ANNUAL REPORT 2020

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
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AINSE 2020 Annual Report

From the President and the Managing Director

The start of 2020 for AINSE was filled with optimism. The AINSE strategic plan was well into the second year and developing international connections was an early year focus. AINSE signed a new three-year Memorandum of Understanding with ANSTO and the Embassy of France in Australia to continue the Scholarship AINSE ANSTO French Embassy (SAAFE) with many enquiries from researchers across Australia and France. The Managing Director attended the February Human Resource Development for Nuclear Energy in Asia meeting in Japan and had the opportunity to network with international connections in Japan regarding possible future collaborative schools. Soon after these opportunities arose the pandemic became a threat in Australia and restrictions quickly followed that could have severely limited AINSE operations.

Despite the lockdowns in Australia, New Zealand and globally, AINSE demonstrated that it could instantly respond to the changing conditions. Within days the business implemented changes to start the process of moving the major events to an online format. As a consequence of the release of a new website the previous year, AINSE was well equipped to maintain an online shopfront through the website and social media to keep researchers informed. AINSE hosted regular drop-in Zoom sessions for members and students, an online Winter School was rapidly developed and webinars connecting researchers to ANSTO were held.

Whilst 2020 continued to be an anxious year both locally and globally, the AINSE team used this time as an opportunity to focus on online content development. With the regular face-to-face programs not occurring the staff had time to pivot the business into online mode. This set up the business to provide a range of range of opportunities for members to enhance their capabilities in nuclear science and engineering and related fields through connecting with ANSTO staff and facilities online. Through these online platforms AINSE was able to highlight its collaborative potential and increase the value of the brand beyond nuclear scientists and engineers to a wider audience online both domestically and internationally with overseas delegates welcomed online.

Whilst AINSE adapted to the new environment with its members and beyond, the ANSTO scientists actively engaged with the research community to keep them informed on research opportunities, supported them with the mail-in of samples and assisted early career researchers (in particular AINSE honours students and postgraduate award holders) to modify research to be able to collaborate remotely. The ANSTO staff, in particular the staff in the Nuclear Science & Technology, and Landmark Infrastructure (NSTLI) team, worked tirelessly to support the research community during this difficult time.

A highlight in 2020 was the presentation of the AINSE Gold Medal. AINSE Gold Medals are awarded by the AINSE Council for excellence in research based on publications over the last five years that acknowledge AINSE support. In May 2020, Dr. Gabriel Murphy formerly from the University of Sydney, and Dr. Cynthia Isley from Macquarie University, were both presented with an AINSE Gold Medal in an online event hosted prior to the AINSE Annual General Meeting in which colleagues, family and friends attended.

AINSE continued to offer a variety of funding opportunities and extensions to existing programs throughout 2020, including: Honours Scholarships; Postgraduate Research Awards (PGRA); Residential Student Scholarships (RSS); Scholarship AINSE ANSTO French Embassy (SAAFE) and extensions and Early Career Researcher Grants (ECRG). AINSE awarded 24 new Honours scholarships to support students from 12 Wmembers, 42 new PGRAs from 19 members, and 6 new RSS scholarships.

The Postgraduate Research Awards continued to be the most highly funded program with support provided to 107 PhD students in 2020. During the year AINSE were notified of 29 published research theses from students completing their higher degree research programs.

In 2020, AINSE continued to grow its Early Career Researcher Grants (ECRG) for PhD students and postdoctoral researchers. This grant attracted applications from 20 different members, 17 of which were approved for funding. The ECRG covers travel and accommodation, consumables, as well as carer requirements.

The AINSE schools played a major role by keeping students engaged in an online format to help further create a pipeline of students interested in further enhancing capacity in nuclear science, engineering, and related research fields. AINSE held three schools online in 2020: the AINSE Winter School; Postgraduate Orientation Week; and the Women in STEM and Entrepreneurship (WISE) School.

The AINSE Winter School celebrated its 24th year in July and was attended by 80 students from 34 member institutions. The capacity of this school was increased due to the online nature allowing a record capacity attendance. ANSTO staff carefully planned experiments that could be filmed or adapted to the online setting with live camera feeds to keep the audience engaged online. The Research Roundup event that is normally held as a dinner was converted to Zoom and breakout rooms were used with parallel sessions throughout the afternoon to enhance collaboration between students and ANSTO staff. This event stimulated research collaborations that will lead into 2021.

AINSE President Prof. Ian Gentle (2nd row, 2nd column), AINSE Managing Director Michelle Durant (2nd row, 4th column), and ANSTO CEO Dr. Adi Paterson (2nd row, 5th column) address the 2020 Winter School cohort at the close of the online Winter School, July 2020.

The Postgraduate Orientation Week in October was also held online, where 33 new PhD scholars attended. This included scholars from the PGRA and RSS programs and the ANSTO Graduate Institute. Online participants were able to gain an overview of ANSTO research programs inside and outside their own areas of expertise and meet with their ANSTO supervisors to gain familiarity with their research facilities. At this event students also participated in Nuclear Science Week online, a global event celebrating the benefits of nuclear science. As this was held as an online global event there were opportunities to attend programs around the world.

Our final school of the year was the WISE School, in which 57 students attended online from 27 Universities. AINSE attracted leading speakers for this school with keynote speakers Prof. Tanya Monro, Chief Defence Scientist, Defence Science Technology Group (DSTG); Ms. Kylie Walker, Chief Executive Officer, Australian Academy of Technology & Engineering and Prof. Brian Schmidt, Noble Laureate, Vice Chancellor Australian National University along with a long list of other inspirational speakers.

We would like to thank and congratulate the AINSE team that were onboard for the whole year, Michael Rose, Kim Shields, Nerissa Phillips, Laura Owen, and Lillian Caruana for their commitment to the business in 2020. We also thank Joshua Keegan and Cara Smith who finished up with AINSE earlier in the year. It took great resilience and stamina and a highly nimble team to switch the business around to an online format whilst continuing to offer excellent support to the research community through this difficult time.

AINSE finished 2020 with a surplus of $277,146 of which a large proportion was due to the lack of travel undertaken by scholars as a result of the pandemic. The funds were announced as a carryover in the budget for the next year at the final General Meeting of AINSE Ltd in November. These funds will provide extra opportunities for members in areas such as student quarantine support, student professional development opportunities and an increase in stipend for the PGRA Scholars.

We thank Dr. Adi Paterson, Chief Executive Officer of ANSTO and Mr. Shaun Jenkinson Acting Chief Executive Officer of ANSTO in 2020, for allowing us to utilise the ANSTO facilities and collaborate with the ANSTO staff to maximise benefits for our members. We also thank Dr. Simone Richter, Group Executive NSTLI, and her team for making sure the students were so well supported in 2020. The NSTLI staff responded so positively in supporting both students and researchers during this time and we are very grateful.

We express thanks to the AINSE Board for their strong commitment to the company in 2020 as it was guided through its first major pandemic. There was an increase in Board meetings as expected in which the Board showed unified strength in supporting the AINSE staff.

We look forward to continuing and expanding AINSE programs in 2021 and utilising the skills and experience of the AINSE Secretariat and AINSE Board in working towards our strategic goals. There is no doubt that the enforced changes have allowed the organisation to develop new and exciting abilities that will add value to our offerings for our members going forward. It is certainly a different setting to what we could have imagined at the commencement of 2020, but we are well equipped for any challenges in 2021.

Prof. Ian Gentle
AINSE President

Ms. Michelle Durant
AINSE Managing Director

AINSE Board 2020

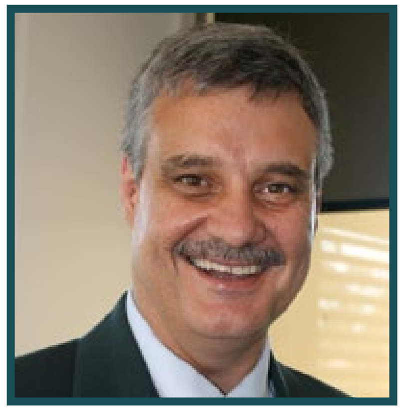
Prof. Ian Gentle
President
University Representative

Ms. Michelle Durant
Managing Director

Dr. Leonie Walsh
Independent Director

Ms. Helen Liossis
Independent Director

Prof. William Boyd
University Representative



Prof. Roland De Marco
University Representative

Ms. Roslyn Hatton
ANSTO Representative

Prof. Andrew Peele
ANSTO Representative

Dr. Suzanne Hollins
ANSTO Representative

AINSE Staff:

Managing Director:

Michelle Durant
BSc, BFinAdmin, GradDipAppCorpGov, FGIA, FCIS

Secretariat:

Business Manager:
Kim Shields
GradCertMgt, AIPA AFA

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

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

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

Administration and Events Assistant:
Lillian Caruana (casual)
BLS

Membership Officer:
Cara Smith (concluded June 2020)
BA

Administration Assistant:
Joshua Keegan (casual, concluded January 2020)

The AINSE staff throughout 2020. Above left: Joshua Keegan. Above right: Cara Smith. Below, clockwise from top-left: Kim Shields, Laura Owen, Michael Rose, Lillian Caruana, Michelle Durant, and Nerissa Phillips.

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 the nuclear science, engineering and related research fields nationally and internationally and builds capability and diversity through training and education.

Strategic Priorities

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

- Play a key role in supporting research collaboration and networking opportunities.
- Explore targeted international opportunities.

2. Create a large pipeline of skilled students/graduates by facilitating new opportunities for the next generation of students with an interest in nuclear science and engineering and related research fields.

- Support the next generation of students by facilitating new opportunities nationally and internationally.
- Work with Universities for continued improvement of existing programs and identify new opportunities to enhance learning for students.

3. Be a visible and respected brand with strong targeted global 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 and Industry partners.
- Effectively communicate AINSE's purpose to a wide range of different stakeholders.

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

- Liaise with local, national and international policy makers to influence and communicate future priorities.
- Manage and protect AINSE's information assets.

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

- Diversify AINSE's membership and stakeholder base, while recognising the importance of existing membership.
- Seek new opportunities for funding beyond AINSE's traditional sources.
- Develop links with the philanthropic community.

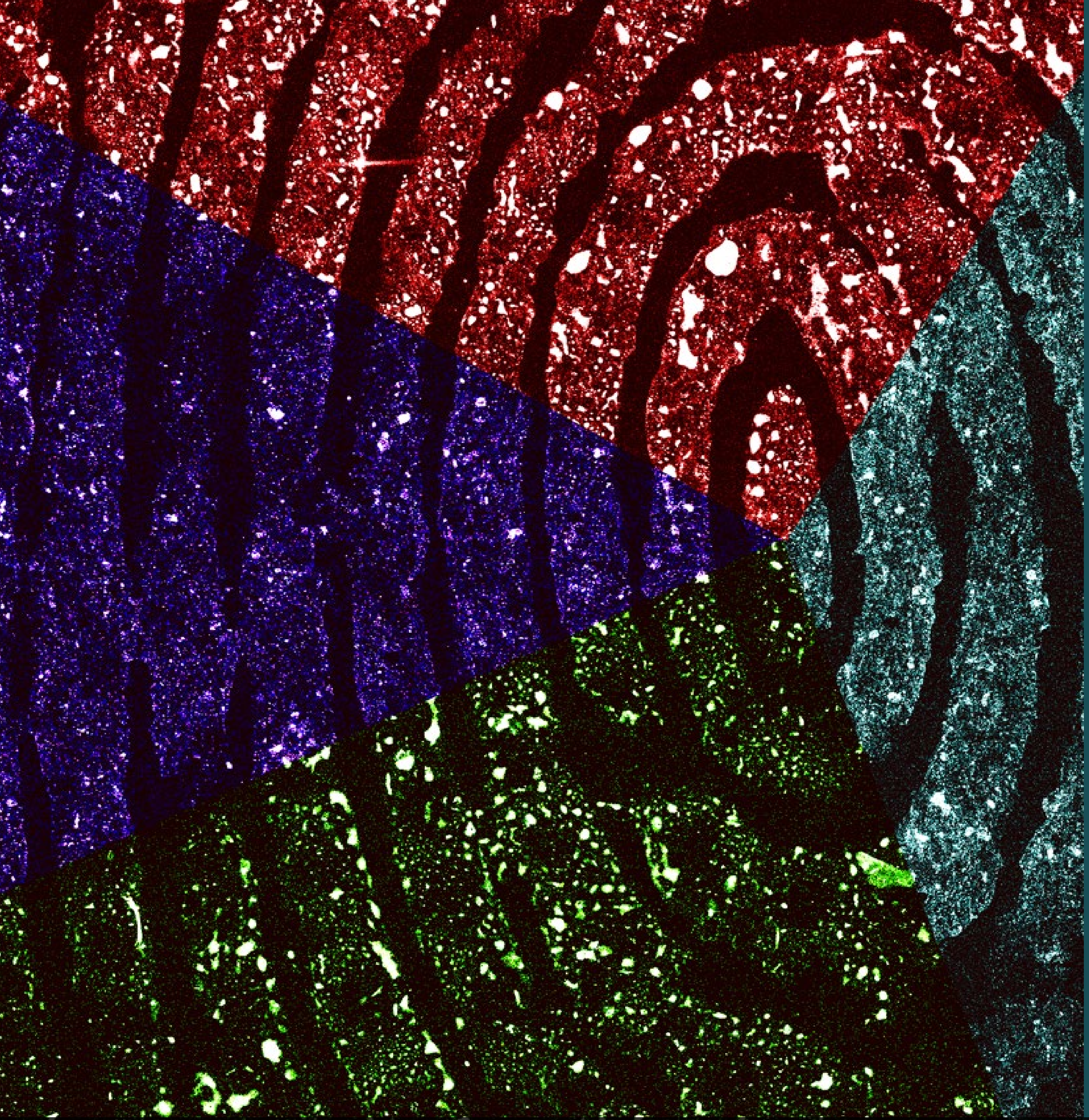


Image of the metal content in a natural fingermark generated from data collected on the X-ray Fluorescence Microscopy beamline at ANSTO's Australian Synchrotron. The image shows the natural abundance of Iron (purple), Potassium (green), Titanium (cyan) and Zinc (red) in a latent fingermark. Image credit: Rhiannon Boseley, AINSE PGRA scholar.

