, The University of Adelaide.

Daniel Doherty

Doherty, D 2024, 'Evolution and inhibition of cholesterol catabolising P450 enzymes in pathogenic mycobacteria', Ph.D. Thesis, The University of Adelaide.

Pol Gimeno-Fonquernie

Gimeno-Fonquernie, P, Albalad, J, Evans, J D, Price, J R, Doonan, C J, Sumby, C J 2024, 'Topological analysis and control of post-synthetic metalation sites in Zr-based Metal-organic frameworks', Journal of Materials Chemistry C, vol. 12, pp. 2359-2369.
Available from: doi:10.1039/D3TC03606E

Junnan Hao

Chen, Q, Hao, J, Zhang, S, Tian, Z, Davey, K, Qiao, S-Z 2024, 'High-Reversibility Sulfur Anode for Advanced Aqueous Battery', Advanced Materials, vol. 36, no. 1, p. 2309038.
Available from: doi:10.1002/adma.202309038

Sailin Liu

Liu, S, Zhang, R, Wang, C, Mao, J, Chao, D, Zhang, C, Zhang, S, Guo, Z , 'Zinc ion Batteries: Bridging the Gap from Academia to Industry for GridScale Energy Storage', Angewandte Chemie International Edition, vol. 63, no. 17, p. E202400045.
Available from: doi:10.1002/anie.202400045

Fletcher Nixon

Nixon, F, Tyler, J, Priestley, S, Cohen, T, Klaebe, R, Hua, Q, Keppel, M, Pollard, T, Drysdale, R, Karlstrom, L, Crossey, L, Polyak, V, Asmerom, Y, Hall, P 2024, 'Palaeoclimate in Australia's arid interior: Insights from clumped isotope analysis', Oral presentation delivered at the AQUA Conference 2024, North Stradbroke Island, 24-28 June 2024.

Jingxi Li

Lyu, Y, Yuwono, J A, Fan, Y, Li, J, Wang, J, Zeng, R, Davey, K, Mao, J, Zhang, C, Guo, Z 2024, 'Selective Extraction of Critical Metals from Spent Li-Ion Battery Cathode: Cation–Anion Coordination and Anti-Solvent Crystallization', Advanced Materials, vol. 36, no. 24, p. 2312551.
Available from: doi:10.1002/adma.202312551

Zheng, W, Liang, G, Guo, H, Li, J, Zou, J, Yuwono, J A, Shu, H, Zhang, S, Peterson, V K, Johannessen, B, Thomsen, L, Hu, W, Guo, Z 2024, 'Enhancing the reaction kinetics and structural stability of high-voltage $LiCoO_2$ via polyanionic species anchoring', Energy & Environmental Science, vol. 17, pp. 4147-4156.
Available from: doi:10.1039/D4EE00726C

Gemeng Liang

Zou J., Liang, G., Yuwono J. A., Zhang, F., Fan, Y., Zhang, S., Johannessen, B., Sun, L., Guo, Z 2024, 'Size dependent effects of Ru nanoparticles on $LiCO_2$ batteries', ACS Energy Letters, vol. 9, pp. 5145-5155.
Available from: doi:10.1021/acsenergylett.4c01567

The University of Auckland

Marco Vás

Vás, M, Ferguson, A, Rov, R, Sauceda Flores, J, Christopher, T, Vella, J, Maynard-Casely, H, Gilbert, E, Ulrich, C, Yick, S, Söhnel, T 2024, 'Controlling Skyrmions in Cu_2OSeO_3 through Doping: Insights into the Relationship Between Crystal Structure and Magnetic Ordering', Poster presented at the The University of Auckland Science Research Showcase, Auckland, New Zealand, 9-13 September 2024.

Vás, M, Ferguson, A, Vella, J, Ulrich, C, Gilbert, E, Yick, S, Söehnel, T 2023, 'The Effects of Doping on the Magnetic Transition Regions of the Skyrmion Hosting Material, Cu_2OSeO_3', Oral presentation delivered at the Materials Research Society Fall Meeting and Exhibition, Boston, USA, 26 November - 1 December 2023.

Vás, M, Ferguson, A, Vella, J, Ulrich, C, Gilbert, E, Yick, S, Söehnel, T 2024, 'The Effects of Doping on the Magnetic Transition Regions of the Skyrmion Hosting Material, Cu_2OSeO_3', Oral presentation delivered at the ANSTO ACNS Clip Day, ANSTO, Lucas Heights, Australia, 6-7 June 2024.

Vás, M, Ulrich, C, Gilbert, E, Yick, S, Söehnel, T 2024, 'Future Prospects of Thin Films Spintronic Devices: A Cu_2OSeO_3 Case Study', Oral presentation delivered at the MacDiarmid Institute Thin Film Hui, Ohakune, New Zealand, 24-26 June 2024.

Vás, M, Vella, J, Gu, Q, Ulrich, C, Gilbert, E, Yick, S, Söehnel, T 2024, 'Structural Expansion upon Cooling in the Skyrmion Hosting Material, Cu_2OSeO_3', Oral presentation delivered at the ANSTO User Meeting 2024, Melbourne, Victoria, Australia, 27 - 29 November 2024.

Xin Sun

Sun, X, Chan, E W C, Chen, Q, Kirby, N, Yang, J, Mata, J P, Kingston, R L, Barker, D, Domigan, L, Travas-Sejdic, J 2024, 'Copolymers of Gelatin-*graft*-poly (3-hexylthiophene) for Transient Electronics', ACS Applied Materials & Interfaces, vol. 16, no. 18, pp. 23872-23884.
Available from: doi:10.1021/acsami.4c02174.

Sun, X, Chan, E W C, Chen, Q, Kirby, N, Yang, J, Mata, J P, Kingston, R L, Barker, D, Domigan, L, Travas-Sejdic, J 2024, 'Copolymers of Gelatin-*graft*-poly (3-hexylthiophene) for Transient Electronics', Oral presentation delivered at the Australian Centre for Neutron Scattering (ACNS) Clip Day, Sydney, New South Wales, Australia, 6-7 June 2024.

Sun, X, Barker, D, Travas-Sejdic, J 2023, 'Copolymers of Gelatin-*graft*-poly(3-hexylthiophene) for Transient Electronics', Oral presentation delivered at the 8th Asia-Oceania Conference on Green and Sustainable Chemistry, Auckland, New Zealand, 29 November–1 December 2023.

Sun, X, Chan, E W C, Chen, Q, Kirby, N, Yang, J, Mata, J P, Kingston, R L, Barker, D, Domigan, L, Travas-Sejdic, J 2023, 'Smart Self-transform Biodegradable Electronics based on Graft Copolymers of conducting polymers', Poster presented at the University of Auckland Faculty of Science Research Showcase, Auckland, New Zealand, 25 August 2023.

The Australian National University

Shankar Dutt

Dutt, S 2024, 'Fundamentals and Applications of Ion Tracks and Nanopores in Solid State Membranes', Ph.D. Thesis, The Australian National University.

Rebecca Majchrzak

Majchrzak, R 2024, 'Binuclear Boron Compounds Supported by a Bulky Xanthene-Based Diamido Scaffold: Reactivity and Reduction Studies', Honours thesis, The Australian National University.

Daniel Yu

Yu, D S, Outram, M A, Smith, A, McCombe, C L, Khambalkar, P B, Rima, S A, Sun, X, Ma, L, Ericsson, D J, Jones, D A, Williams, S J 2024, 'The structural repertoire of *Fusarium oxysporum* f. sp. *lycopersici* effectors revealed by experimental and computational studies', eLife, vol. 12, pp. RP89280.
Available from: doi:10.7554/eLife.89280.1.

Yu, D 2023, 'Structural investigation of the interaction between SIX effectors and resistance proteins', Ph.D. Thesis, The Australian National University.

Teng Lu

Lv, Z, Lu, T, Liu, Z, Hu, T, Hong, Z, Guo, S, Xu, Z, Song, Y, Chen, Y, Zhao, X, Lin, Z, Yu, D, Liu, Y, Wang, G 2024, '$NaNbO_3$ ceramics for explosive energy conversion application', Advanced Energy Materials , vol. 14, vol. 2304291.
Available from: doi: 10.1002/aenm.202304291

Carl McCombe

McCombe, C 2023, 'Functional characterisation of Nudix hydrolase effectors from phytopathogenic fungi ', Ph.D. Thesis, The Australian National University.

Jessica Porter

Porter, J 2024, 'Stabilisation and Reactivity of Hypervalent Metal Hydrides Within a Supramolecular Assembly', Honours thesis, The Australian National University.

Benjamin Silke

Silke, B 2024, 'Engineering resistance against *Magnaporthe oryzae* using nanobodies', Honours thesis, The Australian National University.

University of Canterbury

Ashleigh Johns

Johns, A 2023, 'Defining the interaction between the transcriptional regulator NanR and DNA through mutational analysis.', Honours thesis, University of Canterbury.

Samantha Jane Alloo

Alloo, S 2024, 'Multimodal Intrinsic Speckle-Tracking: Complementary, Rapid, and High-Resolution X-ray Imaging', Ph.D. Thesis, University of Canterbury.

Michael Currie

Davies, J S, Currie, M J, North, R A, Scalise, M, Wright, J D, Copping, J M, Remus, D M, Gulati, A, Morado, D R, Jamieson, S A, Newton-Vesty, M C 2023, 'Structure and mechanism of a tripartite ATP-independent periplasmic TRAP transporter', Nature Communications, vol. 14, p. 1120.
Available from: doi:10.1038/s41467-023-36590-1.

Currie, M J, Davies, J S, Scalise, M, Gulati, A, Wright, J D, Newton-Vesty, M C, Abeysekera, G S, Subramanian, R, Wahlgren, W Y, Friemann, R, Allison, J R. 2024, 'Structural and biophysical analysis of a Haemophilus influenzae tripartite ATP-independent periplasmic (TRAP) transporter', ELife, vol. 13, no. 12, p. RP92307
Available from: doi:10.7554/eLife.92307.3.

King-Hudson, T-R J, Davies, J S, Quan, S, Currie, M J, Tillett, Z D, Copping, J, Pajikar, S, Friemann, R, Allison J R, North R A & Dobson R C J 2024, 'On the function of TRAP substrate-binding proteins: Conformational variation in the sialic acid specific binding protein SiaP', Journal of Biological Chemistry, vol. 300, no. 11, pp. 107851.
Available from: doi:10.1016/j.jbc.2024.10785.

Pedro Doll

Doll, P, Eaves, S R, Kennedy, B M, Blard, P-H, Nichols, A R L, Leonard, G S, Townsend, D B, Cole, J W 2023, 'Cosmogenic ^{3}He constraints of postglacial edifice construction at Mt. Ruapehu', Oral presentation delivered at the Annual Conference of the Geological Society of New Zealand, Wellington, New Zealand, 13-16 November 2022.

Doll, P, Eaves, S R, Kennedy, B M, Blard, P-H, Nichols, A R L, Leonard, G S, Townsend, D B, Cole, J W, Conway, C E, Baldwin, S, Fenisse, G, Tibari, B, Zimmermann, L 2024, 'Cosmogenic ^{3}He chronology of postglacial lava flows at Mt. Ruapehu, Aotearoa New Zealand', Geochronology, vol. 6, pp. 365-395.
Available from: doi:10.5194/gchron-6-365-2024.

Michael Newton-Vesty

Currie, M J, Davies, J S, Scalise, M, Gulati, A, Wright, J D, Newton-Vesty, M C, Abeysekera, G S, Subramanian, R, Wahlgren, W Y, Friemann, R, Allison, J R, Mace, P D, Griffin, M D W, Demeler, B, Wakatsuki, S, Drew, D, Indiveri, C, Dobson, R C J, North, R A 2024, 'Structural and biophysical analysis of a Haemophilus influenzae tripartite ATP-independent periplasmic (TRAP) transporter', eLife, vol. 12.
Available from: doi:10.7554/eLife.92307.3.

Newton-Vesty, M C, Wright, J D, Currie, M J, Davies, J D, Jamieson, S A, Tillett, Z A, Abeysekera, G S, Love, M J, Mace, P D, North, R A, Dobson, R C J 2024, 'Understanding selective bacterial nutrient uptake through structural and functional analysis', Poster presented at the 49th Lorne Conference on Protein Structure and Function, Lorne, Victoria, Australia, 4-8 February 2024.

Jovarn Sullivan

Sullivan, J V, Currie, M J, Eccersall, S E, Hambrook, N M, Frampton, R A, Sethi, A, Panjikar, S, Morris, V K, Smith, G R, Meisrimler, C N, Dobson, R C J 2023, 'Elucidating the Role of an *Austropuccinia psidii* Effector Protein During Myrtle Rust Infection', Poster presented at the NZSBMB 50th Anniversary Conference, Hanmer Springs, New Zealand, 28 November-1 December 2023.

Sullivan, J V, Currie, M J, Eccersall, S E, Hambrook, N M, Frampton, R A, Sethi, A, Panjikar, S, Morris, V K, Smith, G R, Meisrimler, C N, Dobson, R C J 2024, 'Elucidating the Role of an *Austropuccinia psidii* Effector Protein During Myrtle Rust Infection', Poster presented at the 49th Lorne Conference on Protein Structure and Function, Lorne, Victoria, Australia, 4-8 February 2024.

Sullivan, J V, Currie, M J, Eccersall, S E, Hambrook, N M, Frampton, R A, Sethi, A, Panjikar, S, Morris, V K, Smith, G R, Meisrimler, C N, Dobson, R C J 2024, 'Elucidating the Role of an *Austropuccinia psidii* Effector Protein During Myrtle Rust Infection', Oral presentation delivered at the IV International Young Researchers Conference on Invasive Species, Online, 15-16 July 2024.

Jacob Hartshorn

Hartshorn, J 2024, 'Defining the Internal Structure in Biomolecular Condensates: Effects on Molecular Interactions and Material Properties', Honours thesis, University of Canterbury.

Jacqueline Ormsby

Ormsby, J 2024, 'Function of the Atypical Kinase RIOK3: Ubiquitination and Rift Valley Fever Viral Response', Honours thesis, University of Canterbury.

Michelangelo Santos

Santos, M 2024, 'Ruthenium-gold cluster catalysts for potential CO_2 conversion', Honours thesis, University of Canterbury.

University of Canberra

Matthew Jeromson

Jeromson, M R, Fujioka, T, Fink, D, Simon, K, Smith, J, Hillenbrand, C-D, Kuhn, G, Post, A L, Sanchez-Palacios, J T, Blaxell, M, Enge, T G, White, D A 2024, 'Circumpolar Deep Water upwelling is a primary source of ^{10}Be in Antarctic continental shelf sediments ', Global and Planetary Change, vol. 236, p. 104424.
Available from: doi:10.1016/j.gloplacha.2024.104424.

CSIRO

Niloofar Karimian

Karimian, N, Johnston, S G, Tavakkoli, E, Frierdich, A J, Burton, E D 2023, 'Mechanisms of Arsenic and Antimony Co-sorption onto Jarosite: An X-ray Absorption Spectroscopic Study ', Environmental Science & Technology, vol. 57, no. 12, pp. 4813–4820.
Available from: doi:10.1021/acs.est.2c08213.

Charles Sturt University

Alexandra Bastick

Bastick, A 2024, 'Impacts of gamma radiation on the growth of the Australian tropical marine microalga *Tisochrysis lutea* at environmentally relevant dose rates', Honours thesis, Charles Sturt University.

Curtin University

Breah Milford

Milford, B 2024, 'Synthesis and Photophysical Properties of Osmium(II) Tetrazole Complexes', Honours thesis, Curtin University.

Meg Willans

Willans, M, Szczecinski, E, Roocke, C, Williams, S, Timalsina, S, Vongsvivut, J, McIlwain, J, Naderi, G, Linge, K L, Hackett, M J 2023, 'Development of a rapid detection protocol for microplastics using reflectance-FTIR spectroscopic imaging and multivariate classification. ', Environmental Science: Advances, vol. 2, no. 4, pp. 663-74.
Available from: doi:10.1039/D2VA00313A .

Willans, M, Khambatta, K, Stone, C, Sanglard, L M V P, Howard, D L, James, S A, Naim, F, Hackett, M J 2023, 'XANES mapping of Mn speciation in leaf tissue infected with a fungal pathogen: investigating the role of nutritional immunity', Oral presentation delivered at the 20th International Conference on Biological Inorganic Chemistry, Adelaide, South Australia, Australia, 16-21 July 2023.

Willans, M, Khambatta, K, Stone, C, Sanglard, L M V P, Howard, D L, James, S A, Naim, F, Hackett, M J 2023, 'Honey, I shrunk the leaf!', Poster presented at the Q2XAFS, Melbourne, Victoria, Australia, 17-18 August 2023.

Keea Inder-Smith

Inder-Smith, K R, Mamotte, C D S, Kidman, C J, Klein, A R, Vongsvivut, J, Tobin, M J, Hackett, M J, Ravensdale, J T, Graham, R M 2023, 'Variation in lipid content and its composition observed within individual pancreatic islets using high-resolution synchrotron ATR-FTIR microspectroscopy', Poster presented at the 9th Congress of the International Society for the Study of Iron in Biology and Medicine, Darwin, Northern Territory, Australia, 27-31 August 2023.

Inder-Smith, K R, Kidman, C J, Mamotte, C D S, Klein, A R, Vongsvivut, J, Tobin, M J, Hackett, M J, Graham, R M 2023, 'The Role of Biometals in Gastrointestinal Disease', Poster presented at the Curtin Medical School Research Symposium, Curtin University, Western Australia, Australia, 7 July 2023.

Inder-Smith, K R, Mamotte, C D S, Kidman, C J, Klein, A R, Vongsvivut, J, Tobin, M J, Hackett, M J, Ravensdale, J T, Graham, R M 2023, 'Biochemical Mapping of Lipid-Iron Interplay in Pancreatic Islets Using ATR-FTIR Microspectroscopy', Poster presented at the ANSTO User Meeting 2023, Sydney, New South Wales, Australia, 27-29 November 2023.

Kyran Williamson

Williamson, K, Yurong, L, D´Angelo, A M, Humphries, T D, Paskevicius, M, Buckley, C E 2024, 'Thermochemical energy storage in $SrCO_3$ composites with $SrTiO_3$ or $SrZrO_3$', Energy, vol. 292, p. 130524.
Available from: doi:10.1016/j.energy.2024.130524.

Williamson, K, Møller, K, T, D'Angelo, A M, Humphries, T D, Paskevicius, M, Buckley, C E 2021, 'Energy storage Rocks: Metal Carbonates as Thermochemical Energy Storage Materials', Oral presentation delivered at the Australian Institute of Physics - Student conference, Perth, Australia, 25 November 2021.

Deakin University

Senlin Gu

Gu, S, de Campo, L, Kong, L 2023, 'Enhancing Nanofiltration Performance through Aligned Hexagonal Lyotropic Liquid Crystal', Oral presentation delivered at the ANSTO User Meeting (AUM2023), Sydney, New South Wales, Australia, 27-29 November 2023

Gu, S, de Campo, L, Kong, L 2023, 'Structure retention and polymerization of nanofiltration membrane active layer templated from hexagonal lyotropic liquid crystal', Poster presented at the 13th International Congress on Membranes and Membrane Processes (ICOM2023), Chiba, Japan, 9 July 2023.

Gu, S, de Campo, L, Kong, L 2023, 'Nanofiltration membranes templated from hexagonal lyotropic liquid crystal', Poster presented at the 2023 IFM Research Conference, Geelong, Victoria, Australia, 14 November 2023.

Gu, S, de Campo, L, Kong, L 2024, 'Localization of monomers within hexagonal packing system for precise administration of nanofiltration membrane structures', Oral presentation delivered at the ACNS & NDF Clip Day 2024, Sydney, New South Wales, Australia, 5 June 2024.

Gu, S, de Campo, L, Kong, L 2024, 'Interfacial design of support substrate for a continuous mesophase-templated active layer with adjustable pore size', Colloids and Surfaces A: Physicochemical and Engineering Aspects, vol. 698, p. 134569.
Available from: doi:10.1016/j.colsurfa.2024.134569

Gu, S, de Campo, L, Kong, L 2023, 'Enhancing Nanofiltration Performance through Aligned Hexagonal Lyotropic Liquid Crystal', Oral presentation delivered at the Materials Innovation in Surface Engineering (MISE2023), Brisbane, Queensland, Australia, 29 October 2023.

Baoqi Dong

Dong, B, Jiang, L, Dorin, T, Sokolova, A, Marceau, R, Hodgson, P 2023, 'Revisiting the role of Mo on precipitates and phase transformation from austenite to ferrite in Ti-Mo steels', Poster presented at the Institute for Frontier Materials Conference, Geelong, Victoria, Australia, 14 November 2023.

Dong, B, Sokolova, A, Jiang, L, Dorin, T, Marceau, R, Hodgson, P 2023, 'Investigating the role of Mo on precipitation in Ti-containing steel by Small Angle Neutron Scattering (SANS)', Oral presentation delivered at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27 November 2023.

Dong, B, Sokolova, A, Jiang, L, Dorin, T, Marceau, R, Hodgson, P 2024, 'Investigating the role of Mo on precipitation in Ti-containing steel by tempering', Oral presentation delivered at the The Annual Conference of Baosteel-Australia Joint Research and Development Centre (BAJC) , Hunter Valley, New South Wales, Australia, 26 February 2024.

Dong, B, Sokolova, A, Dorin, T, Jiang, L, Marceau, R, Hodgson, P 2024, 'Revisiting the precipitation behaviour in Ti-Mo steel using Small angle neutron scattering', Oral presentation delivered at the ACNS Clip Day , Lucas Heights, New South Wales, Australia, 6 June 2024 .

Griffith University

Felicia Haase

Haase, F 2023, 'Unravelling the Early Diagenesis of Vanadium in Anoxic Marine Environments', Ph.D. Thesis, Griffith University.

Haase, F J, Vessey, C J, Sekine, R, Doriean, N J C, Welsh, D T, Otte, J A, Hamilton, J, Canfield, D E, Wang, Y, Lombi, E, Bennett, W W 2024, 'Reductive sorption of vanadium by iron monosulfide in seawater', Chemical Geology, vol. 649, p. 121983.
Available from: doi:10.1016/j.chemgeo. 2024.121983".

Haase, F J, Sekine, R, Doriean, N J C, Welsh, D T, Howard, D L, Wang, Y, Hamilton, J, Canfield, D E, Lombi, E, Bennett, W W 2024, 'The Fate of Vanadium-Bearing Iron Oxyhydroxides in Marine Sediments: Integrating Gel-Based In Situ Mineral Probes with Synchrotron X-ray Fluorescence Microspectroscopy', ACS Earth and Space Chemistry, vol. 8, no. 5, pp. 1011–1026.
Available from:
doi:10.1021acsearthspacechem.3c00364.

La Trobe University

Sarah Green

Green, S L, Holland, A, Klein, A, Shakya, M, Dworkin, S, Lowe, R, Dutta, K, Silvester, E 2023, 'Molecular variations to the proteome of zebrafish larvae induced by environmentally relevant copper concentrations', Aquatic Toxicology, vol. 272, p. 106963.
Available from: doi:10.1016/j.aquatox.2024.106963.

Samuel Leong

Leong, S L, Murdolo, L , Maddumage, J C, Koutsakos, M, Kedzierska, K, Purcell, A W, Gras, S, Grant, E J 20224, 'Characterisation of HLA-B*18:01 restricted highly immunogenic influenza-derived peptides', Clinical Translation Immunology, vol. 13, no. 5, pp. e1509.
Available from: doi:10.1002/cti2.1509.

Lawton Murdolo

Augusto, D G, Murdolo, L D, Chatzileontiadou, D S M, Sabatino, J J Jr, Yusufali, T, Peyser, N D, Butcher, X, Kizer, K, Guthrie, K, Murray, V W, Pae, V, Sarvadhavabhatla, S, Beltran, F, Gill, G S, Lynch, K L, Yun, C, Maguire, C T, Peluso, M J, Hoh, R, Henrich, T J, Deeks, S G, Davidson, M, Lu, S, Goldberg, S A, Kelly, J D, Martin, J N, Vierra-Green, C A, Spellman, S R, Langton, D J, Dewar-Oldis, M J, Smith, C, Barnard, P J, Lee, S, Marcus, G M, Olgin, J E, Pletcher, M J, Maiers, M, Gras, S, Hollenbach, J A 2023, 'A common allele of HLA is associated with asymptomatic SARS-CoV-2 infection', Nature, vol. 620, pp. 128-136.
Available from: doi:10.1038/s41586-023-06331-x.