Research Highlights

The 20,000-year environmental history of Arthur's Pass Valley, South Island, New Zealand

Patrick Adams[1], Patrick Moss[1], Jamie Shulmeister[2], Craig Woodward[3], David Fink[3]

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The Southern Alps of New Zealand are well positioned to study Southern Hemisphere climate, due to their SW/NE orientation, peak elevations over 3,000m, and latitude range (46–42°S).

The prevailing moist, westerly wind is intercepted by the Southern Alps and forced upwards by an orographic barrier effect, resulting in a high precipitation regime along the West Coast and rain shadow to the east of the divide with a steep gradient on the lee side. The site chosen for this study (Figure 1) is located near the mid-point of this precipitation gradient, where changes in paleoclimate conditions are highly sensitive to changes in the strength and direction of the prevailing westerlies.

The aim of this research is to obtain high-resolution climate records covering the period from the Last Glacial Maximum (LGM, ~20,000 years ago), when valley glaciers were at their peak extent, into the Holocene (~10,000 years ago), when glacial conditions were similar to what we see today. These two periods cover glacial to interglacial climates, an understanding of which could improve our understanding of natural climate variability in New Zealand's alpine environments. This benefits the broader community by informing future climate predictions and trends, hence aiding socio-economic decision making on all levels of private, public and governmental institutions.

We have sampled glacially deposited rock and bedrock to obtain a chronological record of glacial advance and retreat using the technique of cosmogenic exposure dating. Radiocarbon dating of cores from peat bogs, coupled with pollen analyses, then allows us to document environmental changes (such as sedimentation regime and vegetation changes) through glacial and interglacial times.

Arthur's Pass is one of very few high mountain areas to have experienced significant human impact, as it has been utilized throughout successive waves of both Maori and European

> *Arthur's Pass is one of very few high mountain areas to have experienced significant human impact...*

colonization of the country. Despite this status, the area remains relatively understudied.

The bog core record also allows us to discern human impact in High Country of the Canterbury region of New Zealand. This knowledge is of high importance to the local traditional owner groups, as well as the broader New Zealand community.

We are aiming for 57 new ages to be added to this chronology by mid-2021...

After being transported down-valley by advancing ice, boulders and overrun bedrock subsequently become exposed to cosmic ray bombardment once the ice retreats at the onset of warming. The cosmic rays create radionuclides in the rock surface, such as Be-10 and Al-26, which act as atomic clocks – the longer the exposure, the larger the number of cosmogenic nuclides produced. We use the technique of Accelerator Mass Spectrometry (AMS) to count these rare nuclides and thus determine the length of time since the ice retreated. All cosmogenic exposure samples were measured at ANSTO utilising the Sirius Accelerator.

Example sampling locations and exposure ages are given in Figure 2. We are aiming for 57 new ages to be added to this chronology by mid-2021, complemented by dates previously obtained by Fink et al. (2017). When coupled with other deglaciation studies in adjacent valleys (such as the valleys of Rangitata and Waimakariri; see Rother et al., 2014), a regional picture of the last ice age in New Zealand will be provided. There is a significant opportunity to also demonstrate the existence and timing of local Little Ice Age (LIA) glaciation ~500-200 years ago in the upper Otira Valley, as the temperature depression and timing of the LIA across New Zealand is currently uncertain (Carrivick et al., 2020). The suspected Otira LIA moraine samples are scheduled for AMS measurement at ANSTO in early 2021.

Aside from glacio-fluvial geomorphology, we also retrieved three cores from moraine impounded bogs that complement four others collected previously by Dr. Woodward and Dr. Fink. Extensive radiocarbon and Pb-210 dating on a 2m core from Upper Lance's Tarn has delivered a high-resolution age-depth model which, when coupled with ITRAX chemical composition analyses, macro-charcoal counts, organic content and palynology (Figure 3), provided a high-quality paleo-record during the Holocene. The westerly wind strength was based on pollen counts; specifically, West Coast taxa pollen influx and in-valley vegetation succession.

The Early Holocene was generally wet and windy, apart from a period ~9,500-8,500 years ago when winds were marginally weaker. Of interest is the past 2,500 years, where our results point to a novel finding: Prior to this study, evidence pointed to an intensification of the westerly flow over the South Island. Our findings point to a weakening of the flow over

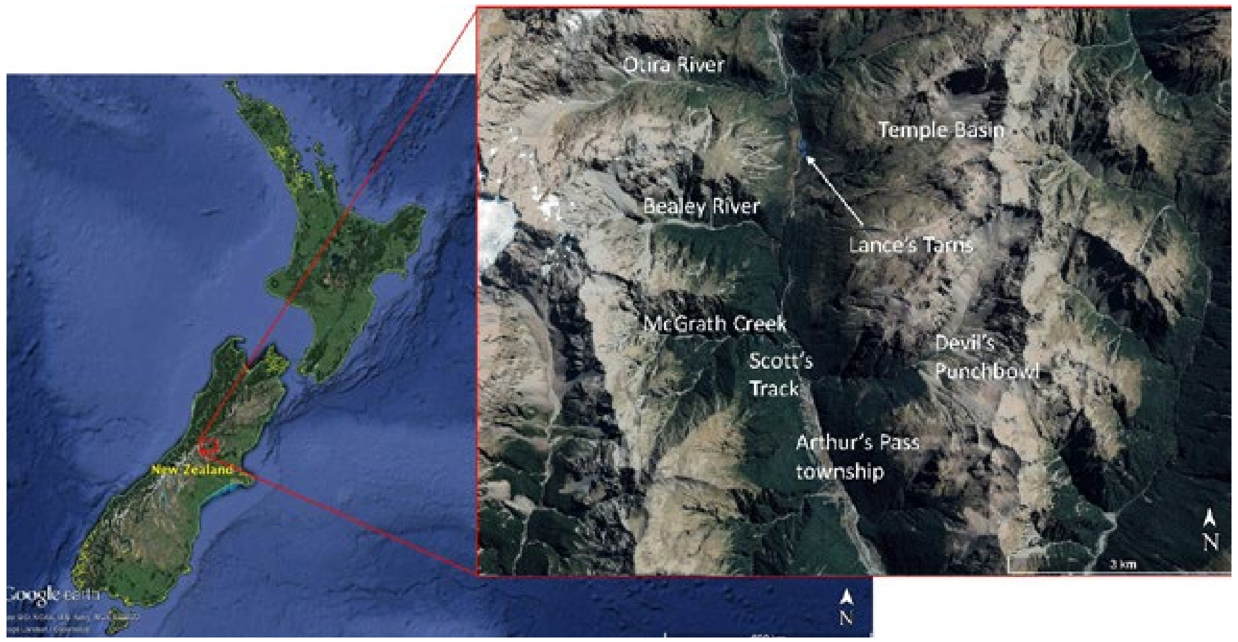

Figure 1: Location of Arthur's Pass Valley, South Island, New Zealand.

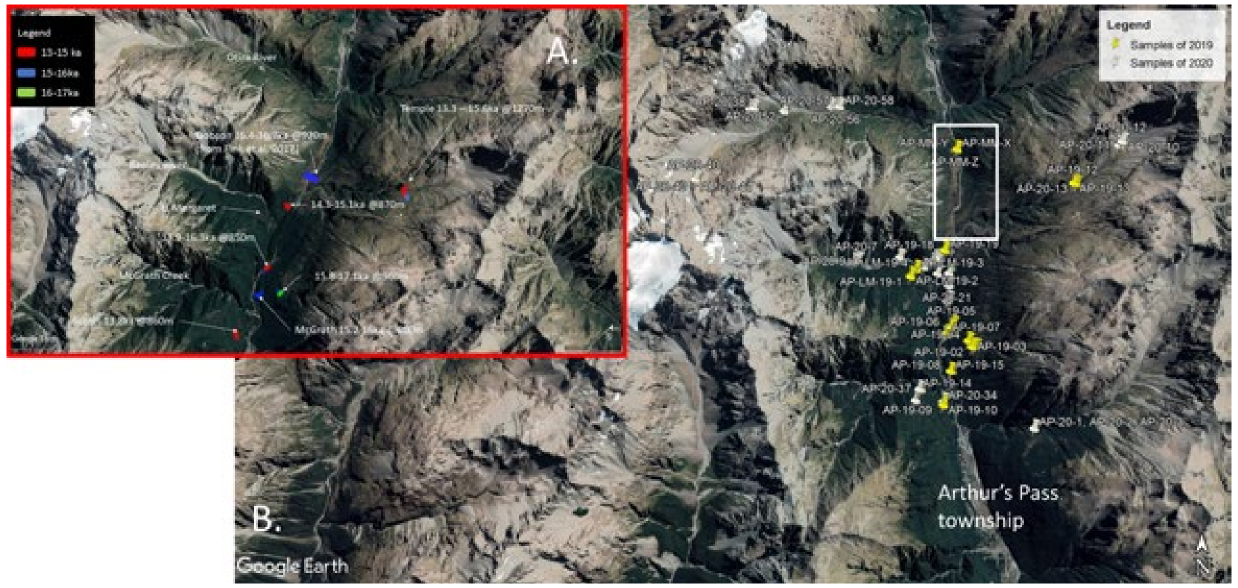

Figure 2: (a) Selection of ages and respective ice margin limits; (b) The locations of cosmogenic radionuclide samples collected for this project over two field campaigns (2019 and 2020), Fink et al. (2017) sampling area in white rectangle.

the central portion of the Southern Alps, with a likely migration southward of the Westerlies. This finding is supported by Turney et al. (2016), who found intensification of the wind belt on Campbell and Auckland Islands south of New Zealand. As a result, rainfall decreased in the Central Alps and air flow increased through more southern regions of the South Island.

Macro-charcoal concentrations suggest increased fire incidence, which may be a result of the increased air mass instability and storms derived from the Canterbury region with lightning as the natural ignition source. In contrast, the Early- and Mid-Holocene had very low to no incidence of local fire. At least one significant sized fire was recorded at ~800 ACE, which pre-dates human arrival at around 1280 ACE (Wilmshurst et al., 2008). Post-human arrival, we observe an increase in charcoal but no shift in sedimentary regime. We propose that the drier and cooler conditions of the Little Ice Age promoted grass/herb expansion (from our pollen analysis), providing abundant ignitable fuel. Since the sedimentation rates are not altered despite the presence of charcoal, we conclude that the fires are small and of low intensity.

We speculate that fires are caused by accidental ignition from Polynesian campfires. Some sources report that Arthur's Pass was used as a war party travel route to the West Coast (Roberts and Skinner, 1912, Brailsford, 1984), however the evidence is contested. In our view, it is unlikely that natural ignition rate was a sole reason for the frequent burning of the Arthur's Pass saddle as the ignition rate exceeds any prior natural fire levels. The fire history record thus proves that the pass was indeed utilized by the Maori.

Post-European arrival, however, the sedimentation rate increases dramatically. This is coupled with a decline in tree cover and, again, expansion of grass field resulting from the large and often deliberate fires that have burned in the area (some of which have been documented in the early literature, e.g. Cockayne (1898) and Cockayne and Sledge (1932)).

This work is the subject of a PhD thesis of Patrick Adams (University of Queensland), with primary supervision from Professor Patrick Moss (University of Queensland), authority on fire regimes, biogeography and paleo-environments; Professor Jamie Shulmeister (University of Canterbury, NZ), world authority on glacial, fluvial and coastal geomorphology and global climate systems); Dr. Craig Woodward (University of Wollongong / ANSTO), authority in paleo-environments, palynology and macro-fossils; and Dr. David Fink (University of Wollongong / ANSTO), world authority on Accelerator Mass Spectrometry, glacial geochronology and landscape evolution using cosmogenic

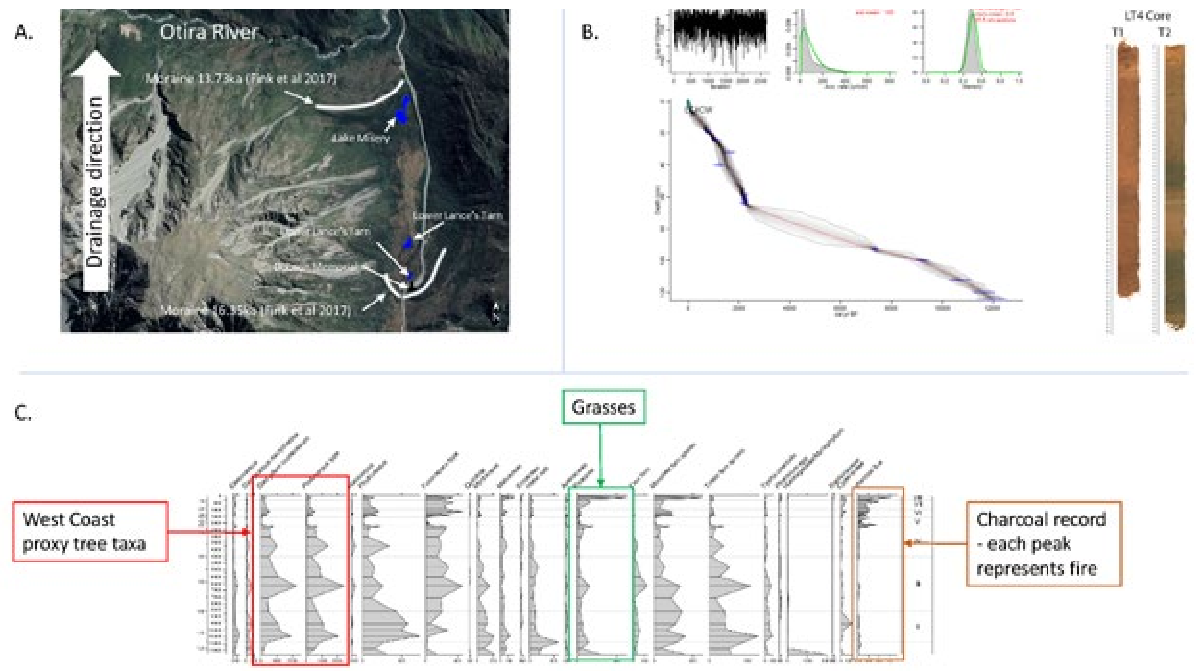

Figure 3: (a) Location of Upper Lance's Tarn (coring location) showing surrounding topography and main geomorphological features; (b) Age-depth model derived from lead-210 and radiocarbon dating, and optical image of the core; (c) Pollen (flux) against age (primary) and depth (secondary) axis. West coast proxy, grass pollen and fire proxy are highlighted.

exposure dating. This research was supported by an AINSE Residential Student Scholarship.

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A novel climatic proxy from ancient pandanus nutshell: Madjedbebe, northern Australia

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Little is known about the climate of northern Australia at the time of early human movement into the region. This means that archaeologists, interested in the early lifestyles of people in this continent, are hindered from properly exploring the relationships between the First Australians and the novel environments they encountered.

Our research, recently published in *Nature Ecology and Evolution*, provides a novel proxy for past precipitation at Madjedbebe, Australia's oldest known archaeological site.

Madjedbebe, a large sandstone rockshelter located on Mirarr country in the Alligator Rivers region of northern Australia, has evidence for human occupation from at least 65,000 years ago to the present (see Fig. 1). The site provides insights into the behaviour of the first people to reach Australia, including evidence of a broad diet of plant foods, the early use of hafted edge-ground axes, and grinding stones and reflective pigments (Clarkson et al., 2017, Florin et al., 2020).

One of the plant foods used by people frequenting Madjedbebe from early levels of occupation to the recent past is the nut of anyakngarra, otherwise known as pandanus (*Pandanus spiralis*; see Fig. 2; Florin et al., 2020). The remains of this nutshell were

Our research... provides a novel proxy for past precipitation at Madjedbebe, Australia's oldest known archaeological site.

...the Alligator Rivers region may have been a relatively favourable environment for people and animals during these periods of glacial aridity...

preserved through the process of burning in ancient fireplaces at the site, and are the basis for our research into changing precipitation at Madjedbebe over the past 65,000 years.

It has long been understood that there is a relationship between water availability in the growing phase of C_3 plants (plants that undergo less efficient metabolic pathways in relation to turning CO_2 into sugars) and their stable carbon isotope discrimination (Farquhar and Richards, 1984). As pandanus is a C_3 plant, we wanted to use this relationship to provide data for past precipitation at Madjedbebe. This was done in two phases: (1) testing the modern relationship between the $\delta^{13}C$ isotopic values of *P. spiralis* nutshell and mean annual precipitation; and (2) analysing the $\delta^{13}C$ isotopic values of the archaeological *P. spiralis*, using the modern data to interpret the archaeological values.

We found that whilst there was decreased precipitation at Madjedbebe during global glacial stages MIS (Marine Isotope Stage) 2 and 4, the lowest effective annual precipitation is occurring at the present time (see Fig. 3). This suggests that the Alligator Rivers region may have been a relatively favourable environment for people and animals during these periods of glacial aridity, which were exposed to more extreme climates across other parts of the Australian continent. This is supported archaeologically by the peaks in the number of stone artefacts recovered at Madjedbebe during these relatively dry phases (Fig. 3), suggesting an increased use of the site during these times.

Figure 1: Photo of Madjedbebe rockshelter, Mirarr country, Alligator Rivers region of northern Australia. Reproduced with the permission of Gundjeihmi Aboriginal Corporation.

*Figure 2: Anyakngarra trees (*Pandanus spiralis*) on the edge of the Magela Creek floodplain, Mirarr country, Alligator Rivers region of northern Australia, with an inset displaying the aggregate fruit of the tree that contains edible nuts.*

The isotopic analysis and some radiocarbon dating were carried out at ANSTO as part of an AINSE Post-Graduate Research Award awarded to S. Anna Florin, under the supervision of Linda Barry and Dr Quan Hua. A number of researchers and Traditional Owners helped to interpret this data and connect it to the archaeological story at Madjedbebe.

We are grateful to the custodians of Madjedbebe, the Mirarr Senior Traditional Owners, Yvonne Margarula and May Nango, and our research partner, Gundjeihmi Aboriginal Corporation, for permission to carry out and publish this research. This research was supported by an Australian Institute of Nuclear Science and Engineering Postgraduate Research Award (11877), Wenner-Gren Dissertation Fieldwork Grant (9260), a Dan David Scholarship, an Australian Research Council (ARC) Research Training Program scholarship, an ARC Centre of Excellence for Australian Biodiversity and Heritage Irinjili Research Training Program Internship for Women and an ARC Discovery Project (DP110102864).

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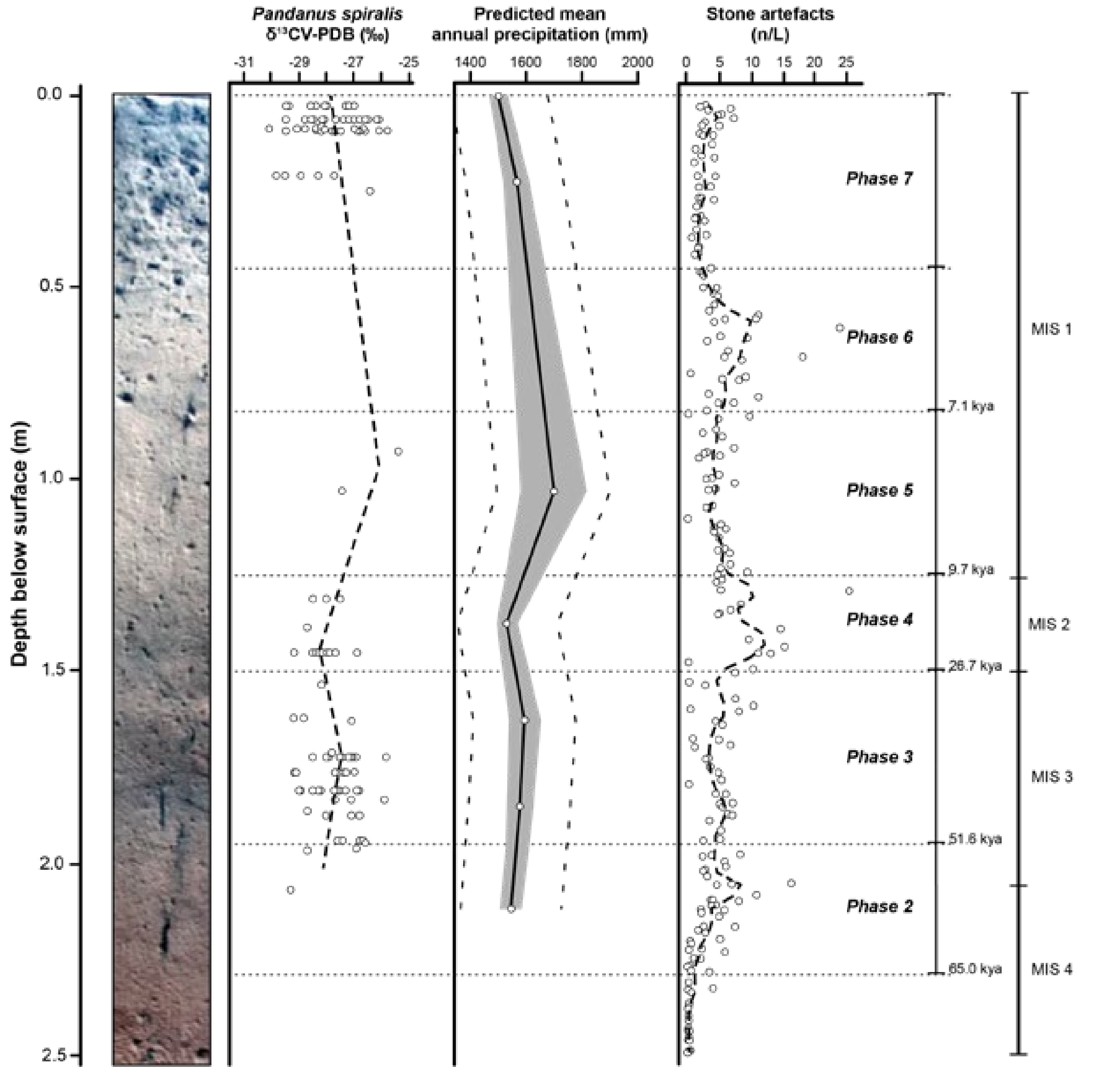

Figure 3: Changes in predicted palaeoprecipitation at Madjedbebe in comparison to changes in the stone artefact assemblage by depth. Age estimates are based on the modelled mid-point value of the 95% confidence interval for the start and end date of each phase (Clarkson et al., 2017).

Australian palaeofloras of the late Pleistocene and implications for palaeoclimate reconstructions

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The Last Glacial Period (approximately 100,000 to 12,000 years ago) and, in particular, the Last Glacial Maximum (LGM, approximately 20,000 years ago), are thought to have exerted a significant influence over the current distribution of mesic forest taxa in southeast Australia. However, limited taxonomic resolution afforded by fossil pollen has meant that the nature of glacial biotic communities remains poorly understood.

Pollen-based palaeoclimate reconstructions of southeast Australia at the LGM suggest widespread treelessness, which (in part) has led to the conclusion that the glacial climate of southeastern Australia was cold (up to 8°C colder in summer) and dry (30-50% reduction in effective precipitation) (Petherick et al., 2013; Williams et al., 2009). But this story does not fit neatly with the processes thought to have given rise to modern-day species distribution patterns. In contrast to continental-scale, repeated migrations of arboreal taxa into and out of southern European refugia (summarised in Byrne, 2008), population genetics of southeast Australian plants and animals suggest that most forest species persisted through the Pleistocene glaciations in multiple, small, disjunct local refugia (see, for example, Garrick et al., 2004, Nevill et al., 2014 and Worth et al., 2010).

One explanation for the apparent conflict between climate reconstructions and species distribution histories could lie in the limitations of fossil pollen analysis. Though pollen is abundant and has informed much of our understanding of past changes in climate, its usefulness is limited by its coarse taxonomic resolution. Pollen of narrow-range species that might be used as ecological indicators, for example, can be difficult or impossible to distinguish from the pollen of geographically widespread - and therefore less climatically informative - taxa. To address these issues, Birks & Birks (2000) argue that pollen should be supplemented with plant macrofossils,

Our study will provide precise new insights into the southeast Australian glacial climate and biotic communities based on species-level identifications of plant and insect mesofossils.

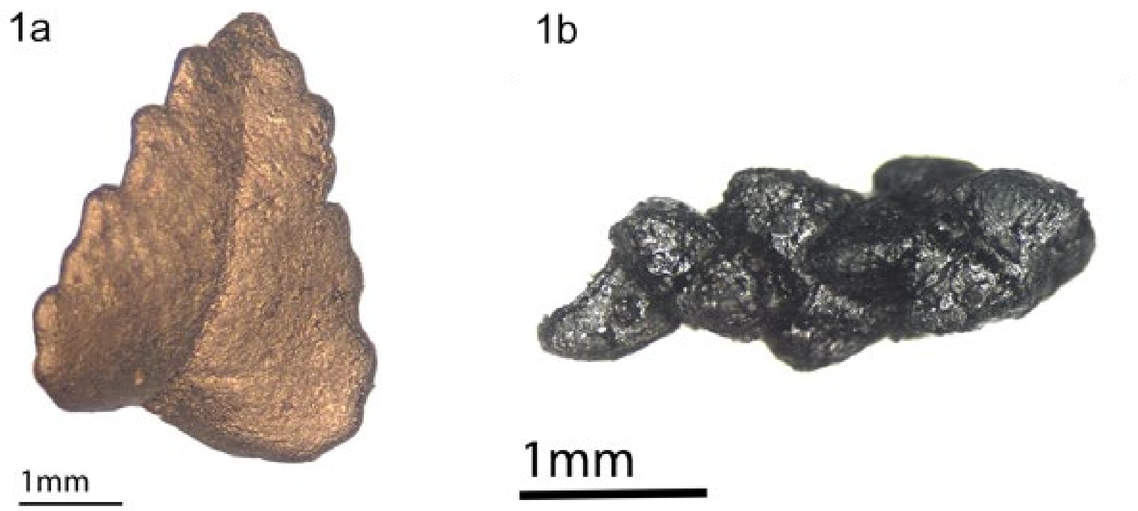

Figure 1: Fossil leaves of Nothofagus cunninghamii *(a) and* Pherosphaera hookeriana *(b) from Henty Bridge, Tasmania.*

which are frequently identified to species level.