Leong, S L, Murdolo, L, Maddumage, J C, Koutsakos, M, Kedzierska, K, Purcell, A W, Gras, S, Grant, E J 2024, 'Characterisation of novel influenza-derived HLA-B*18:01-restricted epitopes', Clinical & Translational Immunology, vol. 13, no. 5, p. e1509.
Available from: doi:10.1002/cti2.1509.

Murdolo, L D, Augusto, D G, Chatzileontiadou, D S M, Hollenbach, J A, Gras, S 2023, 'How some of us remain asymptomatic after COVID-19', Poster presented at the Australian Society for Biochemistry and Molecular Biology (ASBMB) 2023, Canberra, Australia, 15-17 November.

Murdolo, L D, Augusto, D G, Chatzileontiadou, D S M, Hollenbach, J A, Gras, S 2024, 'How some of us remain asymptomatic after COVID-19', Poster presented at the 49th Lorne Conference on Protein Structure and Function, Lorne, Victoria, Australia, 4-8 February 2024.

You Min Ahn

Ahn, Y M, Maddumage, J C, Grant, E J, Chatzileontiadou, D S M, Perera, W W J G, Baker, B M, Szeto, C, Gras, S 2024, 'The impact of SARS-CoV-2 Spike mutation on peptide presentation is HLA allomorph-specific', Current Research in Structural Biology, vol. 7, p. 100148.
Available from: doi:10.1016/j.crstbi.2024.100148.

Ahn, Y M, Maddumage, J C, Grant, E J, Chatzileontiadou, D S M, Perera, W W J G, Baker, B M, Szeto, C, Gras, S 2024, 'The impact of SARS-CoV-2 Spike mutation on peptide presentation is HLA allomorph-specific', Poster presented at the 49th Lorne Conference on Protein Structure and Function, Lorne, Victoria, Australia, 4-8 February 2024.

Jerome Knappett

Knappett, J B M, Haydon, B, Cowie, C C C, Kewish, C M, van Riessen, G A 2024, 'Evaluation of the X-ray/EUV Nanolithography Facility at AS through wavefront propagation simulations', Journal of Synchrotron Radiation, vol. 31, pp. 485-492.
Available from: doi:10.1107/S1600577524002534.

The University of Melbourne

Ashleigh Hallinan

Hallinan, A 2023, 'Investigating landscapes as cultural artefacts: A palaeoecological study into the longevity of landscape openness in Northwest Tasmania', Honours thesis, The University of Melbourne.

Bohao Dong

Dong, B, Hausmann, N, Prendergast, A, Otter, L, Drysdale, R 2024, 'Do palaeoenvironmental reconstruction archives have uniform trace element distributions in contemporaneous increments? Investigating Tridacna shells through LIBS', Poster presented at the 44th International Symposium on Archaeometry (ISA), Melbourne, Victoria, Australia, 27-31 May 2024.

Dong, B, Hausmann, N, Prendergast, A, Otter, L, Drysdale, R 2024, 'Do palaeoenvironmental reconstruction archives have uniform trace element distributions in contemporaneous increments? Investigating Tridacna shells through LIBS', Oral presentation delivered at the Australasian Quaternary Association 2024 Conference (AQUA), Minjerribah (North Stradbroke Island), Queensland, Australia, 24-28 June 2024.

Dong, B, Prendergast, A, Liu, Z, Alidoostsalimi, M, Stringer, C 2023, 'Deciphering the Tale of the Shells, In Melbourne', Oral presentation delivered at the 2023 High-Resolution Micro-Analysis and Paleoclimate/Paleoweather Workshop, Xi'an, China, November 2023.

Kia Matley

Matley, K 2024, 'Pollen and macrofossil-based reconstructions of southeast Australian vegetation, and their implications for Late Pleistocene palaeoclimate reconstructions ', Ph.D. Thesis, The University of Melbourne.

Calla Gould-Whaley

Gould-Whaley, C N, Drysdale, R N, Treble, P C, May, J-H, Priestley, S C, Hellstrom, J C, Vardanega, C, Buswell, C 2024, 'Hydroclimate of southern Australia during Heinrich 5: insights from subaqueous speleothems', Oral presentation delivered at the Australasian Quaternary Association 2024 Conference (AQUA), Minjerribah (North Stradbroke Island), Queensland, Australia, 24-28 June 2024.

Nutpakal Ketprasit

Ketprasit, N, Dogovski, C, Khandokar, Y, Tai, C-W, Hilko, D, Leeming, M, Sharma, V, Manickam, Y, Shami, G, Nie, S, Williamson, N, Sharma, A, Poulsen, S-A, Panjikar, S, Xie, S, Tilley, L 2023, 'Targeting adenylate-forming enzyme to combat malaria', Oral presentation delivered at the Graduate research conference, Melbourne, Australia, 25 September 2023.

Ketprasit, N, Dogovski, C, Khandokar, Y, Tai, C-W, Hilko, D, Leeming, M, Sharma, V, Manickam, Y, Shami, G, Nie, S, Williamson, N, Sharma, A, Poulsen, S-A, Panjikar, S, Xie, S, Tilley, L 2023, 'Hijacking tRNA charging process: a novel approach to combat malaria', Oral presentation delivered at the FAOBMB 2023 Conference, Bangkok, Thailand, 22-25 November 2023.

Ketprasit, N, Dogovski, C, Khandokar, Y, Tai, C-W, Hilko, D, Leeming, M, Sharma, V, Manickam, Y, Shami, G, Nie, S, Williamson, N, Sharma, A, Poulsen, S-A, Panjikar, S, Xie, S, Tilley, L 2023, 'Hijacking tRNA charging process: a novel approach to combat malaria', Poster presented at the The 26th Congress of the IUCr 2023, Melbourne, Australia, 22-29 August 2023.

Ketprasit, N, Dogovski, C, Khandokar, Y, Tai, C-W, Hilko, D, Leeming, M, Sharma, V, Manickam, Y, Shami, G, Nie, S, Williamson, N, Sharma, A, Poulsen, S-A, Panjikar, S, Xie, S, Tilley, L 2024, 'Hijacking tRNA charging process: a novel approach to combat malaria', Poster presented at the Molecular Approach to Malaria, Lorne, Australia, 18-22 February 2024.

Haikun Liu

Vidallon, M L P, William, A P, Moon, M J, Liu, H, Trépout, S, Bishop, A I, Teo, B M, Tabor, R F, Peter, K, de Campo, L, Wang, X 2024, 'Revealing the structural intricacies of biomembrane-interfaced emulsions with small- and ultra-small-angle neutron scattering', Small Methods, vol. 8, no. 10, p. 2400348.
Available from: doi:10.1002/smtd.202400348.

Chloe Stringer

Stringer, C A, Prendergast, A L 2023, 'Freshwater mollusc sclerochronology: Trends, challenges, and future directions', Earth-Science Reviews, vol. 247, p. 104621.
Available from: doi:10.1016/j.earscirev.2023.104621.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, Greig, A, Levchenko, V, Wong, H, Gadd, P & First People of the Millewa Mallee Aboriginal Corporation 2023, 'A proxy calibration study for a freshwater archive in south-east Australia and its implications for understanding past human-animal-environment relationships', Oral presentation delivered at the International Union for Quaternary Research Congress, Rome, Italy, 13-20 July 2023.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, McCasker, N & First People of the Millewa Mallee Aboriginal Corporation 2023, 'Towards a holistic understanding of past, present, and future human-animal-environment relationships in the Central Murray River Basin, south-east Australia', Poster presented at the International Union for Quaternary Research Congress, Rome, Italy, 13-20 July 2023.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, Greig, A, Levchenko, V, Wong, H, Gadd, P & First People of the Millewa Mallee Aboriginal Corporation 2023, 'Investigating Late Quaternary environmental change and seasonal resource use on Ngintait Country in the Central Murray Basin using freshwater mollusc sclerochronology', Oral presentation delivered at the International Council for Archeozoology Conference, Cairns, Australia, 8-12 August 2023.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, Levchenko, V 2024, 'A freshwater reservoir effect investigation in the Central Murray River Basin, Ngintait, Latji Latji, Ngaiawang, and Yorta Yorta Countries', Oral presentation delivered at the Victorian Archaeology Colloquium, Melbourne, Australia, 2 February 2024.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, First People of the Millewa Mallee Aboriginal Corporation, Drysdale, R, Levchenko, V, Wong, H 2024, 'People, mussels, and Country: Investigating human-mussel-environment relationships during the Late Quaternary on Ngintait and Latji Latji Country, south-east Australia', Poster presented at the 44th International Symposium on Archaeometry, Melbourne, Australia, 27-31 May 2024.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, Drysdale, R & First People of the Millewa Mallee Aboriginal Corporation 2024, 'Growth and geochemistry (δ18O and δ13C) of freshwater mussels as high-resolution hydrological proxies of Ngintait and Latji Latji Country, Central Murray River Basin', Oral presentation delivered at the Australasian Quaternary Association Conference, Minjerribah (North Stradbroke Island), Queensland, Australia, 24-28 June 2024.

Stringer, C, Prendergast, A, Garvey, J, May, J-H, Drysdale, R, Levchenko, V 2024, 'Freshwater reservoir effect investigation for the lower and central Murray River', Poster presented at the Australasian Quaternary Association Conference, Minjerribah (North Stradbroke Island), Queensland, Australia, 24-28 June 2024.

Stanley Bagio

Bagio, S 2024, 'Investigations in Rare Earth Tetrabromocatecholate Complexes', Honours thesis, The University of Melbourne.

Monash University

Niloofar Karimian

Karimian, N, Johnston, S G, Tavakkoli, E, Frierdich, A J, Burton, E D 2023, 'Mechanisms of Arsenic and Antimony Co-sorption onto Jarosite: An X-ray Absorption Spectroscopic Study ', Environmental Science & Technology, vol. 57, no. 12, pp. 4813–4820. Available from: doi:10.1021/acs.est.2c08213.

Gloria Diaz-Arenas

Diaz-Arenas, G 2024, 'Membrane separation and characterisation of bio-sourced xylooligosaccharides', Ph.D. Thesis, Monash University.

Diaz-Arenas, G L, Hoang H Q, Raghuwanshi, V S, Sokolova, S, Cainglet, H, Sadiq, M M, Garnier, G, Tanner, J 2024, 'Unlocking the potential of xylooligosaccharides: Nanofiltration for fractionation of hardwood hydrolysates', Separation and Purification Technology, vol. 344, p. 127151. Available from: doi:10.1016/j.seppur.2024.127151.

Sans Rodríguez, E, Díaz-Arenas, G L, Makart, S, Ghosh, D, Patti, A F, Garnier, G, Tanner, J, Paull, B 2022, 'Determination of xylooligosaccharides produced from enzymatic hydrolysis of beechwood xylan using high-performance anion-exchange chromatography tandem mass spectrometry', Journal of Chromatography A, vol. 1666, p. 462836. Available from: doi:10.1016/j.chroma.2022.462836.

Díaz-Arenas, G L, Lebanov, L, Sans Rodríguez, E, Sadiq, M M, Paull, B, Garnier, G, Tanner, J 2022, 'Chemometric optimisation of enzymatic hydrolysis of beechwood xylan to target desired xylooligosaccharides', Bioresource Technology, vol. 352, p. 127041. Available from: doi:10.1016/j.biortech.2022.127041.

Yang Guo

Guo, Y 2024, 'The Application of Squaramides Embedded in Lipidic Cubic Phases as Sulfate Ion Detectors', Honours thesis, Monash University.

Meiling Han

Han M L, Alsaadi Y, Zhao J, Zhu Y, Lu J, Jiang X, Ma W, Patil N A, Dunstan R A, Le Brun A P, Wickremasinghe H 2024, 'Arginine catabolism is essential to polymyxin dependence in *Acinetobacter baumannii*. ', Cell Reports, vol. 43, no. 7, p. 114410. Available from: doi:10.1016/j.celrep.2024.114410.

Lai X, Chow S H, Le Brun A P, Muir B W, Bergen P J, White J, Yu H H, Wang J, Danne J, Jiang J H, Short F L, Han M L, Strugnell, R A,Song, J, Cameron, N R, Peleg, A Y, Li, J, Shen, H-H 2024, 'Polysaccharide-Targeting Lipid Nanoparticles to Kill Gram-Negative Bacteria.', Small, vol. 20, no. 6 , p. 2305052. Available from: doi:10.1002/smll.202305052.