Our study will provide precise new insights into the southeast Australian glacial climate and biotic communities based on species-level identifications of plant and insect mesofossils. Where recovered fossil remains correspond to extant species, bioclimatic niche modelling will be used to quantitatively reconstruct palaeoclimate (Birks et al., 2010; Porch, 2010). The results will contribute to a globally-significant debate about the role of the Pleistocene glacial-interglacial cycles in the generation and maintenance of terrestrial biodiversity, and also to the increasingly urgent discussion of the degree of sensitivity of Australian plant taxa to a changing climate.

Six field sites in Victoria and Tasmania have been chosen based on previous fossil pollen studies (Colhoun, 1977; Colhoun 1985; Flannery & Gott, 1989; Pittock, 1989; McKenzie & Kershaw, 2000; Gardner et al., 2006). These pollen-based reconstructions provide a direct point of comparison for macrofossil-based reconstructions that we will produce from the same sites. Radiocarbon dating conducted at ANSTO suggests that these deposits span from before 50,000 years ago to the height of the LGM, with one further deposit being confined to the Holocene. Two additional sites, for which radiocarbon dating is scheduled for 2021, will extend this range to cover the last deglaciation.

A deposit spanning the period immediately preceding the LGM at Henty Bridge, Tasmania, is particularly rich. There, identified species have been used to make climatic predictions

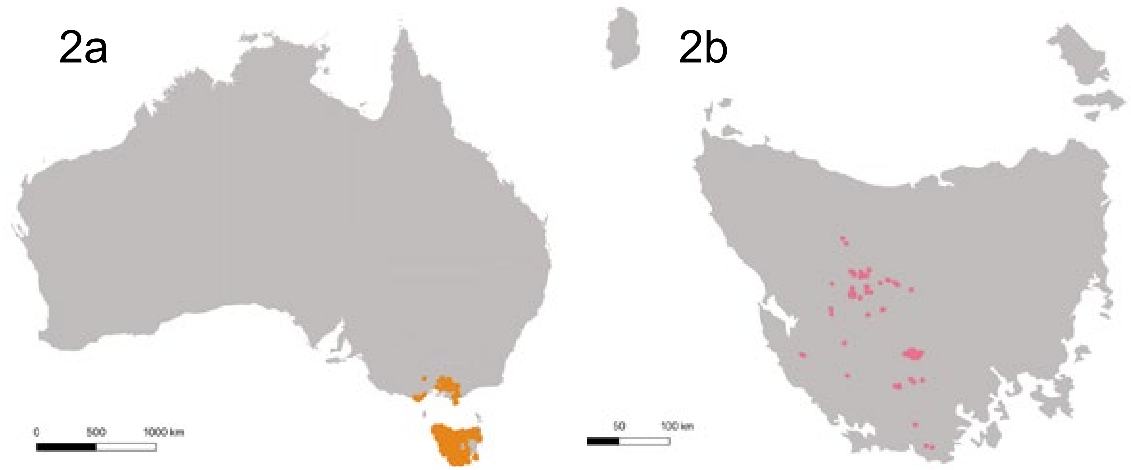

Figure 2: Distributions of Nothofagus cunninghamii *(a) and* Pherosphaera hookeriana *(b), sourced from the Atlas of Living Australia.*

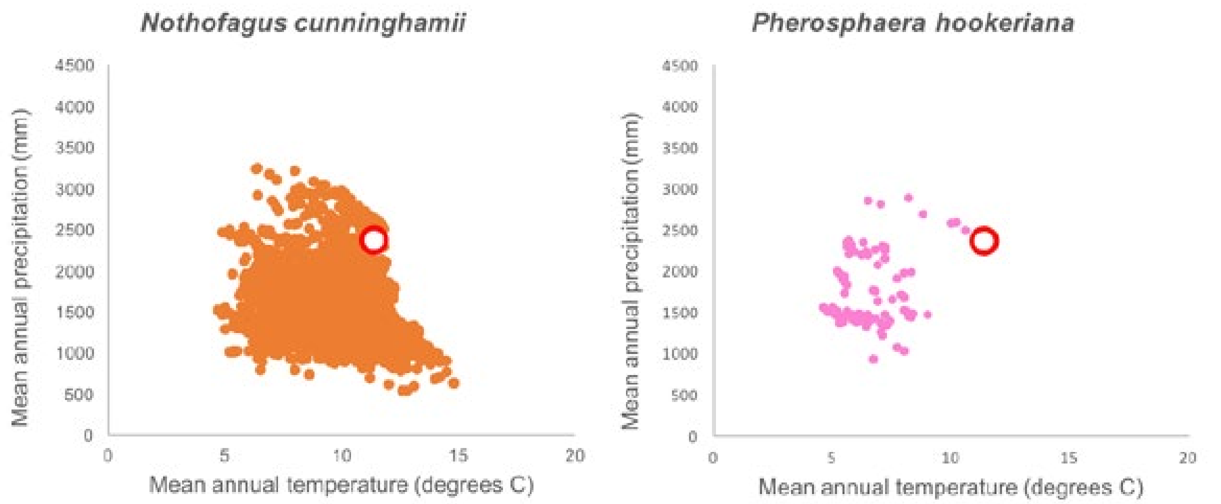

Figure 3: Scatterplots of mean annual temperature (Bioclim parameter Bio01) and mean annual precipitation (Bioclim parameter Bio12) for Nothofagus cunninghamii *(orange) and* Pherosphaera hookeriana *(purple). These datapoints correspond to each of the observations of the species in Figure 2. The red circle indicates the current-day climatic parameters of the sampling site at Henty Bridge, Tasmania.*

This preliminary data provides evidence that temperatures leading into the LGM were significantly cooler than at present, and also demonstrates that these species have been able to migrate in response to changes in climate.

using bioclimatic niche modelling. Where fossil species exist in the same sedimentary layer of the same deposit, it is possible to use the implied coexistence of these species, and their combined climatic tolerances, to infer the climatic parameters at the time of their deposition. If we can show that a number of species grew in the same place at the same time, then the temperature range (presumed to be the limiting factor for plant distributions in Tasmania) can be constrained by the most heat-sensitive and the most cold-sensitive species in the assemblage.

The use of radiocarbon dating to link fossils from either end of the 20-metre exposure makes this task possible, and the climatic interpretations are much more precise as a result. The assemblage includes well-preserved leaf materials, including fossils of *Nothofagus cunninghamii* (Figure 1a) and *Pherosphaera hookeriana* (Figure 1b). The modern-day distributions of these species (Figure 2) can be linked with a range of bioclimatic parameters to develop scatterplots of the ‘climate space’ occupied by each of these species (Figure 3)(Porch, 2010). These parameters are then compared with the modern-day conditions of the depositional site. *Pherosphaera hookeriana*, the most heat-sensitive species in the assemblage, today only grows in areas that are cooler by at least two degrees than the site at which the fossils were recovered. This preliminary data provides evidence that temperatures leading into the LGM were significantly cooler than at present, and also demonstrates that these species have been able to migrate in response to changes in climate.

This research forms part of the PhD project of Kia Matley, under the supervision of Dr Quan Hua, Associate Professor Andrew Drinnan, Dr Kale Sniderman, and Dr Nicholas Porch. This research is supported by the University of Melbourne Botany Foundation, The Ecological Society of Australia Holsworth Wildlife Research Endowment, and an AINSE Postgraduate Research Award.

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Elucidating carbon sources and food web interactions in groundwater ecosystems

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Groundwaters, together with deep sea environments, are some of the least explored ecosystems in the world. Despite the recent upsurge in subterranean investigations and the environmental importance of groundwater, the subsurface ecological framework still suffers from a lack of knowledge in terms of biological diversity and ecological functioning.

Subsurface obligate aquatic fauna–namely stygofauna–display arrays of specific adaptations to life underground (loss of eyes and pigmentation, long antennae, etc.) (Figure 1). Stygofauna are perceived as adapted to a stable physico-chemical environment but there is also evidence of high degrees of resilience to the fluctuations of the subterranean conditions, such as groundwater recharge, source of organic matter, and energy.

Rainfall events are considered major drivers in shaping hydrological dynamics in aquifers via processes like percolation or lateral flow, and stygofauna respond both in function and community composition to these hydraulic changes. Several groundwater investigations indicate that inflows of terrestrial organic material (OM) cause ecological shifts within subsurface communities. However, the interpretation of carbon flows and trophic web interactions within groundwater biota is far from straightforward, with recent studies indicating composite pathways for the incorporation of OM, highlighting the need for interdisciplinary research (Saccò et al. 2019a).

The arid western side of Australia, with its array of calcrete environments sustaining unique stygofaunal communities, has been the object of a large number of studies on taxonomy,

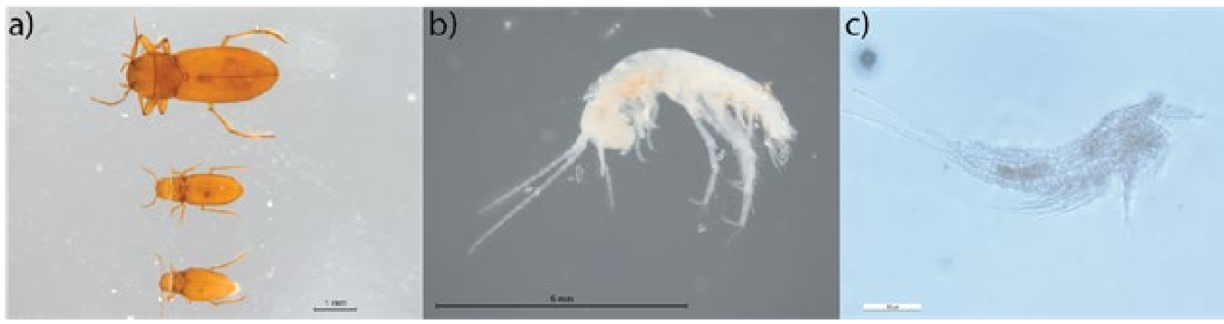

Figure 1: Example of some stygofaunal specimens from the Sturt Meadows calcrete. a) subterranean beetles Paroster macrosturtensis *(top),* Paroster mesosturtensis *(middle),* Paroster microsturtensis *(bottom) (all Watts & Humphreys 2006), b) amphipod* Stygochiltonia bradfordae *(King 2012) and c) copepod* Harpacticoida *(G. O. Sars 1903).*

Figure 2: Photos at the weather station (top) and close to a nearby flooded river (bottom) during the wet season at Sturt Meadows calcrete.

biogeography and evolutionary patterns. In particular, the Sturt Meadows calcrete in the Yilgarn region, one of the most ancient cratons in the world, has unveiled a plethora of species (Figure 1). This investigation aims to expand our current knowledge of the ecological dynamics at Sturt Meadows by focusing on the carbon end energy flows that regulate microbial and stygofaunal diversity.

Our research design is composed of hydrological analyses (rainfall monitoring through a weather station (Figure 2) and analysis of nutrients and physicochemical parameters in water) and isotopic (stable isotopes and radiocarbon analyses) investigations, combined with molecular analysis (DNA metabarcoding). The specific objectives of this work are: 1) to unravel the biochemical paths that regulate the microbially-mediated nutrient assimilation among the stygofaunal community, 2) to elucidate the flow of carbon and energy fluxes within primary/secondary consumers and predators and 3) to understand the ecological functioning of a calcretice biotic community under two contrasting rainfall periods (low rainfall, LR and high rainfall, HR).

Our findings indicated that rainfall acts as a

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This investigation provides novel modelling that can bring further light to the processes regulating biodiversity in groundwater ecosystems.

driver in regulating inputs of old carbon sources that is ultimately available and exploited by the microbial community at Sturt Meadows calcrete (Saccò et al. 2020c). Concurrently, subterranean invertebrate population dynamics coupled with shifts in microbially-derived organic matter incorporations, and revealed a tendency towards more deterministic driving forces under the HR regime. Overall, varied rainfall regimes triggered shifts in stygofaunal ecological niche occupations driven by increased nutrient availability and dissolved oxygen concentrations under HR conditions (Saccò et al. 2020a).

The stygofaunal community at Sturt Meadows calcrete presented high levels of ecological tolerance as a response to evolutionary and adaptative forces. The analysis of conventional and compound-specific isotopic data indicated rainfall-driven shifts in carbon flows and pinpointed two trophic levels (consumers amphipods and copepods, and predatory beetles). Stygofaunal trophic behaviours, dominated by opportunism and omnivory (Saccò et al. 2020b), shaped bottom-up (differential OM assimilations within consumers) and top-down (increased pressures from predators) controls linked with rainfall regimes (Saccò et al. 2019b, 2021) (Figure 3).

This investigation provides novel modelling that can bring further light to the processes regulating biodiversity in groundwater ecosystems. The understanding of these dynamics is crucial to evaluate the current state of conservation and infer future trends of these essential but deeply underrated environments. Understanding how ecological dynamics shape groundwater ecosystems is of importance far beyond subterranean ecology, and helps to understand how biota benefit from specific environmental conditions and respond to varying climate regimes.

We would like to thank AINSE for providing support for this project through a Postgraduate Research Award. We wish to acknowledge the Traditional Custodians of the land, the Wongai people, and their Elders, past, present and emerging. We acknowledge and respect their continuing culture and the contribution they make to the life of Yilgarn region. The authors thank Flora, Peter and Paul Axford of Sturt Meadows Station for their kindness and generosity in providing both accommodation and access to their property. We acknowledge financial support from the Australia Research Council (Linkage Project LP140100555) and the Curtin International Postgraduate Research Scholarship (CIPRS). This project would not have been possible without the effort of a great international and multidisciplinary team of collaborators: Dr Colin Smith (La Trobe University), Dr Alison Kuhl (University of Bristol), Dr Philip Bateman (Curtin University), Dr Alex Laini (University of Parma), Prof Christian Griebler (University of Vienna), Dr Stéphane Karasiewicz (IFREMER), Prof Steven J. B. Cooper (University of Adelaide and South Australian Museum), Prof Andrew D. Austin (University of Adelaide), Dr Jen A. Middleton (University of Western Australia), Dr Matthew Campbell (Curtin University) and Dr Masa Mousavi-Derazmahalleh (Curtin University).

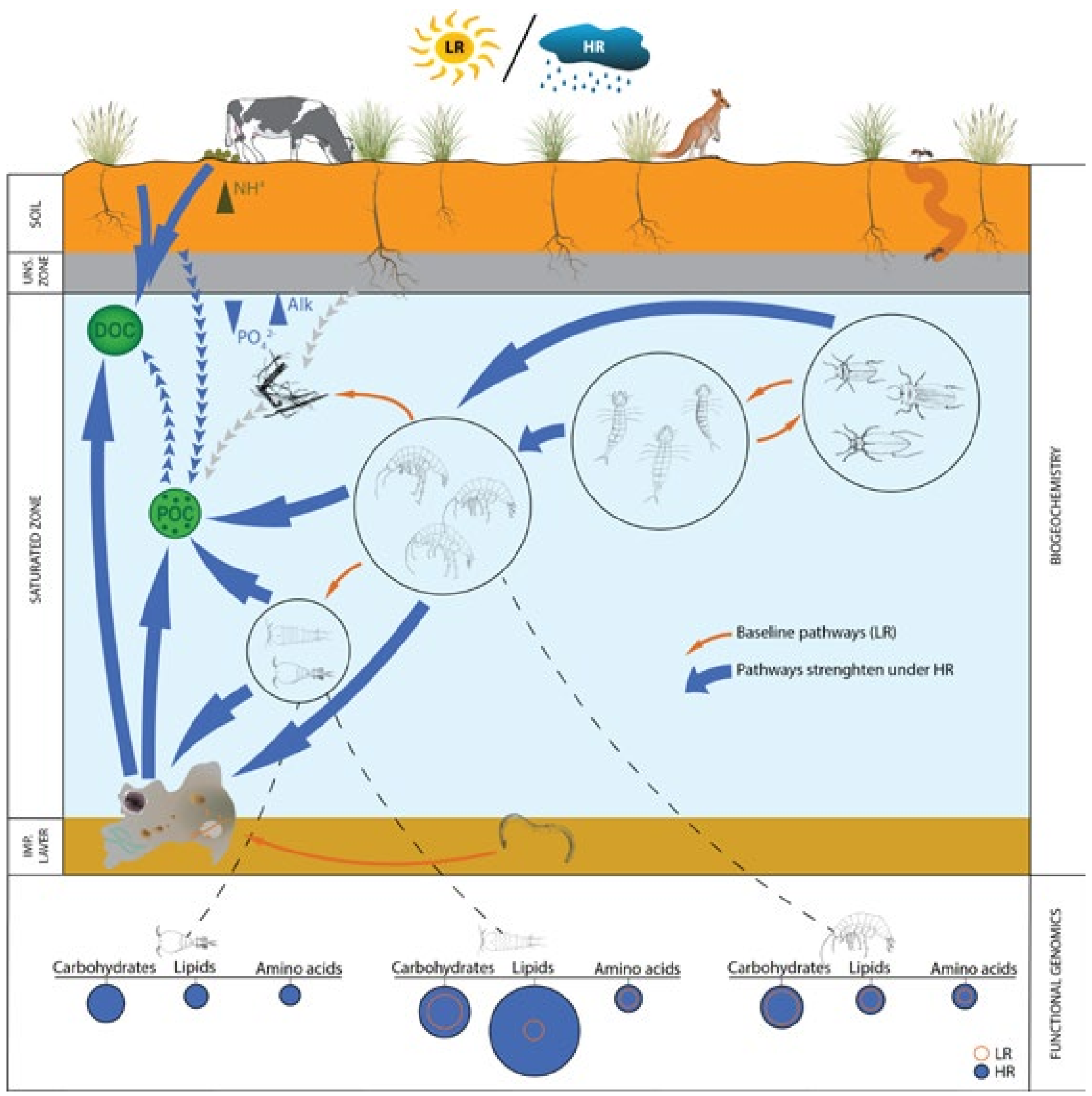

Figure 3: Conceptual modelling of the ecological functioning at Sturt Meadows calcrete. LR: low rainfall; HR: high rainfall; DOC: dissolved organic carbon; POC: particulate organic carbon; Alk: alkalinity; NH_4: ammonium; PO_4^{2-}: phosphate; uns.: unsaturated; imp.: impermeable. Stygofaunal groups within the bubbles from left to right: copepods, amphipods, beetles larvae and beetles adults.

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Gamma radiation-induced responses of the mitochondrial translocator protein (TSPO)

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Ionising radiation is widely used in medicine for both diagnostic and therapeutic purposes. Despite the prevalence of its use, the responses of the brain to low-dose ionising radiation exposure are not yet well-characterised. This is also complicated by the growing body of evidence describing disparate biological responses to high- and low-dose ionising radiation (Betlazar et al. 2016). Whilst the brain's innate immune cells, microglia, transition to an activated state in response to higher doses, the responses of these cells to low dose exposure remain scarcely understood.

The translocator protein (TSPO), localised on the outer mitochondrial membrane, is expressed in activated microglia in contrast to resting microglia, and is therefore widely used as a biomarker of microglial activation across a range of disease states. It has been shown to play a fundamental role in mitochondrial energy metabolism and interacts with the molecular drivers of immune responses (Betlazar et al. 2020). Whilst TSPO is abundantly expressed in activated microglia, we have also demonstrated its expression in vascular endothelial cells, ependymal cells, and neural stem cells of the brain (Betlazar et al. 2018). Given these characteristics of TSPO, we investigated the expression of TSPO as a marker of brain tissue responses after gamma irradiation.

To conduct both in vitro and in vivo irradiation studies, primary microglial cell cultures and mice were exposed to a single dose of 0.01 Gy, 0.1 Gy, or 2 Gy gamma radiation, plus a sham irradiated 0 Gy control at ANSTO's GATRI facilities. In order to determine the involvement of TSPO in radiation-induced responses, we also compared wild type mice to TSPO knockout mice generated by our laboratory (Banati et al. 2014). Tissue samples were collected from mice 48 hours after irradiation for analysis.

In brain tissue, TSPO messenger RNA, as measured by real-time polymerase chain reaction (RT-qPCR), and TSPO protein expression, as measured by western blotting, were found to decrease after 0.01 Gy relative to sham-irradiated controls, though remained relatively unchanged at the higher doses of 0.1 Gy and 2 Gy (Figure 1). Immunohistochemical staining of brain tissue sections confirmed this

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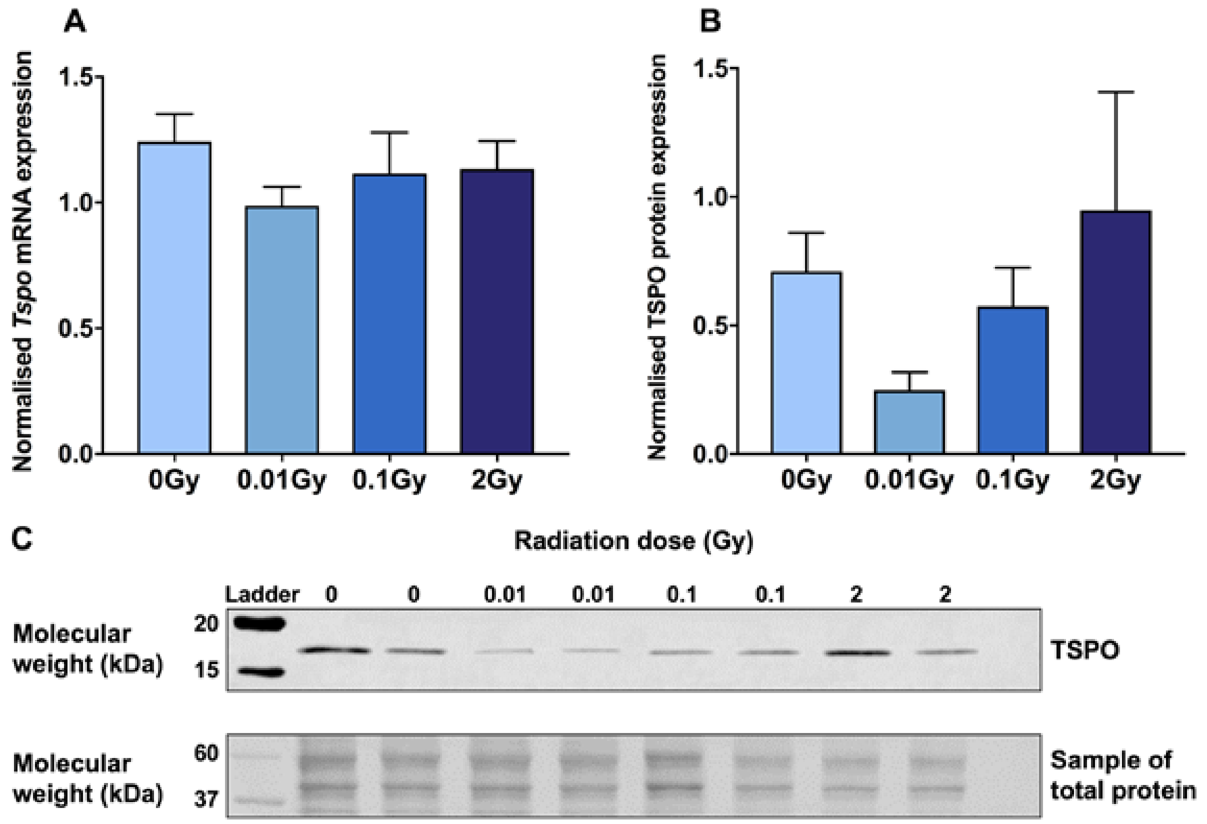

Figure 1: In the brain tissue of mice exposed to whole body single dose gamma radiation, TSPO mRNA (A) and protein (B, C) expression demonstrated a downregulation after 0.01 Gy 48 hours post-irradiation.

decrease in TSPO expression after 0.01 Gy in vascular endothelial cells of the hippocampus (Figure 2) and in ependymal cells lining the ventricles. Furthermore, the concentrations of the pro-inflammatory protein cytokine IL-6 and the anti-inflammatory protein cytokine IL-10 in plasma were modulated differently by both low and high doses, as IL-6 levels were lower after 0.01 Gy and higher after 2 Gy, and IL-10 levels were significantly decreased after 2 Gy, with differences between wild type and TSPO knockout animals. Additionally, in vitro, immunocytochemical staining of irradiated primary microglial cell cultures demonstrated a reduction in TSPO expression 1 hour after 0.01 Gy irradiation.

Together, this work has demonstrated that acute high- and low-dose ionising radiation can differentially modulate the expression of TSPO, microglial activation, and both pro-inflammatory and anti-inflammatory systemic cytokine levels. In particular, this work has demonstrated a consistent trend towards downregulated TSPO expression after 0.01 Gy low-dose ionising radiation, thereby providing novel insights into the neurobiological impact of acute low-dose ionising radiation exposure.

We would like to gratefully acknowledge support from AINSE (Postgraduate Research Award to Calina Betlazar). We would also like to acknowledge support from the NSTLI Human Health Research Theme and Biosciences Platform, where all research was undertaken.