Lai X, Han M L, Ding Y, Chow S H, Le Brun A P, Wu C M, Bergen P J, Jiang J H, Hsu H Y, Muir B W, White J 2022, 'A polytherapy based approach to combat antimicrobial resistance using cubosomes. ', Nature Communications , vol. 13, no. 1, p. 343. Available from: doi:10.1038/s41467-022-28012-5

Calum Butler

Butler, C 2022, 'Exploring the effects of molecular structure on surfactant behaviour, micelle morphology and formulation properties', Ph.D. Thesis, Monash University.

Butler, C S, Giles, L W, Sokolova, A V, De Campo, L, Tabor, R F, Tuck, K L 2022, 'Structure– performance relationships for tail substituted zwitterionic betaine–azobenzene surfactants', Langmuir, vol. 38, no. 24, pp. 7522-7534. Available from: doi:10.1021/acs.langmuir.2c00523.

Butler, C S, King, J P, Giles, L W, Marlow, J B, Vidallon, M L P, Sokolova, A, de Campo, L, Tuck, K L, Tabor, R F 2021, 'Design and synthesis of an azobenzene–betaine surfactant for photo- rheological fluids', Journal of Colloid and Interface Science, vol. 594, pp. 669-680. Available from: doi:10.1016/j.jcis.2021.02.061.

Butler, C S, Kelleppan-Meaney, V T, Williams, A P, Giles, L W, Vidallon, M L P, Sokolova, A, de Campo, L, Tuck, K L, Tabor, R F 2024, 'Influence of tail group and amide functionality on betaine surfactant behaviour', Journal of Colloid and Interface Science, vol. 653 (A), pp. 338-350. Available from: doi:10.1016/j.jcis.2023.08.171.

Thulya Chakkumpulakkal Puthan Veettil

Veettil, T C P 2023, 'Vibrational Spectroscopic Approaches for Disease and Metabolic Diagnosis', Ph.D. Thesis, Monash University.

Veettil, T C P, Guaita, D P, Kochan, K, Williams, G C, Bourke, K, Kostoulias, X, Peleg, A Y, Lyras, D, De Bank, P A, Wood, B R 2024, 'A multimodal spectroscopic approach combining mid-infrared and near-infrared for discriminating Gram-positive and Gram-negative bacteria', Analytical Chemistry, vol. 96, no. 46, pp. 18392 - 18400. Available from: doi:10.1021/acs.analchem.4c03060.

Peije Russell

Russell, P, Lengkeek, N, Walker, A, Arthur, A, Esser, L, Hagemeyer, C E, Voelcker, N H 2023, 'Theranostic porous silicon nanoparticles for improved treatment of blood clots', Poster presented at the Drug Delivery Australia 2023, Melbourne, Victoria, Australia, 30 November-1 December 2023.

Russell, P, Li, S, Hall, A, Lengkeek, N, Esser, L, Hagemeyer, C E, Voelcker, N H 2024, 'Theranostic porous silicon nanoparticles for personalised treatment of thrombosis', Oral presentation delivered at the 14th International Nanomedicine Conference, Sydney, New South Wales, Australia, 24-26 June 2024.

Alice Yong Jia Tiong

Tiong, A 2024, 'Legume Protein Isolate Properties and the Implications for Meat Analogue Production ', Ph.D. Thesis, Monash University.

Tiong, A Y J, Crawford S, Jones, N C, McKinley, G H, Batchelor, W, van't Hag, L 2024, 'Pea and soy protein isolate fractal gels: The role of protein composition, structure and solubility on their gelation behaviour', Food Structure, vol. 40, p. 100374. Available from: doi:10.1016/j.foostr.2024.100374.

Tiong, A Y J, Crawford, S, de Campo L, Ryukhtin, V, Garvey, C J, Batchelor, W, van't Hag, L 2024, 'Legume protein gelation: the mechanism behind the formation of homogeneous and fractal gels', Food Hydrocolloids, vol. 159, p. 110639. Available from: doi:10.1016/j.foodhyd.2024.110639.

Daniel Williams

Williams, D E, Suraweera, C D, Harrop, S, Michniewski, S, Venugopal, H, Lithgow, T, Jameson, E, Corrie, S R, Dunstan, A, McGowan, S 2024, 'Developing phage depolymerase enzymes to disarm Klebsiella pneumoniae', Poster presented at the 49th Lorne Conference on Protein Structure and Function, Lorne, Victoria, Australia, 4-7 February 2024.

Williams, D E, Suraweera, C D, Harrop, S, Michniewski, S, Venugopal, H, Lithgow, T, Jameson, E, Corrie, S R, Dunstan, A, McGowan, S 2024, 'Developing phage depolymerase enzymes to disarm Klebsiella pneumoniae', Poster presented at the Protein Society 38th Annual Conference, Vancouver, Canada, 23-26 July 2024.

Callum Weir-Lavelle

Weir-Lavelle, C, Hodgetts, R, Du, H-L, Nguyen, T, Nelson, A, Risse, S, MacFarlane, D, Simonov, A 2023, 'Exploring Lithium-Mediated Ammonia Electrosynthesis through In Situ Neutron Reflectometry', Oral presentation delivered at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27-29 November 2023.

Weir-Lavelle, C, Hodgetts, R, Du, H-L, Nguyen, T, Nelson, A, Risse, S, MacFarlane, D, Simonov, A 2023, 'Interrogation of the Mechanism of Lithium-Mediated Ammonia Electrosynthesis by In Situ Neutron Reflectometry', Oral presentation delivered at the Materials for Sustainable Development Fall 2023, Torremolinos, Spain, 16 October 2023.

Weir-Lavelle, C, Hodgetts, R, Nelson, A, Risse, S, MacFarlane, D, Simonov, A 2024, 'A Reduced Bias Method to Model Time-Resolved Neutron Reflectometry Data', Oral presentation delivered at the ACNS and NDF Clip Day 2024, Sydney, New South Wales, Australia, 6 June 2024.

Fiona Qiu

Qiu, F, Huang, Y, Dziegielewska, K M, Habgood, M D, Saunders, N R 2024, 'Effects of co-administration of lamotrigine on valproate transfer across the placenta and its brain entry in developing Genetic Absence Epilepsy Rats from Strasbourg (GAERS).', European Journal of Neuroscience, vol. 60, no. 4, pp. 4536-4551. Available from: doi:10.1111/ejn.16452.

Huang, Y, Dziegielewska, K M, Habgood, M D, Qiu, F, Leandro, A C, Callaghan, P D, Curran, J E, VandeBerg, J L, Saunders, N R 2024, 'ABC Efflux Transporters and Solute Carriers in the Early Developing Brain of a Marsupial *Monodelphis domestica* (South American Gray Short-Tailed Opossum)', Journal of Comparative Neurology, vol. 532, no. 7, p.e25655.
Available from: doi:10.1002/cne.25655.

Fitzpatrick, G, Huang, Y, Qiu, F, Habgood, M D, Medcalf, R L, Ho, H, Dziegielewska, K M, Saunders, N R 2024, 'Entry of cannabidiol into the fetal, postnatal and adult rat brain', Cell and Tissue Research, vol. 396, pp. 177 - 195.
Available from: doi:10.1007/s00441-024-03867-w.

Qiu, F, Dziegielewska, K M, Huang, Y, Habgood, M D, Saunders, N R 2023, 'Brain entry of antiepileptic drugs, valproate and lamotrigine, during pregnancy and development in a rat model of epilepsy (GAERS)', Poster presented at the Cerebral Vascular Biology Meeting, Uppsala, Sweden, 18-22 June 2023.

James Blyth

Blyth, J, Zhao, M, Sridhar, S, Causer, G, Fuhrer, M, Tadich, A, Edmonds, M 2024, 'Towards ultra-thin Kagome FeSn films', Oral presentation delivered at the International Conference on Nanoscience and Nanotechnology (ICONN), Melbourne, Victoria, Australia, 13-15 February 2024.

Blyth J, Sridhar S, Zhao M, Sajid A, Yen Vu T, Li Q, Maniatis J, Causer G, Fuhrer M.S, Medhekar N.V, Tadich A, Edmonds M 2024, 'Reactivity of Ultrathin Kagome Metal FeSn toward Oxygen and Water', Poster presented at the 1st Australian Workshop on Quantum Light Information Matter and Electronics (QLIME), Melbourne, Victoria, Australia, 9-12 December 2024.

Blyth J, Sridhar S, Zhao M, Sajid A, Yen Vu T, Li Q, Maniatis J, Causer G, Fuhrer M.S, Medhekar N.V, Tadich A, Edmonds M 2024, 'Reactivity of ultra-thin Kagome Metal FeSn towards Oxygen and Water', ACSNano, vol. 18, no. 40, pp. 27570–27578.
Available from: doi:10.1021/acsnano.4c08600.

Michelle Croughan

Croughan, M K 2024, 'Single-exposure directional dark-field x-ray imaging', Ph.D. Thesis, Monash University.

Croughan, M K, Paganin, D M, Alloo, S J, Ahlers, J N, How, Y Y, Harker, S A, Morgan, J S 2024, 'Correcting directional dark-field x-ray imaging artefacts using position-dependent image deblurring and attenuation removal', Scientific Reports, vol. 14, p. 17807.
Available from: doi:10.1038/s41598-024-68659-2.

Croughan M, Ahlers J, How YY, Pennings A, Paganin D, Morgan K 2023, 'Development and application of time-resolved directional dark-field retrieval at IMBL and MCT', Oral presentation delivered at the ANSTO User Meeting 2023, Sydney, New South Wales, Australia, 27-29 November 2023.

Croughan M, Paganin D, Alloo S, Ahlers J, How Y Y, Harker S, Morgan K 2024, 'Correcting directional dark field x-ray imaging artefacts using position dependent image deblurring and attenuation removal', Scientific Reports, vol. 14, no. 1, p. 17807.
Available from: doi:10.1038/s41598-024-68659-2.

The University of Newcastle

Mohammadali Faraji

Faraji, M, Borsato, A, Frisia, S, Hartland, A, Hellstrom, J C, Greig, A 2023, 'High-resolution reconstruction of infiltration in the Southern Cook Islands based on trace elements in speleothems', Quaternary Research, vol. 118, pp.1-21.
Available from: doi: 10.1017/qua.2023.51.

Anna Carpenter

Carpenter, A 2024, 'Calculating finite temperature magnetic moment structures in a sawtooth spin chain', Honours thesis, The University of Newcastle.

Hayden Robertson

Robertson, H, Gresham, I J, Nelson, A R J, Gregory, K P, Johnson, E C, Craig, V S J, Prescott, S W, Webber, G B, Wanless, E J 2024, 'Solvent modulated specific ion effects: PNIPAM brushes in non-aqueous electrolytes ', Langmuir, vol. 40, no. 1, pp. 335-347.
Available from: doi:10.1021/acs.langmuir.3c02596.

Robertson, H 2024, 'Decoding Specific Ion Effects: Polymer Brushes in Complex Electrolytes', Ph.D. Thesis, The University of Newcastle.

The University of New South Wales

Aurpa Bhuiyan

Bhuiyan, A, Wong, V, Abraham, J L, Aughterson, R D, Kong, L, Farzana, R, Gregg, D J, Sorrell, C C, Zhang, Y, Koshy, P 2021, 'Phase assemblage and microstructures of Gd2Ti2-xZrxO7 (x= 0.1–0.3) pyrochlore glass-ceramics as potential waste forms for actinide immobilization', Materials Chemistry and Physics, vol. 273, p.125058.
Available from:
doi:10.1016/j.matchemphys.2021.125058.

Michael Moschetti

Moschetti, M, Xu, A, Hohenwarter, A, Wei, T, Davis, J, Short, K, Thorogood, G, Kong, C, Couzinié, J-P, Bhattacharyya, D, Kruzic, J J, Gludovatz, B 2024, 'The influence of phase formation on irradiation tolerance in a nanocrystalline TiZrNbHfTa refractory high-entropy alloy', Advanced Engineering Materials, vol. 26, no. 4, pp. 2300863.
Available from: doi:10.1002/adem.202300863.

Daniel Connor Morris

Hammond, O S, Morris, D C, Bousrez, G, Li, S, de Campo, L, Recsei, C, Moir, M, Glavatskih, S, Rutland, M W, Mudring, A-V 2024, 'Small-Angle Neutron Scattering Insights into 2-Ethylhexyl Laurate: A Remarkable Bioester', ACS Journal of Sustainable Chemical Engineering, vol. 12, no. 5, pp. 1816–1821.
Available from: doi:10.1021/acssuschemeng.3c04736.