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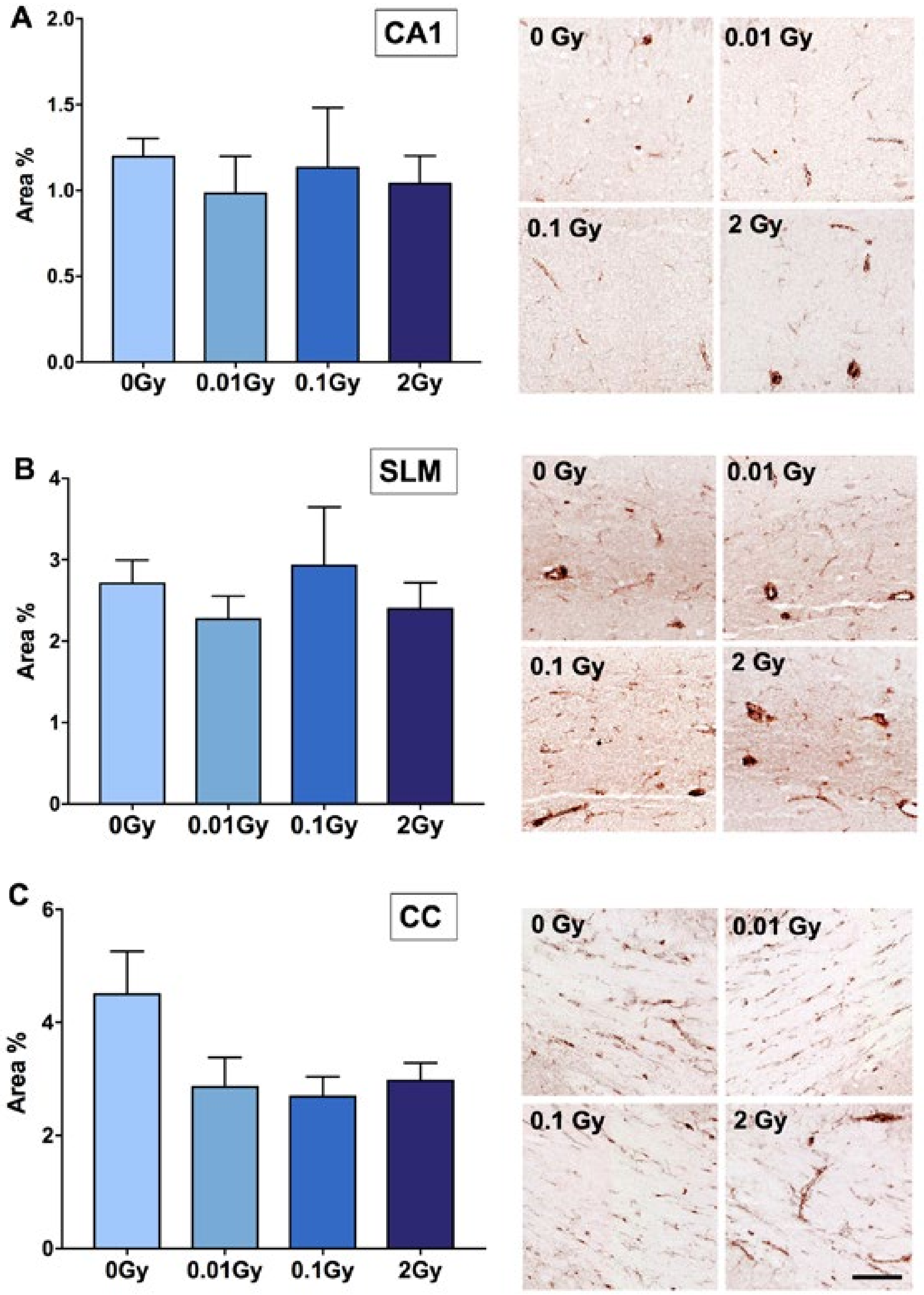

Figure 2: . Immunohistochemical staining of TSPO in the hippocampal region of the brain after whole body single dose gamma irradiation of mice. Regions measured were (A) CA1, (B) stratum lacunosum moleculare (SLM) and (C) the corpus callosum (CC). A trend towards a downregulation in TSPO expression was observed after 0.01 Gy across these regions. Scale bar = 40 µm.

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Understanding the mechanics of programmed cell death

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Programmed cell death is an essential process for multicellular organisms. Cells are required to die for many reasons, including regulation of cell numbers and as preventative measures against cancer and the replication of intracellular pathogens such as viruses.

This project focused on a recently discovered cell death program called *necroptosis*, a form of cell death thought to have evolved to combat pathogen infection (Silke and Hartland, 2013).

The final stages of necroptosis are executed by a protein called MLKL (Mixed Lineage Kinase domain-Like) that, when activated, translocates to the cell membrane and disrupts it (Petrie et al., 2017). The integrity of the cell membrane is essential for the function of the cell, so breaking the membrane serves two purposes: it kills the cell, thereby halting any pathogen replication that could be occurring within, and it allows the intracellular contents to leak out into the extracellular fluid.

The presence of intracellular contents outside the cell is a strong inflammatory signal that activates the immune system and helps it to fight infection. Inflammation is a double-edged sword however, and excessive necroptotic cell death has been linked to various human inflammatory pathologies (Molnár et al., 2019). Our research seeks to better understand the molecular mechanisms that govern the execution of necroptotic cell death, which may lead to the ability to manipulate the pathway for therapeutic benefit.

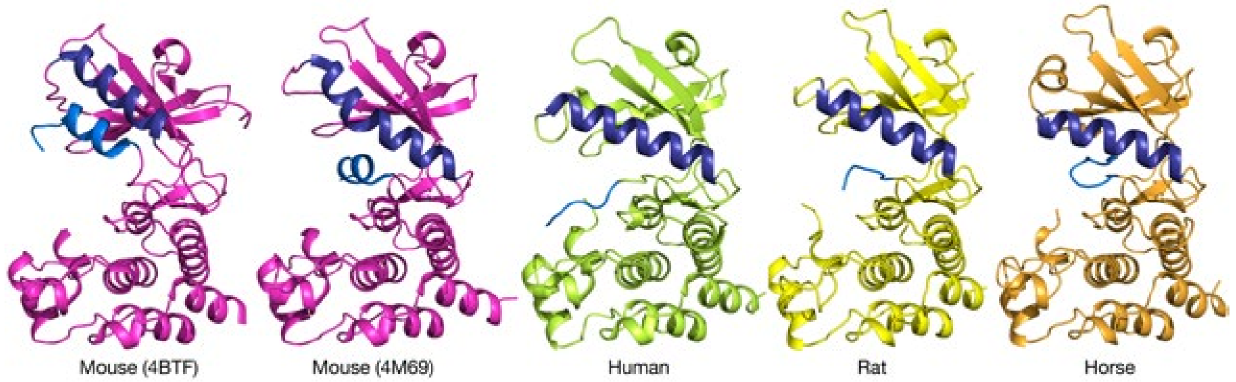
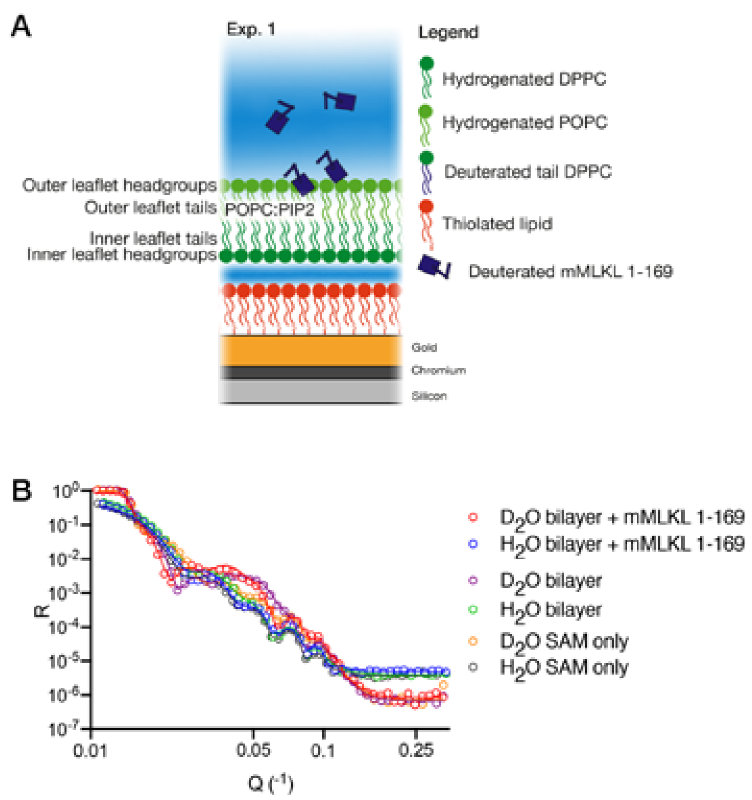


Figure 1: Comparison of horse, rat, mouse human MLKL pseudokinase domain structures. All orthologues have the αC helix in dark blue, and activation loop in light blue (regions important for activation). Mouse (PDB 4BTF; 4M69) (Murphy et al., 2013, Xie et al., 2013) is in magenta, human (PDB 4MWI) (Murphy et al., 2014) in green, rat (PDB 6BVZ)(Davies et al., 2020) in yellow and horse (PDB 6VC0) (Davies et al., 2020) in orange.



C		Bilayer only	Bilayer + mMLKL 1-169
Inner leaflet headgroups	thickness (Å)	12.71	14.65
	SLD ($\times10^{-6}$Å^{2})	D_2O: 5.44 H_2O:-0.26	D_2O: 2.90 H_2O: 0.50
Inner leaflet tails	thickness (Å)	20.64	22.49
	SLD ($\times10^{-6}$Å^{2})	D_2O: 2.57 H_2O:-0.17	D_2O: 2.77 H_2O:-0.28
Outer leaflet tails	thickness (Å)	20.52	21.64
	SLD ($\times10^{-6}$Å^{2})	D_2O: 2.47 H_2O:-0.21	D_2O: 3.49 H_2O:-0.30
Outer leaflet headgroups	thickness (Å)	14.63	15.73
	SLD ($\times10^{-6}$Å^{2})	D_2O: 3.81 H_2O:-0.19	D_2O: 3.88 H_2O: 0.53

Figure 2: Observing changes to the bilayer after addition of MLKL using neutron reflectometry. A Summary of experiment performed with a hydrogenous DPPC lower leaflet, hydrogenous 9:1 POPC|PIP2 upper leaflet, and deuterated MLKL 1-169 protein. B Raw scattering curves for Experiment 1. Raw data is plotted in circles and the fits are solid lines. C Table summarising the observed changes to the bilayer thickness, and changes to the SLD (a property relating to how the neutrons interact with the sample) of each layer in the D2O and H2O buffer before and after addition of protein..

This work suggests that low dose ionizing radiation may alter neuroinflammatory processes...

We sought to understand various stages of necroptosis, including what conformational changes to MLKL are associated with its activation. To determine the structure of the MLKL protein, we used a technique called X-ray crystallography. This technique requires crystalline samples composed of millions of copies of the same protein arranged in a highly ordered repeating lattice, and an intense X-ray beam such as that produced at ANSTO's Australian Synchrotron.

We successfully crystallised and solved two novel structures of the rat and horse version of the MLKL protein, using datasets collected at the MX2 beamline at the Australian Synchrotron. When compared with existing human and mouse MLKL structures, we were able to observe commonalities between the structures of different species (Figure 1), which helped us to understand which parts of the MLKL protein are essential for conversion into an activated state (Davies et al., 2020).

After improving our understanding of MLKL activation and the early stages of necroptosis, we also wanted to understand the final stage of necroptosis, how MLKL breaks apart the cell membrane. To do this we employed a technique called neutron reflectometry, which can be used to examine thin films. In our case, we used a system designed to mimic the cell membrane called a floating supported bilayer. The technique relies upon the properties of neutrons, which penetrate much further into a sample than X-rays. This study was performed on the Platypus beamline at ANSTO's Australian Centre for Neutron Scattering with collaborators Dr Anton Le Brun and Karyn Wilde.

By adding the MLKL protein to the outside of the cell membrane mimetic system, we learned about the depth of MLKL insertion into the membrane, as well as the type of membrane disruption that MLKL induces (Figure 2). Through this work we were able to disprove one of the MLKL pore formation mechanisms that had been proposed in the literature (Xia et al., 2016).

The studies undertaken using the Australian Synchrotron and the Australian Centre for Neutron Scattering. helped us to better understand the early stages of MLKL activation, and its final role in disrupting the cell membrane.

This work would not have been possible without the MX2 beamline at the Australian Synchrotron, Dr Anton Le Brun and the Platypus neutron reflectometer at the Australian Institute for Neutron Scattering, and Karyn Wilde from the National Deuteration Facility. AINSE PGRA scholarship support was provided to Katherine Davies in undertaking this work, as well as an Australian Government Research Training Program Scholarship.

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Biotechnology and Biomedical Sciences BBS

Characterisation of organic semiconductors for dosimetry in radiation therapy

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Patient safety during exposure to ionizing radiation over the course of radiation therapy treatment requires novel materials and detectors that can accurately monitor and measure the dose deposited within the human body.

While there are numerous mandatory pretreatment quality assurance procedures for radiation therapy, there is no such strenuous protocol for *in vivo* dosimetry (IVD), that is, during the actual radiation treatment of the patient.