Hammond, O S, Morris, D C, Bousrez, G, Li, S, de Campo, L, Recsei, C, Moir, M, Glavatskih, S, Rutland, M W, Mudring, A -V 2024, 'Small-Angle Neutron Scattering Insights into 2-Ethylhexyl Laurate: A Remarkable Bioester', ACS Sustainable Chemistry & Engineering, vol. 12, no. 5, pp. 1816 - 1821.
Available from: doi:10.1021/acssuschemeng.3c04736.

Morris, D C, Greaves, T L, de Campo, L, Mole, R A, De Souza, N R, Price, W S, Prescott, S W, Harper, J B 2023, 'Structure-dynamics relationships of ionic liquid mixtures to understand differences in reaction outcome', Oral presentation delivered at the The European Molecular Liquids Group/Japanese Molecular Liquids Group Annual Meeting, Bordeaux, France, 4-7 September 2023.

Morris, D C, Hsieh, A Y, de Souza, N R, de Campo, L, Price, W S, Rutland, M W, Harper, J B, Prescott, S W 2024, 'QENS will show you what NMR can't: Multiscale analysis of the dynamics dictating reactivity in ionic liquids', Oral presentation delivered at the The 11th Australasian Symposium on Ionic Liquids, Melbourne, Victoria, Australia, 2-3 May 2024.

Morris, D C, Hsieh, A Y, de Souza, N R, de Campo, L, Price, W S, Rutland, M W, Harper, J B, Prescott, S W 2024, 'QENS will show you what NMR can't: Multiscale analysis of the dynamics dictating reactivity in ionic liquids', Oral presentation delivered at the Sydney Surfaces and Soft Stuff Meeting, Sydney, New South Wales, Australia, 15 May 2024.

Yeping Ji

Ji, Y, Radlinski, A P, Blach, T, Vu, P, Roshan, H, Regenauer-Lieb, K 2024, 'Environmental cell for (U) SANS/(U)SAXS studies with aggressive fluids at high pressures and temperatures ', Measurement, vol. 235, p. 114997.
Available from:
doi:10.1016/j.measurement.2024.114997.

Jodie Mann

Mann, J, Farzana, R, Aughterson, R D, Dayal, P, Sorrell C C, Koshy, P, Gregg, D J 2024, 'Characterisation of hot isostatically pressed (HIPed) hollandite wasteform-canister interaction zone', Journal of Nuclear Materials, vol. 589, p. 154863.
Available from: doi:10.1016/j.jnucmat.2023.154863.

Micheline Campbell

Campbell, M, Treble, P C, McDonough, L K, Naeher, S, Baker, A, Grierson, P F, Wong, H, Andersen, M S 2024, 'Combustion completeness and sample location determine wildfire ash leachate chemistry', Geochemistry, Geophysics, Geosystems, vol. 25, no. 5, p. e2024GC011470.
Available from: doi:10.1029/2024GC011470.

Dillon Frost

Frost, D G, Burr, P A, Obbard, E G, Veliscek-Carolan, J 2024, 'Controlling low temperature sintering of UO2+x', Journal of Nuclear Materials, vol. 600, p. 155269.
Available from: doi:10.1016/j.jnucmat.2024.155269.

Taren Cataldo

Cataldo, T, Le Caer, S, Veliscek-Carolan, J, Bedford, N 2023, 'Investigating radiolytic stability of metal (IV) phosphonate sorbents designed for nuclear waste treatment using x-ray absorption spectroscopy', Poster presented at the Q2XAFS 2023, Melbourne, Australia, 17-18 August 2023.

Cataldo, T, Le Caer, S, Veliscek-Carolan, J, Bedford, N 2023, 'Radiolytic stability of metal (IV) phosphonate sorbents designed for nuclear waste treatment', Poster presented at the AUM 2023, Sydney, Australia, 27-29 November 2023.

Cataldo, T, Veliscek-Carolan, J, Bedford, N, Le Caer, S 2024, 'Radiolytic Stability of Metal (IV) Phosphonate Sorbents Designed for Minor Actinide-Lanthanide Separations', Oral presentation delivered at the ATALANTE 2024, Avignon, France, 1-6 September 2024.

Melody Ranger

Ranger, M, Obbard, E G, Peterson, V K, Stansby, J H, Wakeham, D, Baldwin, C, Burr, P A 2023, 'The development of in situ nuclear fuel studies on Wombat diffractometer', Oral presentation delivered at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27-29 November 2023.

Ranger, M, Stansby, J H, Sweidan, F, Hester, J R, Burr, P A, Adorno Lopes, D, Peterson, V K, Olsson, P, Obbard, E G 2024, 'Using in situ neutron diffraction to study the thermal expansion of fission product doped UN', Oral presentation delivered at the The Minerals, Metals & Materials Society (TMS) , Orlando, Florida USA, 3-7 March 2024.

King-Fa Luo

Luo, K-F, Seyfouri, M, Valanoor, N 2023, 'BiFeO3 Ferroelectric Resonant Tunnelling Diode', Poster presented at the FLEET Legacy Workshop, Gold Coast, Queensland, Australia, 29 November - 1 December 2023.

Luo, K-F, Seyfouri, M, Valanoor, N 2024, 'BiFeO3 Ferroelectric Resonant Tunnelling Diode', Poster presented at the Quantum Australia 24, Sydney, New South Wales, Australia, 20-22 February 2024.

Robert Rourke

Rourke, R 2022, 'Targeting Protein–Protein Interactions in the Bacterial Transcription Cycle as a Strategy for Overcoming Antibiotic Resistance', Poster presented at the UNSW Second Year HDR Student Presentations, Sydney, New South Wales, Australia, 25 May 2022.

Rourke, R, Kumar N, Wilcox, M, Fraser, B, Wyatt, N 2022, 'Design and Synthesis of Substituted 1H-Indol-3-yl Ureas, as Novel Bacterial RNA Polymerase Inhibitors', Poster presented at the Southern Highlands Conference on Heterocyclic Chemistry, Sydney, New South Wales, Australia, 28-30 August 2022.

Rourke, R, Kumar N, Wilcox, M, Fraser, B, Wyatt, N 2022, 'Design and Synthesis of Substituted 1H-Indol-3-yl Ureas, as Novel Bacterial RNA Polymerase Inhibitors', Poster presented at the Organic and Medicinal Chemistry Conference, Wollongong, New South Wales, Australia, 20-23 November 2022.

Rourke, R, Kumar N, Wilcox, M, Fraser, B, Wyatt, N 2024, 'Design and Synthesis of Novel RNA Polymarase Inhibitors, as Antibacterial Agents', Poster presented at the Ischia Advanced School of Organic Chemistry, Ischia, Italy, 19-23 September 2024 .

Jessica Degeling

Degeling, J 2024, 'Cs-Loaded IONSIV® Waste Immobilisation in Hot Isostatically Pressed Glass-Ceramic Waste Forms', Honours thesis, The University of New South Wales.

University of Otago

Larissa Lopes Cavalcante

Lopes Cavalcante, L, Maynard-Casely, H E, Chaouche-Mechidal, N, Ennis, C 2023, 'Towards the formation and characterisation of the pyridine:diacetylene co-crystal on Titan', Poster presented at the IUCr/2023; Acta Crystallographica Section A: Foundations and Advances, Melbourne, Victoria, Australia, 21-29 August 2023.

Lopes Cavalcante, L, Maynard-Casely, H E, Ennis, C 2024, 'The formation of NPAHs within pyridine-based co-crystals via irradiation', Poster presented at the Astrobiology Science Conference, Providence, Rhode Island, USA, 5-10 May 2024.

Julian Eschenroeder

Eschenroeder, J, Moy, C M, Naeher, S, Vandergoes, M J, Rach, O, Sachse, D, Tjallingii, R, Saunders, K M, Howarth, J D, Shepherd, C 2024, 'Unveiling Undisturbed Alpine Lake Ecosystems: A Multiproxy Approach to Reconstruct past Ecological Response to Climate Variability in the New Zealand Southern Alps', Oral presentation delivered at the European Geosciences Union (EGU) General Meeting, Vienna, Austria, 14-19 April 2024.

The University of Queensland

Michael Healy

Healy, M D, McNally, K E, Butkovič, R, Chilton, M, Kato, K, Sacharz, J, McConville, C, Moody, ER, Shaw, S, Planelles-Herrero, V J, Yadav, S K 2023, ' Structure of the endosomal Commander complex linked to Ritscher-Schinzel syndrome', Cell, vol. 186, no. 10, pp. 2219-37. Available from: doi:10.1016/j.cell.2023.04.003.

Amy Thompson

Thompson, A J, McMurtrie, J C, Clegg, J K 2021, 'Understanding crystal flexibility with VT and charge density on a home source', Oral presentation delivered at the Rigaku User Meeting, Online, 7-8 April 2021.

Teresa Dixon

Dixon, T, Rudd, R, Kemp, J, Marx, S, Moss, P, Callow, N, Hall, P, Hua, Q, McGowan, H 2024, 'Hydroclimate variability in the eastern Kimberley, Australia, since the last deglaciation', Poster presented at the Australasian Quanternarist Association, Minjerribah, Queensland, Australia, 24-28 June 2024.

Milton Chai

Zulkifli, M Y B, Chen, R, Lin, R, Yao, Y, Chai, M, Appadoo, D, Wang, W, Zhu, Z, Liang, K, Chen, V, Hou, J 2024, 'Regulating thermal dynamics and gas transport of metal oraganic framework glass through silver composites', AIChE Journal, vol. 70, no. 2 , p. e18287. Available from: doi:10.1002/aic.18287.

Xuemei Li

Li, X 2024, 'Metal-Organic Framework Crystal Glass Composites', Ph.D. Thesis, The University of Queensland.

Queensland University of Technology

Joshua Morris

Morris, J 2024, 'Development of a radiobiological framework for evaluating the impact of Neutron Capture Enhanced Particle Therapy in treatment planning', Honours thesis, Queensland University of Technology

RMIT University

Haitao Yu

Yu, H, Dyett, B, Kirby, N, Cai, X, Mohamad, M El, Bozinovski, S, Drummond, C J, Zhai, J 2024, 'pH Dependent Lyotropic Liquid Crystalline Mesophase and Ionization Behavior of Phytantriol-Based Ionizable Lipid Nanoparticles', Small, vol. 20, Issue 2309200. Available from: doi:10.1002/smll.202309200.

Iscaro, J, Yu, H, Martinez, N, Subramaniam, S, Joyce, P, Wang, H, Dyett, B P, White, J A P, Drummond, C J, Bozinovski, S, Zhai, J 2024, 'Lyotropic Liquid Crystalline Phase Nanostructure and Cholesterol Enhance Lipid Nanoparticle Mediated mRNA Transfection in Macrophages', Advanced Functional Materials, vol. 36, p. 2405286. Available from: doi:10.1002/adfm.202405286

Yu, H, Sarkar, S, Shaw, Z L, Dyett, B, Cai, X,Yap, S L, Conn, C E, Elbourne, A, Drummond, C J, Zhai, J 2024, 'Ionizable Lipid Containing Nanocarriers for Antimicrobial Agent Delivery', Small Science, vol. 4, Issue 10, p.2400145. Available from: doi:10.1002/smsc.202400145.

Bayrak, M, Han, Q, Greaves, T L, Seibt, S, Yu, H, Floury, J, Mata, J, Logan, A, Conn, C E 2024, 'Correlating Structure and Activity of Pepsin Enzyme in H2O and D2O for the Study of Gastric Digestion', Food Chemistry Advances, vol. 4, p.100638. Available from: doi:10.1016/j.focha .2024.1 00638.

Cai, X, Refaat, A, Fan, B, Yu, H, Thang, S H, Drummond, C J, Voelcker, N H, Tran, N, Zhai, J 2024, 'Angiopep-2-Functionalized Lipid Cubosomes for Blood-Brain Barrier Crossing and Glioblastoma Treatment', ACS Applied Materials & Interfaces, vol. 16, pp.12161-12174. Available from: doi:10.1021/acsami.3c1470 9.

Dyett, B P, Sarkar, S,Yu, H, Strachan, J,Drummond, C J, Conn, C E 2024, 'Overcoming Therapeutic Challenges of Antibiotic Delivery with Cubosome Lipid Nanocarriers', ACS Applied Materials & Interfaces, vol. 16, pp.24191-24205. Available from: doi:10.1021/acsami.4c0092 1.

Yap, S L, Yu, H, Li, S, Drummond, C J, Conn, C E, Tran, N 2024, 'Cell Interactions with Lipid Nanoparticles Possessing Different Internal Nanostructures: Liposomes, Bicontinuous Cubosomes, Hexosomes,and Discontinuous Micellar Cubosomes', Journal of Colloid and Interface Science, vol. 656, p.409-423. Available from: doi:10.1016/j.jcis.2023.11.059.

Stuart Brown

Brown, S 2023, 'Designer Solvents for Understanding Protein Stability', Ph.D. Thesis, RMIT University

Brown, S J, Ryan, T M, Drummond, C J, Greaves, T L, Han, Q 2024, 'Lysozyme aggregation and unfolding in ionic liquid solvents: Insights from small angle x-ray scattering and high throughput screening', Journal of Colloid and Interface Science, vol. 655, pp. 133-144. Available from: doi:10.1016/j.jcis.2023.10.139.

Brown, S J, Christofferson, A J, Drummond, C J, Han, Q, Greaves, T L 2024, 'Exploring Solvation Properties of Protic Ionic Liquids by Employing Solvatochromic Dyes and Molecular Dynamics Simulation Analysis', Liquids, vol. 4, no. 1, pp. 288-304. Available from: doi:10.3390/liquids4010014.

Brown, S J, Drummond, C J, Greaves, T L, Han, Q 2024, 'A small angle x-ray scattering study comparing protic ionic liquid solvent effects on hen egg white and human lysozyme', Journal of Molecular Liquids, vol. 404, p. 124970. Available from: doi:10.1016/j.molliq.2024.124970"

Nisal Wanasingha

Wanasingha, N 2024, 'Resilin-mimetic Polypeptides: Biosynthesis and Structure-Function Correlation', Ph.D. Thesis, RMIT University.

Alshehhi, J R M H, Wanasingha, N, Balu, R, Mata, J P, Shah, K, Dutta, N K, Choudhury, N R 2024, '3D-Printable Sustainable Bioplastics from Gluten and Keratin', MDPI Gels, vol. 10, no. 2, p. 136. Available from: doi:10.3390/gels10020136.

Zoe Shaw

Shaw, Z L 2024, 'Low-Dimensional Materials for Antimicrobial Treatment', Ph.D. Thesis, RMIT University.

Shaw, Z L, Awad, M N, Gharehgozlo, S, Greaves, T L, Haidari, H, Kopecki, Z, Bryant, G, Spicer, P T, Walia, S, Elbourne, A, Bryant, S J 2024, 'Deep eutectic solvent eutectogels for delivery of broad-spectrum antimicrobials', ACS Applied Bio Materials, vol. 7, no. 3, pp. 1429-1434. Available from: doi:10.1021/acsabm.3c00971.

Nicholas Florent

Florent, N, Bryant, G, Bryant, S J, Iles, G N, Mata, J 2023, 'Measurements of Porosity in Martian mineral analogues using Small and Ultra Small Angle Neutron Scattering', Poster presented at the ANSTO User Meeting 2023, Sydney, New South Wales, Australia, 27-29 November 2023.

Florent, N C, Petkov, M P, Voecks, G E, Iles, G N 2021, 'Characterisation of hydrated Martian minerals for development of water extraction devices', Poster presented at the AIAC 2021: 19th Australian International Aerospace Congress, Barton, ACT, Australia, 29-30 November 2021.

Angus Campbell

Campbell, A G, Cartwright, I, Cendón, D I, Currell, MJ 2024, 'Multiple isotope tracers reveal the sources of water sustaining ecologically and culturally significant springs, and their vulnerability to mining development. ', Journal of Hydrology, vol. 645, p. 132078.

Campbell, A G, Currell, M J, Cartwright, I Cendon, D I 2022, 'Aquifer mixing and groundwater – spring interaction in an area of mining development (Galilee Basin)', Oral presentation delivered at the Australian Groundwater Conference, Perth, Western Australia, Australia, 20-24 November 2022.

Campbell, A G, Currell, M J, Cartwright, I, Webb, J A, Cendon, D I 2023, 'Inter-aquifer connectivity and sensitive spring GDEs Galilee Basin Australia', Oral presentation delivered at the Australasian Groundwater/ New Zealand Hydrological Society Conference, Auckland, New Zealand, 28 November - 1 December 2023.

Louisa Huang

Huang, L Z, Elbourne, A, Shaw, Z L, Cheeseman, S, Goff, A, Orrell-Trigg, R, Chapman, J, Murdoch, B J, Crawford, R J, Friedmann, D, Bryant, S J 2022, 'Dual-action silver functionalized nanostructured titanium against drug resistant bacterial and fungal species', Journal of Colloid and Interface Science, vol. 628 (B) , pp. 1049-1060. Available from: doi:10.1016/j.jcis.2022.08.052.

Huang, L Z, Shaw, Z L, Penman, R, Cheeseman, S, Truong, V K, Higgins, M J, Caruso, R A, Elbourne, A 2023, 'Cell Adhesion, Elasticity, and Rupture Forces Guide Microbial Cell Death on Nanostructured Antimicrobial Titanium Surfaces', ACS Applied Bio Materials, vol. 7, no. 1, pp. 344–361. Available from: doi:10.1021/acsabm.3c00943.

Huang, L Z, Leong, M M, Gharehgozlo, S, Elbourne, A, & Caruso, R A 2023. Interactions between microbial cells and titanium implant surfaces. In Methods in Microbiology, vol. 54, pp. 125-171.
Avaliable from: https://doi.org/10.1016bs mim.2023.10.004.

Rowan Penman

Penman, R, Kariuki, R, Shaw, Z L, Dekiwadia, C, Christofferson, A J, Bryant, G, Vongsvivut, J, Bryant, S J, Elbourne, A 2024, 'Gold nanoparticle adsorption alters the cell stiffness and cell wall bio-chemical landscape of Candida albicans fungal cells', Journal of Colloid And Interface Science, vol. 654 (A), pp. 390-404.
Available from: doi:10.1016/j.jcis.2023.10.017.

Ikram Ul Hassan

Ul Hassan, I, Toh, R J, Chen, X-B, Cole, I S, Luzin, V 2024, 'Effect of different toolpath strategies on surface properties of laser based directed energy deposited (L-DED) samples', Poster presented at the ACNS Annual Clip Day 2024, Sydney, New South Wales, Australia, 6 June 2024.

Lauren Giles

Giles, L 2024, 'The Investigation of Lipid-coated Mesoporous Silica Nanoparticles for Enhanced Biomimetic Drug Delivery of Tetracycline', Honours thesis, RMIT University.

Southern Cross University

James Padilla Montalvo

Padilla-Montalvo, J A, Maher, D, Sippo, J, Tait, D 2024, 'Estimating groundwater discharge along the Hawkesbury-Nepean River tidal freshwater zone using high spatiotemporal resolution radon measurements and mass balance', Poster presented at the Australian Marine Sciences Association Annual Meeting 2024, Hobart, Tasmania, 15-20 September 2024.

Luke Jeffrey

Jeffrey, L C, Moras, C A, Tait, D R, Johnston, S G, Call, M, Sippo, J Z, Jeffrey, N C, Laicher-Edwards, D, Maher, D T 2023, 'Large Methane Emissions From Tree Stems Complicate the Wetland Methane Budget', Journal of Geophysical Research: Biogeosciences, vol. 128, no. 12, p. e2023JG007679.
Available from: doi:10.1029/2023JG007679.

Jeffrey, L C, Johnston, S G, Tait, D R, Dittmann, J, Maher, D T 2024, 'Rapid bark-mediated tree stem methane transport occurs independently of the transpiration stream in Melaleuca quinquenervia', New Phytologist, vol. 242, no. 1, pp. 49-60.
Available from: doi:10.1111/nph.19404.

The University of Sydney

Md Arafat Mahmud

Mahmud, M A, Zheng, J, Chang, J -F, Wang, G, Liao, C, Rahman, M H, Tarique, W B, Tang, S, Bing, J, Li, Z, Yang, L, Novikova, N, Leung, T L, Chen, H, Yi, J, Tao, R, Jankovec, M, Bremner, S P, Cairney, J, Uddin, A, Nguyen, H T, Smith, T, Peracchi, S, Chueh, C -C, HoBaillie, A 2024, 'Halogenated Polycyclic Aromatic Hydrocarbon for Hole Selective Layer/ Perovskite Interface Modification and Passivation for PerovskiteOrganic Tandem Cells with Record Fill Factor', Oral presentation delivered at the 35th International Photovoltaic Science and Engineering Conference (PVSEC35) in Numazu, Japan.

Sienna Clarke

Clarke, S 2024, 'Control and kinetics of functional amyloid assembly: Investigating the role of disordered regions', Honours thesis, The University of Sydney.

Esther Zhang

Zhong, Y, Wilkinson-White, L, Zhang, E, Mohanty, B, Zhang, BB, McRae, MS, Luo, R, Allport, TA, Duff, AP, Zhao, J, El-Kamand, S, Plessis, MD, Cubeddu, L, Gamsjaeger, R, Ataide, SF, Kwan, AH 2024, 'Peptide nucleic acids can form hairpins and bind RNA-binding proteins', PLoS One, vol. 19, no. 9, e0310565.
Available from: doi:10.1371/journal.pone.0310565.

Zhang, E 2024, 'Towards rapid inhibitor development against RNA-binding proteins', Honours thesis, The University of Sydney.

Maria Nicholas

Nicholas M K, Zhang Z, Gu Q, Griffith C S, Maynard-Casely H E, Mullens B G, Bennett C J, Kennedy B J 2024, 'Exploring Phase Transition and Structural Complexity in the Mixed Cation Uranium Oxide $CaUNb_2O_8$', Inorganic Chemistry., vol. 33, pp. 15433-15442.
Available from: doi:10.1021/acs.inorgchem.4c02496.

Isaac Gresham

Gresham, I J, Johnson, E C, Robertson, H, Willott, J D, Webber, G B, Wanless, E J, Nelson, A R J, Prescott, S W 2024, 'Comparing polymer surfactant complexes to polyelectrolytes', Journal of Colloid and Interface Science, vol. 655, pp. 262-272.
Available from: doi:10.1016/j.cis.2023.10.101.

Celia Chen

Chen, C 2022, 'Negative Thermal Expansion in Metal–Organic Frameworks', Honours thesis, The University of Sydney.

Andrew Braz

Braz, A 2024, 'Spin Crossover in Chalcogen-Containing Heterocyclic Metal–Organic Frameworks', Ph.D. Thesis, The University of Sydney.

Carra Williams

Williams, C, Webster, J M, Bevitt, J J, Webb, G E, Nothdurft, L D, Paumard, V, McGregor, H, Murphy, R J 2023, 'Neutron Computed Tomography: A novel high-resolution, non-destructive method for diagenetic vetting of fossil coral cores for geochronological and paleoclimate reconstructions', Poster presented at the 36th International Association of Sedimentologists (IAS) Meeting of Sedimentologists, Dubrovnik, Croatia, 12-16 June 2023.

Williams, C, Webster, J M, Humblet, M, Braga, J C, Renema, W, Webb, G, Nothdurft, L, Paumard, V, Lebrec, U, Salles, T 2024, 'Coral reef response since the Mid Pleistocene Climate Transition on the NWS, Australia: insights from fossil coral reef cores', Poster presented at the European Geosciences Union (EGU) General Meeting, Vienna, Austria, 15-19 May 2024.

Williams, C, Webster, J M, Humblet, M, Braga, J C, Renema, W, Webb, G, Nothdurft, L, Paumard, V, Lebrec, U, Salles, T 2024, 'Coral reef response since the Mid Pleistocene Climate Transition on the NWS, Australia: insights from fossil coral reef cores', Poster presented at the Australasian Quaternary Association 2024 Conference (AQUA), Minjerribah (North Stradbroke Island), Queensland, Australia, 17-21 June 2024.

Mia Brennan

Brennan, M, Ling, C, Marlton, F 2023, 'Studying Local Ordering in Sodium Perovskite Solid-State Electrolytes', Poster presented at the International Union of Crystallography (IUCr) 2023, Melbourne, Victoria, Australia, 22-29 August 2023.