IVD immediately identifies the potential errors in dose calculation, data transfer, dose delivery, patient setup and changes in patient anatomy. It is compulsory in many European countries, due to several recent incidents during radiation therapy that resulted in diminished patient safety and even patient death. However, all the current in vivo dosimeters require calibrations for the variation in beam energies and/or dose rates and thus need corrections for changes in field size, source-detector distance, temperature, pressure, and orientation (Mijnheer et al. 2013).

The need for correction factors arises due to the inherent nature of the materials that comprise the current 'state of the art' solid-state detectors. This includes their high mass density (ρ) and atomic number (Z) like the routinely-used silicon based detectors (ρ=2.33 g/cm^3, Z=14) in comparison to soft tissue (ρ=1 g/cm^3, Z=7) that result in their characteristic overresponse at low kiloelectron volt (keV) photon energies (Figure 1).

These corrections limit real-time capabilities and introduce complex procedures that increase the probability of treatment

Organic semiconductors are gaining momentum as an ideal material for advanced dosimetry...

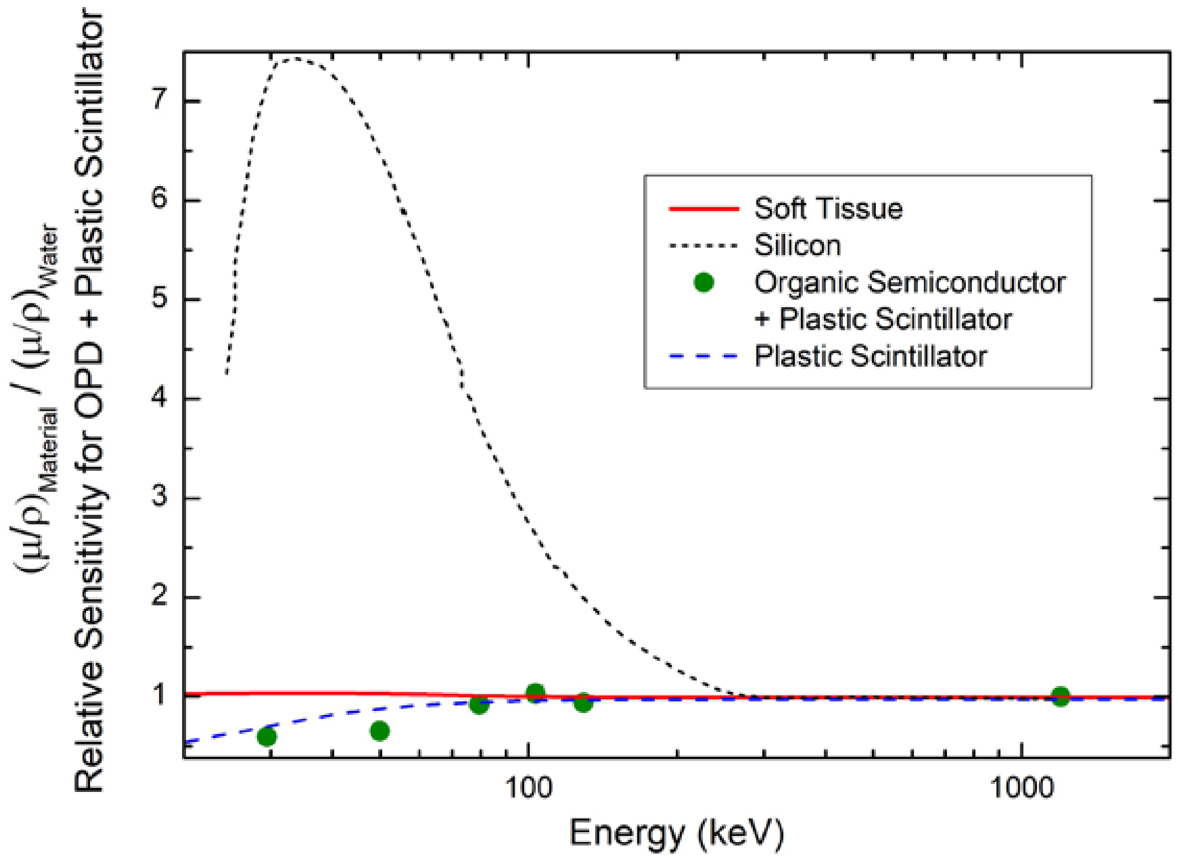

Figure 1: Energy dependence characterised by the response of an organic semiconductor coupled with a plastic scintillator (green circles) at the Illawarra Cancer Care Centre in comparison to the response of a plastic scintillator (blue dash line), silicon (black dot line) and soft tissue (red solid line) obtained from NIST.

errors. Solid-state detectors are also bulky, mechanically rigid detectors that cannot be positioned on the patient during treatment, and therefore have limited utility for IVD. To overcome these limitations of the current solid-state detectors for medical applications, the development of novel materials that can provide instant feedback of the dose deposited within soft tissue while conforming to the complex contours of the human body during IVD is paramount for the prioritization of patient safety.

Organic semiconductors are gaining momentum as an ideal material for advanced dosimetry purposes. The term 'organic semiconductor' implies an electrically-conducting material composed of carbon and hydrogen, elements abundantly found in the human body (Griffith et al., 2020). These identical elements interact equivalently with ionizing radiation, allowing organic semiconductors to instantaneously measure the dose deposited within the human body for any energy or dose-rate without any corrections, termed tissue equivalence (Posar, Davis, Large, et al. 2020). Tissue equivalence is unique to devices composed of organic materials and is extremely advantageous for treatment plans that require both radiotherapy (~MeV) and X-ray imaging (~keV) modalities that maximize patient safety, such as Image Guided Radiation Therapy. Organic semiconductors are also solution-processable, forming printable electroactive inks enabling cheap manufacturing onto flexible substrates. Thus, organic semiconductors meet all the required criteria for IVD that are not achieved by solid-state detectors.

This research project is a feasibility study to explore the use of organic semiconducting photodetectors as advanced radiation dosimeters. One major focus is investigating the radiation damage to the material during exposure to ionizing radiation to determine their longevity in such harsh environments, known as radiation hardness, at ANSTO's Gamma Irradiator GATRI, as well as their ability to be used in clinical settings for radiation therapy

Figure 2 Picture of the Medical Linear Accelerator located at the Illawarra Cancer Care Centre in Wollongong Hospital. The detectors were encased in a solid water-equivalent phantom shown on the right side of the picture to mimic depth within a patient.

...unprecedented advantages over the current detectors used for radiation therapy...

quality assurance procedures.

Using the Medical Linear Accelerator used for radiotherapy treatment at the Illawarra Cancer Care Centre (Figure 2), we recorded energy independence between 100 keV and 1.2 MeV (Figure 1), in addition to dose rate independence between 3.4 x10^{-4} Gy/pulse and 0.31 Gy/pulse when the organic semiconductor was coupled with a plastic scintillator; advocating their use as an indirect dosimeter without requiring beam correction factors (Posar et al., 2020).

To satisfy our investigation on the use of organic semiconductors as an advanced radiation dosimeter, the response for other radiation treatment modalities is crucial. One of the potential applications our group has explored was for Microbeam Radiation Therapy (MRT). MRT is a radiation therapy method to be used for deep-seated tumors that cannot be reached using conventional radiotherapy, currently under development at ANSTO's Australian Synchrotron. It delivers extremely high dose rates: approximately 20 kGy/s, compared to conventional radiotherapy which adopts dose rates of 6 Gy/min. It also adopts many small 'micro'-sized x-ray beams instead of a single large, uniform, and collimated beam. MRT has been shown to be

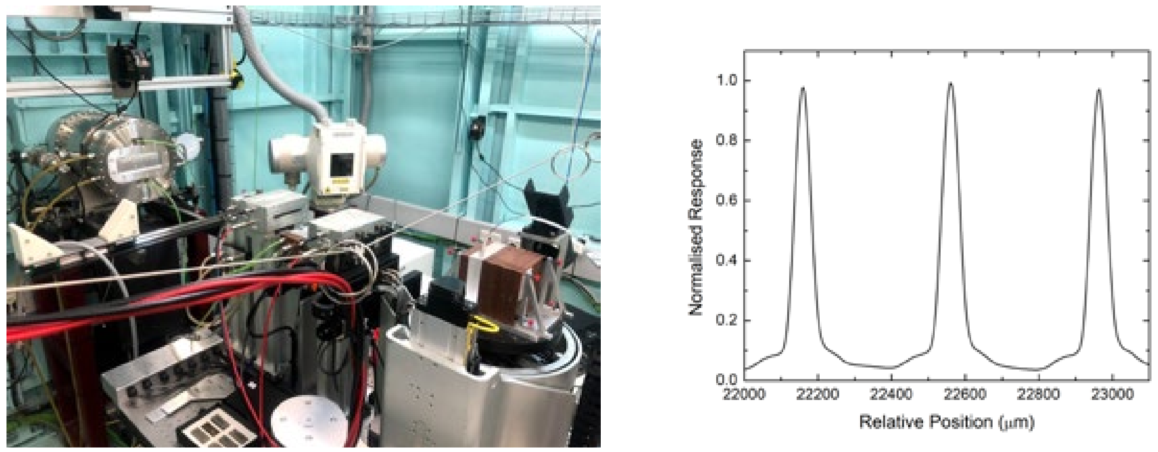

Figure 3: Experimental set-up at the Australian Synchrotron (left) and central microbeams measured using an organic semiconductor exploring their usability to reconstruct the dose profiles for Microbeam Radiation Therapy (right).

a highly effective treatment for brain cancer and other radiation-resistant tumors while minimising damage to the surrounding healthy tissue (Slatkin et al., 1992).

However, MRT requires routine pre-treatment quality assurance with a detector that has an extreme radiation hardness, high spatial resolution to reconstruct the microbeams, and energy independence for low keV energies, which none of the current detectors can achieve. Measurements on the Imaging and Medical Beamline at ANSTO's Australian Synchrotron presented ideal reconstruction of a full range of 50 µm-wide microbeams within 2% using the organic semiconductor as a direct detector with the 500 nm sensitive width (Figure 3). The degradation to the direct detection of 70 keV x-rays stabilized to 30% of the pristine response after 35 kGy, with a 0.5% variation between 770 Gy increments; correlating to total irradiation dose equivalent to 10 years in clinical use as quality assurance equipment.

This work suggests that organic semiconductors possess unprecedented advantages over the current detectors used for radiation therapy due to their matching chemical composition to the human body. The preliminary results for use as an advanced radiation dosimeter in radiotherapy and MRT conditions are very promising for the development of a tissue-equivalent and cost-effective in vivo dosimeter.

Our group is currently focusing on fabricating a fully tissue-equivalent pixelated dosimeter onto a flexible conductive substrate to replace the PCB packaging on the preliminary devices. The flexible device will be tested under clinical conditions as the first prototype for a wearable IVD for radiation therapy. Exploration of new organic semiconductors that exhibit higher tolerances to radiation damage is also underway using ANSTO's Gamma Irradiator.

"Investigating the use of organic semiconductors for dosimetry in radiation therapy" is a project led by Assoc. Prof. Marco Petasecca at the Centre for Medical Radiation Physics, University of Wollongong and is carried out in collaboration with the Illawarra Cancer Care Centre, the Centre for Organic Electronics at the University of Newcastle, ANSTO, the University of Surrey and the University of Bologna. The project is supported by an AINSE Postgraduate Research Award, as well as an Australian Government Research Training Program Scholarship and the University Global Partnership Network Research Collaboration Fund.

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Probing the magnetic properties of lanthanoid molecular nanomagnets

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The ever-increasing demand for faster computing and higher density data storage mandates the development of new magnetic materials and technologies such as quantum computing.

Single-molecule magnets (SMMs) are metal-containing molecules that retain their magnetisation at low temperature. The current best single-molecule magnets incorporate trivalent lanthanoid ions and have recently been shown to exhibit slow magnetic relaxation up to temperatures of 80 K (Guo et al., 2018). Importantly, SMMs display a phenomenon known as quantum-tunnelling of magnetisation (QTM), which gives rise to quantum states that consist of coherent superpositions of the "spin-up" and "spin-down" states. This property gives single-molecule magnets possible use as qubits (quantum bits) in quantum computing.

The properties of these molecular compounds are tuned by varying the electronic structure using traditional synthetic chemistry techniques to modify the ligand environment around the lanthanoid ion. The magnetic properties and QTM can also be modulated by magnetic exchange interaction between the lanthanoid ion and another magnetic moment in the sample, such as another metal ion or an organic radical. However, the effects of exchange coupling are difficult to measure experimentally for many lanthanoid compounds, aside from techniques such as inelastic neutron scattering (INS), which is uniquely suited to studying these systems (Dunstan, Mole and Boskovic, 2019).

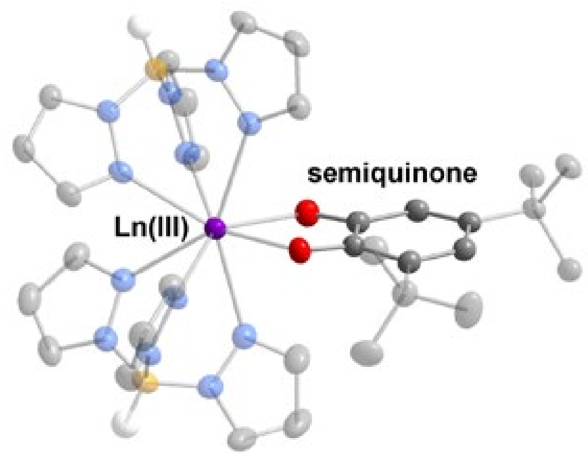

Figure 1: Ln-SQ, with magnetic lanthanoid and semiquinone units highlighted.