Brennan, M, Ling, C, Marlton, F 2023, 'Ionic Conductivity and Disorder in Sodium Perovskite Solid-State Electrolytes', Oral presentation delivered at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27-29 November, 2023.

Brennan, M, Ling, C, Marlton, F 2024, 'Ionic Conductivity and Disorder in Sodium Perovskite Solid-State Electrolytes', Oral presentation delivered at the ANSTO Clip Day, Sydney, New South Wales, Australia, 6-7 June, 2024.

University of Tasmania

Ernest Chuku

Chuku, E O, Rust, S A, Mazumder, D, Smith, G G, Trotter, A J 2024, 'Discovering a model Pacific oyster for aquaculture production and sales optimisation in southern Australia', Frontiers in Sustainable Food Systems (Aquatic Foods), vol. 8, pp. 1-16.
Available from: doi:10.3389/fsufs.2024.1440214.

Chuku, E O, Mazumder, D, Gadd, P, Crawford, J, Rust, S A, Smith, G G, Trotter, A J 2023, 'A novel application of nuclear techniques for characterising Pacific oyster (*Crassostrea gigas*) for aquaculture production', Poster presented at the 4th International Conference on Food Analysis, Melbourne, Victoria, Australia, 21-23 November 2023.

Chuku, E O 2023, 'What does the aquaculture industry want in an oyster?', Oral presentation delivered at the Shellfish Futures, Tasmania, Australia, 7-9 August 2023.

Harrison Stevens

Stevens, H 2024, 'Investigating the Recent Depositional History of Nutrients, Heavy Metals, and Fire Markersin Tasmanian Highland Lakes', Ph.D. Thesis, University of Tasmania.

Stevens, H, Barmuta, L A, Chase, Z, Saunders, K M, Zawadzki, A, Gadd, P, Proemse, B C 2024, 'Identifying the key sources of metal (loid) deposition to remote Tasmanian lakes: is legacy mining a problem?', Journal of Paleoliomnology, vol. 71, pp. 219–235.
Available from: doi:10.1007/s10933-024-00315-1.

Stevens, H, Barmuta, L A, Chase, Z, Saunders, K M, Zawadzki, A, Bowie, A R, Perron, M M G, Rodriguez, E, Paull, B, Child, D P, Hotchkis, M A C, Proemse, B C 2024, 'Comparing levoglucosan and mannosan ratios in sediments and corresponding aerosols from recent Australian fires', Science of the Total Environment, vol. 945, p. 174068.

University of South Australia

Cintya Dharmayanti

Dharmayanti, C 2024, 'Development of pH-responsive polymer homopolypeptide micelles for drug delivery', Ph.D. Thesis, University of South Australia.

Dharmayanti, C, Clulow, A, Gillam, T A, Klingler-Hoffmann, M, Albrecht, H, Blencowe, A 2024, 'Position Matters: Pyridine Regioisomers Influence Secondary Structure and Micelle Morphology in Polymer-Homopolypeptide Micelles', Biomacromolecules, vol. 25, no. 7, pp. 4095–4109.
Available from: doi:10.1021/acs.biomac.4c00204"

Dharmayanti, C, Clulow, A, Gillam, T A, Klingler-Hoffmann, M, Albrecht, H, Blencowe, A 2024, 'Polymer-homopeptide nanoparticles for targeted drug release: An investigation into morphology and pH-responsive behaviour of regioisomers', Poster presented at the Royal Australian Chemical Institute (RACI) 38th Australasian Polymer Symposium, Auckland, New Zealand, 18-21 February, 2024.

Sarah Otto

Otto, S 2023, 'Development of Thermoresponsive Polysaccharides as Tunable Delivery Systems', Ph.D. Thesis, University of South Australia.

University of Technology Sydney

Rebecca Duncan

Duncan, R J 2024, 'Climate change induced shifts in polar microalgae nutritional content: species, community and trophic implications', Ph.D. Thesis, University of Technology Sydney.

Duncan R J, Nielsen D, Søreide J E, Varpe Ø, Tobin M J, Pitusi V, Heraud P, Petrou K 2024, 'Biomolecular profiles of Arctic sea-ice diatoms highlight the role of under-ice light in cellular energy allocation', ISME communications, vol. 4, no. 1, pp. 1-15.
Available from: doi:10.1093/ismeco/ycad010.

Duncan R J, Søreide J E, Varpe Ø, Wiktor J, Pitusi V, Runge E, Petrou K 2024, 'Spatio-temporal dynamics in microalgal communities in Arctic land-fast sea ice', Progress in Oceanography, vol. 224, p. 103248.
Available from: doi:10.1016/j.pocean.2024.103248.

Duncan R J, Søreide J E, Nielsen D A, Varpe Ø, Wiktor J, Tobin M J, Pitusi V, Petrou K 2024, 'Seasonal environmental transitions and metabolic plasticity in a sea-ice alga from an individual cell perspective', Scientific Reports, vol. 14, no. 1, p. 14984.
Available from: doi:10.1038/s41598-024-65273-0.

Dance M, Duncan R J, Gevers M, Honan E M, Runge E, Schalamon F R, Walch D M 2024, 'Coming in from the cold: Addressing the challenges experienced by women conducting remote polar fieldwork', PLOS Climate, vol. 3, no. 6, p. e0000393.
Available from: doi:10.1371/journal.pclm.0000393.

Carin Basirun

Basirun, C 2024, 'Investigating Cardiovascular Mechanotransduction: Insights from Cardiac Models Under Simulated Microgravity and Radiation', Ph.D. Thesis, University of Technology Sydney.

Lissy Hartmann

Hartmann, L M, Holt, S, Pereira Schmidt, A C, Chavali, C H, Deplazes, E, Cranfield, C G 2023, 'Neutron reflectometry shows evidence of ergosterol sequestration by Amphotericin B', Poster presented at the 47th Annual Meeting of the Australian Society for Biophysics, Wollongong, New South Wales, Australia, 3-6 December 2023.

Hartmann, L M, Holt, S, Russell, R A, Le Brun, A P, Pereira Schmidt, A C, Chavali, C H, Deplazes, E, Cranfield, C G 2024, 'How does a milk peptide improve the actions of an antifungal drug?', Oral presentation delivered at the ANSTO Clip Day 2024, Sydney, New South Wales, Australia, 6-7 June 2024.

Hartmann, L M, Holt, S, Russell, R A, Le Brun, A P, Pereira Schmidt, A C, Chavali, C H, Deplazes, E, Cranfield, C G 2024, 'Impact of peptides on the solubility of Amphotericin B and its sterol-specific membrane activity', Poster presented at the 21st IUPAB Congress 2024, Kyoto, Japan, 24-28 June 2024.

Hartmann, L M, Holt, S, Russell, R A, Le Brun, A P, Pereira Schmidt, A C, Chavali, C H, Deplazes, E, Cranfield, C G 2024, 'Peptide impact on the solubility and sterol-specific membrane activity of Amphotericin B', Poster presented at the Biomolecular Horizons 2024, Melbourne, Victoria, Australia, 22-26 September 2024.

Rong Fu

Fu, R 2024, 'Short-range order, structure evolution and diffusion behaviour of liquid metals under an external magnetic field', Oral presentation delivered at the 11th International Conference on Electromagnetic Processing of Materials , Shanghai, China, 20-24 October 2024.

The University of Western Australia

Aston Summers

Summers, A M, Zahir, FZM, Turner, G F, Hay, M A, Riboldi-Tunnicliffe, A, Williamson, R, Bird, S, Goerigk, L, Boskovic, C, Moggach, S A 2024, 'Putting the squeeze on valence tautomerism in cobalt-dioxolene complexes', Nature Communications , vol. 15, no. 1 , p. 8922.
Available from: doi:10.1038/s41467-024-53311-4.

Boer, S A, Price, J R, Riboldi-Tunnicliffe, A, Williamson, R, Robert, R, Summers, A, Turner, G F, Jones, I, Bond, C S, Vrielink, A, Marshall, A C, Hitchings, J, Moggach, S A 2023, 'High-pressure single-crystal diffraction at the Australian Synchrotron', Journal of Synchrotron Radiation, vol. 30, no. 4, pp. 841-846.
Available from: doi:10.1107/S160057752300406X.

Summers, A M, Bird, S A, Goerigk, L, Hay, M A, Turner G F, Zahir, Z H M, Boskovic, C, Moggach, S A 2023, 'Unlocking the Switch: Pressure-Induced Valence Tautomerism', Poster presented at the 26th Congress and General Assembly of the International Union of Crystallography (IUCr) 2023, Melbourne, Australia, 22–29 August 2023.

Nicholas Stapleton

Stapleton, N, Maynard-Casely, E H, Moggach, S A, Spagnoli, D 2023, 'Determining Suitable Periodic DFT Methods for Modelling Titan-relevant Molecular Minerals', Oral presentation delivered at the IUCr 2023 Melbourne, Melbourne, Victoria, Australia, 22-29 August 2023.

Rose-Anne Bell

Bell, R A, Callow, J N 2024, 'Trialling structure from motion in closed canopy streams', Oral presentation delivered at the ANZGG Conference, Gisborne, New Zealand, 12-16 February 2024.

Sonya Emmett

Emmett, S 2024, 'Compositional Diversity of Titan's Surface: Unveiling New Mineral Assemblages', Honours thesis, The University of Western Australia.

Lucas Wong

Wong, L N, Jones, S D, Wood, K, de Campo, L, Darwish, T, Moir, M, Li, H, Segalman, R A, Warr, G G, Atkin, R 2022, 'Polycation radius of gyration in a polymeric ionic liquid (PIL): the PIL melt is not a theta solvent', Physical Chemistry Chemical Physics, vol. 24, pp. 4526-4532.
Available from: doi:10.1039/d1cp05354j.

Wong, L N, Imberti, S, Warr, G G, Atkin, R 2023, 'Bulk nanostructure of a deep eutectic solvent with an amphiphilic hydrogen bond donor', Physical Chemistry Chemical Physics, vol. 25, pp. 31068-31076.
Available from: doi:10.1039/d3cp03587e.

Wong, L N, Brunner, M, Imberti, S, Warr, G G, Atkin R 2023, 'Bulk Nanostructure of Mixtures of Choline Arginate, Choline Lysinate, and Water', The Journal of Physical Chemistry B, vol. 128, no. 19, pp. 4853-4863.
Available from: doi:10.1021/acs.jpcb.4c01482.

The University of Waikato

Marina Kuplich Barcellos

Kuplich Barcellos, M 2024, 'The Effects of Allelic Hinge Variation in IgG3 Antibodies on Protein Dynamics and Effector Functions', Honours thesis, University of Waikato.

University of Wollongong

Matthew Large

Large, M 2024, 'Advanced Methods for Radiation Protection in Medical and Space Applications', Ph.D. Thesis, University of Wollongong.

Yangfan Wang

Wang, Y 2024, 'Development and performance investigation of low activation medium entropy alloy FeCr2VWx via arc melting for fusion applications', Ph.D. Thesis, University of Wollongong.

Dylan Hill

Hill, D 2022, 'Characterisation of Novel Microdosimeters and Response of Mushroom Microdosimeter for Space and Medical Applications', Honours thesis, University of Wollongong.

Ben Regan

Regan, B 2023, 'The Development of a Novel Synthesis Pathway for 10B Enriched 4-Boronobenzoic Acid and Investigations of Antibody Conjugation for the Advance of NCEPT Drug Design', Honours thesis, University of Wollongong.

Tara Oliver

Oliver, T 2023, 'Bismuth-NSAIDs as colorectal cancer chemopreventives', Ph.D. Thesis, University of Wollongong.

Abuduliken Bake

Bake, A 2023, 'Engineering order-disorder transitions at the surface of topological insulators to manipulate electronic transport', Ph.D. Thesis, University of Wollongong.

Guo, L, Zhao, W, Li, Q, Xu, M, Chen, L, Bake, A, Vu, T, He, Y, Fang, Y, Cortie, D, Mo, S, Edmonds, T, Wang, X, Dong, S, Karel, J, Zhneg, R 2023, 'Antiferromagnetic topological insulating state in Tb0.02Bi1.08Sb0.9Te2S single crystals', Physical Review B, vol. 107, p. 125125.
Available from: doi:10.1103/PhysRevB.107.125125.

Thomas Sanders

Sanders, T 2024, 'Understanding the Terahertz Spectra of Amino Acid Molecular Crystals: Experiment and Theory', Ph.D. Thesis, University of Wollongong.

Sanders, T J, Allen, J L, Horvat, J, Lewis, R A 2023, 'Theoretical modelling of the terahertz spectrum of L-tyrosine leads to experimental verification of previously unobserved vibrational mode', The Journal of Chemical Physics, vol. 159, p.105103.
Available from: doi:10.1063/5.0165307.

Allen, J A, Sanders, T J, Horvat, J, Lewis, R A, Rule, K C 2023, 'Determination of Vibrational Modes of L-alanine single crystals by a combination of terahertz spectroscopy measurements and density functional calculations', Physical Review Letters, vol. 130, p. 226901.
Available from: doi:10.1103/PhysRevLett.130.226901.

Sanders, T J, Allen, J L, Horvat, J, Lewis, R A 2023, 'Quantification of anomalous blueshifting with increasing temperature in the terahertz modes of D-glutamine', Oral presentation delivered at the 48th International Conference on Infrared, Millimeter and Terahertz Waves, Montreal, QC, Canada.
Available from: doi:10.1109/IRMMW-THz57677.2023.10298889..

Harley Rutherford

Rutherford, H 2024, 'Development of Novel Dose Quantification Methods for Heavy Ion Radiotherapy Using In-Beam Positron Emission Tomography Imaging', Ph.D. Thesis, University of Wollongong.

Libei Yuan

Yuan, L 2024, 'Designing advanced Zn-based batteries with highly reversible Zn anodes', Ph.D. Thesis, University of Wollongong.

Hao, J N, Zhang, S J, Wu, H, Yuan, L B, Davey, K, Qiao, S Z 2024, 'Advanced Cathodes for Aqueous Zn Batteries beyond Zn2+Intercalation', Chemical Society Reviews, vol. 53, pp. 4312-4332.
Available from: doi:10.1039/D3CS00771E .

Vladimir Pan

Pan, V 2024, 'Radiobiological Effectiveness of Charged Particle Therapeutic Beams: Experimental Derivation, Application for Treatment Optimization and Radiation Protection of Astronauts', Ph.D. Thesis, University of Wollongong.

Pan, V A, Jacobsen, V, Tran, L T, Vestergaard, A, Vohradsky, J, Bassler, N, Rosenfeld, A 2024, 'Implementation of the MicroPlus SOI Microdosimetry System for Patient Specific Plan Evaluation in Terms of LETd Mapping', International Journal of Particle Therapy, vol. 12, p. 100131.
Available from: doi: 10.1016/j.ijpt.2024.100131.

Pan, V A, Tran, L T, Madden, T, Clasie, B, Kooy, H, Rosenfeld, A B, Depauw, N 2024, 'LETd Optimization Verification with an SOI Microdosimeter', International Journal of Radiation Oncology - Biology - Physics , vol. 119, no. 3, pp. 946-956.
Available from: doi:10.1016/j.ijrobp.2023.12.036.

Yangfan Wang
Wang, Y F, Wang, Z Y, Zhu, H L, Qiu Z J, Pan, Z X, Zhu, H T, Wexler, D, Chen, X Z, Zhang, M X, Li, H J 2024, 'Hot compressive deformation of W-modified FeCr2V-based medium entropy alloys: Microstructure and strengthening mechanism studies', Materials Characterization, vol. 210, p. 113803.
Available from: doi:10.1016/j.matchar.2024.113803.

Hao Yin
Yin, H, Waterman, M J, Langendam, A D, Klein, A R, Paterson, D J, Wu, Y, Robinson, S A 2024, 'Metals along ancient mosses as bioindicators of anthropogenic activities in Antarctica', Poster presented at the SCAR-Open Science Conference, Pucón, Chile, 19-23 August 2024.

Caleb Stamper
Stamper, C, Cortie, D, Islam, S M K N, Rahman, R, Yu, D, Yang, G, Al-Mamun, A, Wang, X, Yue, Z 2024, 'Phonon engineering in thermal materials with nano-carbon dopants', Applied Physics Reviews, vol. 11, p. 021336.
Available from: doi:10.1063/5.0173675.

Stamper, C, Cortie, D, Yu, D, Galaviz, P, Rule, K 2023, 'The Unique Lattice Dynamics of Nanodiamond – a Molecular Dynamics and Inelastic Neutron Scattering Investigation', Oral presentation delivered at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27-29 November 2023.

Stamper, C, Cortie, D, Yu, D, Galaviz, P, Rule, K, Baggioli, M 2024, 'The Unique Lattice Dynamics of Nanodiamond – a Molecular Dynamics and Inelastic Neutron Scattering Investigation', Oral presentation delivered at the Condensed Matter and Materials Meeting, Wagga Wagga, New South Wales, Australia, 6-9 February 2024.

Rebecca Farrell
Farrell, R E, Steele, H, Middleton, R J, Skropeta, D, Guo-Jun Liu, G-J 2024, 'Cytotoxicity of phosphoramidate, bis-amidate and cycloSal prodrug metabolites against tumour and normal cells', RSC Medicinal Chemistry, vol. 15, pp. 1973-1981.
Available from: doi:10.1039/D4MD00115J.

Jay Archer
Archer, J W, Villani, E G, Pan, V A, Pastuovic, Z, Hynds, D, BanHani, A M, Voharadsky, J, Bennett, D J, Gazi, M, Peracchi, S, Guatelli, S, Petasecca, M, Lerch, M, Bortoletto, D, Tran, L T, Rosenfeld, A B 2024, 'A Two-Dimensional Characterization of Low-Gain Avalanche Diodes for Low-LET Microdosimetry', IEEE Transactions on Nuclear Science, vol. 71, no. 3, pp. 342-351.
Available from: doi:10.1109/TNS.2024.3359249.

Archer, J W, Villani, E G, Pan, V A, Pastuovic, Z, Hynds, D, BanHani, A M, Voharadsky, J, Bennett, D J, Gazi, M, Peracchi, S, Guatelli, S, Petasecca, M, Lerch, M, Bortoletto, D, Tran, L T, Rosenfeld, A B 2024, 'A Two-Dimensional Characterization of Low-Gain Avalanche Diodes for Low-LET Microdosimetry', Poster presented at the ANSTO User Meeting, Sydney, New South Wales, Australia, 27- 29 November 2023.

Kyle Portwin
Portwin, K A, Galaviz, P, Stamper, C, Kutteh, R, Yu, D, Cheng, Z, Cortie, D L, Rule, K C 2024, 'The role of finite-temperature dynamics and dispersion interactions on the phonon bandgap in thermoelectric SnSe', Physical Review B, vol. 110, p. 094311.
Available from: doi:10.1103/PhysRevB.110.094311.

Sherryn MacLeod
MacLeod, S, Jakubowski, K, Vohdrasky, J, Guatelli, S, Safavi-Naeini, M 2024, 'Benchmarking Monte-Carlo codes for the modelling of target reactions used in AB-BNCT', Oral presentation delivered at the The 5th International Geant4 User Conference, Osaka, Japan, 25- 29 March 2024.

Micah Barnes
Engels E, Paino J R, Vogel S E, Valceski M, Khochaiche A, Li N, Davis J A, O'Keefe A, Dipuglia A, Cameron M, Barnes M, Stevenson A W, Rosenfeld A, Lerch M, Corde S, Tehei M 2023, 'Modulating Synchrotron Microbeam Radiation Therapy Doses for Preclinical Brain Cancer', Radiation, vol. 3, no. 4, pp. 183-202.
Available from: doi:10.3390/radiation3040015.

Bustillo J P, Paino J, Barnes M, Cameron M, Rosenfeld A B, Lerch M L F 2024, 'Characterization of selected additive manufacturing materials for synchrotron monochromatic imaging and broad-beam radiotherapy at the Australian synchrotron-imaging and medical beamline', Physics in Medicine & Biology, vol. 69, no. 11, p. 115055.
Available from: doi:10.1088/1361-6560/ad48f7.

May L, Barnes M, Hardcastle N, Hernandez V, Saez J, Rosenfeld A, Poder J 2024, 'Multi-institutional investigation into the robustness of intra-cranial multi-target stereotactic radiosurgery plans to patient setup errors', Physica Medica, vol. 124, p. 103423.
Available from: doi:10.1016/j.ejmp.2024.103423.

Bustillo J P, Paino J, Barnes M, Cayley J, de Rover V, Cameron M, Engels E M, Tehei M, Beirne S, Wallace G, Rosenfeld A B, LF Lerch M 2024, 'Design, construction, and dosimetry of 3D printed heterogeneous phantoms for synchrotron brain cancer radiation therapy quality assurance', Physics in Medicine & Biology, vol. 69, no. 14, p. 145003.
Available from: doi:10.1088/1361-6560/ad5b48.

Jackson Allen
Allen J L, Heinze L, Mole R A, Lewis R A, Süllow S, Rule K C 2023, 'Understanding the complex magnetic effects in a low-dimensional frustrated magnet through inelastic neutron scattering', Oral presentation delivered at the AIP Summer Meeting 2023, Canberra, Australia, 3-8 December 2023.

Allen J L, Sanders T J, Horvat J, Mole R A, Lewis R A, Rule K C 2023, 'THz and inelastic neutron scattering spectroscopy combined to reveal phonon temperature dynamics of L-Alanine', Oral presentation delivered at the ANSTO User Meeting 2023, Sydney, New South Wales, Australia, 27-29 November 2023.

Harrison Steele
Farrell, R E, Steele, H, Middleton, R J, Skropeta, D, Liu, G J 2024, 'Cytotoxicity of phosphoramidate, bis-amidate and cycloSal prodrug metabolites against tumour and normal cells', RSC Medicinal Chemistry, vol. 15, no. 6, pp. 1973-1981.
Available from: doi:10.1039/D4MD00115J.

Lachlan Souter
Souter, L 2024, 'Gas Sequestration in Polymethylpentene (TPX): a Study Using Mid-to-Far-Infrared Spectroscopy', Honours thesis, University of Wollongong.

Angus Walton
Walton, A 2024, 'Investigating the controls on denudation rates in the Andes using cosmogenic 10Be and 26Al', Honours thesis, University of Wollongong.

Jacob Wright
Wright, J 2024, 'Single Event Transient testing of Operational Amplifier LM124 using pulsed laser light for Qualification of Single Event Effect test bench', Honours thesis, University of Wollongong.

AINSE Member Codes

ADE	The University of Adelaide
AKL	The University of Auckland
ANS	ANSTO
ANU	The Australian National University
CAN	University of Canterbury
CBR	University of Canberra
CDU	Charles Darwin University
CQU	CQUniversity
CSI	CSIRO
CSU	Charles Sturt University
CUR	Curtin University
DEA	Deakin University
ECU	Edith Cowan University
FLI	Flinders University
GRI	Griffith University
JAM	James Cook University
LAT	La Trobe University
MAC	Macquarie University
MEL	The University of Melbourne
MON	Monash University
MUR	Murdoch University
NCT	The University of Newcastle
NSW	The University of New South Wales
OTA	University of Otago
QLD	The University of Queensland
QUT	Queensland University of Technology
RMI	RMIT University
SCU	Southern Cross University
SWI	Swinburne University of Technology
SYD	The University of Sydney
TAS	University of Tasmania
UNE	The University of New England
USA	University of South Australia
USC	University of the Sunshine Coast
USQ	University of Southern Queensland
UTS	University of Technology Sydney
UWA	The University of Western Australia
VIC	Victoria University
VUW	Victoria University of Wellington
WAI	The University of Waikato
WOL	University of Wollongong
WSU	Western Sydney University
IND	Individual Member

Specialist Areas

AGES	Archaeology, Geosciences and Environmental Sciences Committee
BBS	Biomedical Science and Biotechnology Committee
MSE	Materials Science and Engineering Committee

The Australian Institute of Nuclear Science and Engineering, AINSE Ltd.

EMAIL
enquiries@ainse.edu.au

PHONE
+61 2 9717 3376

WEBSITE
ainse.edu.au

AINSE Ltd. ABN:
18 133 225 331

MAIL
Locked Bag 2001
Kirrawee DC NSW 2232
Australia

ADDRESS
New Illawarra Road
Lucas Heights NSW 2234
Australia

AINSE Ltd.

Cover Image: The canopy of a karri tree (top), with an optical scan of karri wood and X-ray fluorescence map of the strontium distribution within (bottom) showing a potential drought or fire signal. Please see p.18 for further details.

Image credit: Casey Ryan, AINSE PGRA scholar and University of Western Australia, Ph.D. field work.