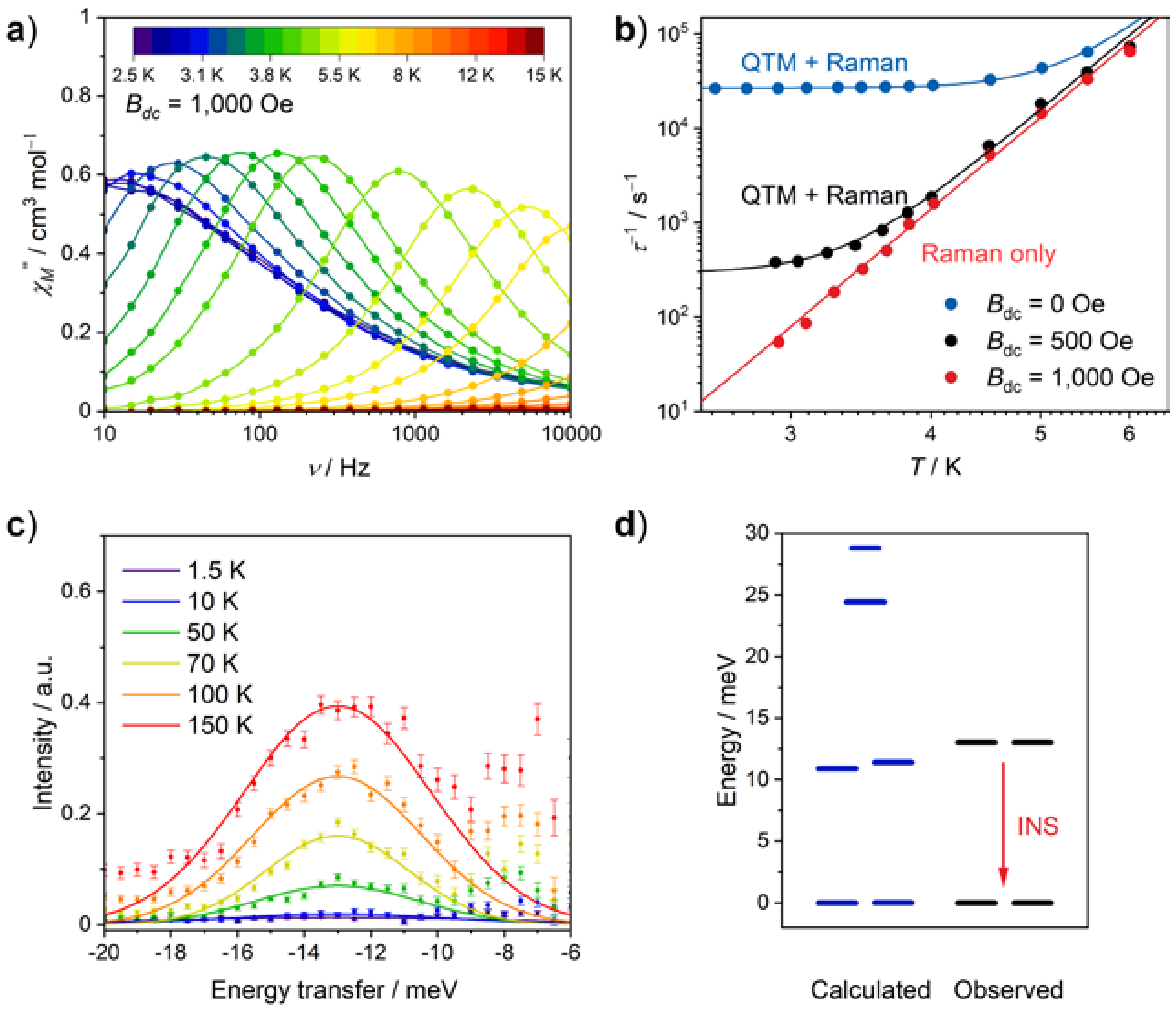

Figure 2: a) Out-of-phase component of the ac magnetic susceptibility of Tb-SQ, measured in an applied field of 1,000 Oe. b) Magnetic relaxation rate of Tb-SQ measured in various fields, highlighting the temperature independent QTM at low field/temperature. c) CF transition measured in Tb-SQ with varying temperature. d) Comparison of experimentally observed CF splitting with ab initio calculated energy levels.

In an INS experiment, the change in kinetic energy of a neutron is measured after scattering from a sample. It is commonly used for measuring vibrational motion and for magnetic excitations, where the neutron will either impart energy to the sample and thus lose kinetic energy, or will gain energy from the sample and thus gain kinetic energy. For molecular systems, magnetic energy levels are quantised and therefore transitions can only occur between discrete energy levels (subject to INS selection rules).

For a trivalent lanthanoid ion (Ln(III)), the energy levels from which the magnetic properties arise are the M_J crystal field (CF) levels, which arise from the weak splitting of the ground spin-orbit multiplet of the lanthanoid ion due to the electronic density of the surrounding ligands. These CF states can be further split by exchange interactions into states where the magnetic moments are either parallel or antiparallel. Transitions between these different states can be measured by INS, provided they fall within the energy range of the spectrometer and satisfy neutron scattering selection rules.

In this study, we chose a family of Ln-radical compounds (Figure 1, Ln-SQ) with a known antiferromagnetic exchange coupling in the gadolinium (Gd) analogue (Caneschi et al., 2000, 2004) to study the crystal field splitting and exchange coupling using a combined spectroscopic, magnetometric, and computational approach.

All the analogues were probed for SMM behaviour using AC magnetic susceptibility on a Physical Properties Measurement System (PPMS, ANSTO). Of the analogues, the terbium

This approach...will aid the design of functional new materials for applications such as quantum computing.

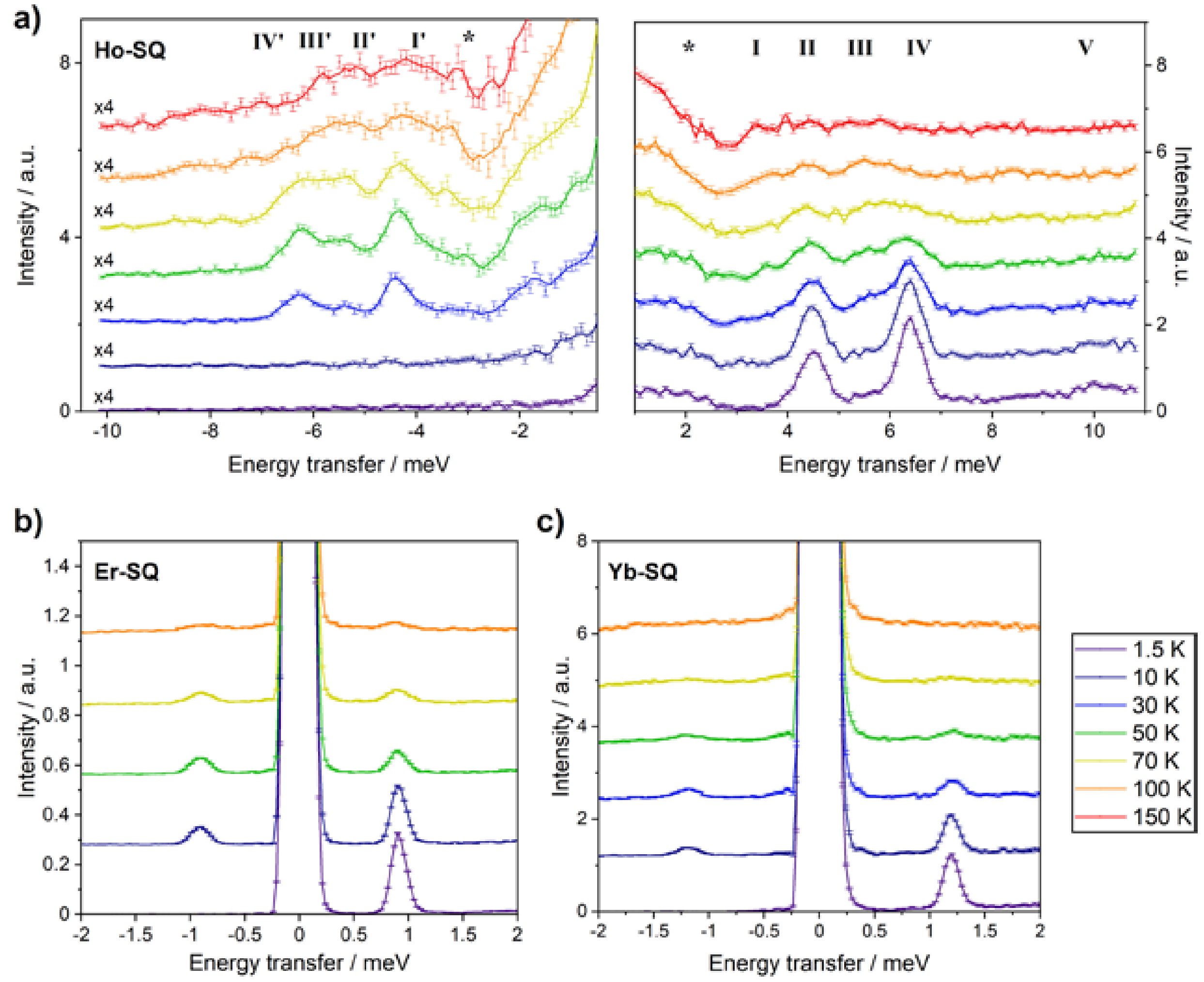

Figure 3: INS spectra of Ho-SQ showing CF excitations at both negative and positive energy transfers (a), and low energy exchange transitions in Er-SQ (b) and Yb-SQ (c).

(Tb) and dysprosium (Dy) analogues show single-molecule magnet behaviour, which can be observed as a temperature dependent peak in the out-of-phase component of the AC magnetic susceptibility for Tb-SQ (Figure 2a). The AC signal was measured in several fields to allow identification of the various relaxation processes in the sample, with Tb-SQ relaxing via quantum-tunnelling of magnetisation at low field and temperature, with thermally activated pathways at higher temperatures (Figure 2b).

We measured partially deuterated analogues of terbium (Tb), holmium (Ho), erbium (Er), and ytterbium (Yb) on the PELICAN time-of-flight inelastic neutron scattering spectrometer at ANSTO's Australian Centre for Neutron Scattering (ACNS). We also measured the diamagnetic rare-earth yttrium (Y) analogue as the phonon background.

The Tb-SQ analogue has one CF transition observed by INS (Figure 2c), indicating a splitting between the ground and first excited state of 13 meV. The increasing intensity of the peak with temperature is indicative of a transition from a higher excited state to a lower state, as the higher state is populated with increasing temperature. The energy splitting is consistent with electronic structure calculations of the CF splitting (Figure 2d). A large CF splitting is consistent with the observed SMM behaviour, as low-lying CF levels will lead to rapid magnetic relaxation.

Crystal field transitions were also observed for the Ho-SQ (Figure 3a) and Er-SQ analogues, with the Ho-SQ compound exhibiting multiple transitions on both the neutron energy loss (positive E transfer) and neutron energy gain (negative E transfer) sides, consistent with many low-lying CF states of mixed wavefunction composition. This energy level splitting information is invaluable as it cannot be obtained from typical magnetometric measurements alone.

We also probed the exchange coupling in these compounds using INS. Low-energy exchange transitions were observed in the Ho-SQ, Er-SQ and Yb-SQ compounds, from which the magnetic exchange coupling can be obtained (Figure 3b, c). This is the first example of Ln-organic radical compounds where an exchange transition has been measured by INS for a series of lanthanoid analogues, allowing us to observe a trend in the magnitude of magnetic exchange coupling across the late lanthanoid(III) ions.

In this study we have demonstrated the use of complementary neutron spectroscopic methods and computational approaches to determine the CF splitting and exchange coupling in a family of Ln(III) compounds. This approach shows promise in facilitating understanding of how structure and magnetic exchange modulate magnetic properties in SMMs, which will aid the design of functional new materials for applications such as quantum computing.

This project was only possible due to the amazing group of collaborators working on it: A/Prof Colette Boskovic (University of Melbourne); A/Prof Alessandro Soncini (University of Melbourne) and Dr Simone Calvello (University of Melbourne/ANSTO) for their electronic structure calculations; PELICAN instrument scientist Dr Richard Mole (ANSTO); and Dr Anwen Krause-Heuer at the National Deuteration Facility (ANSTO) for the deuterated ligand. We thank the Australian Research Council for funding (DP170100034); M. A. D. acknowledges support from AINSE for a Post-Graduate Research Award and the Australian Government for a Research Training Program scholarship.

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Bragg-edge Neutron Strain Tomography

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This project concerned the development and demonstration of algorithms to perform *strain tomography*: full-field reconstruction of the complete elastic strain tensor from neutron measurements, in a manner analogous to density reconstruction in medical computed tomography (CT).

Neutron diffraction-based approaches have long provided an excellent approach to non-contact measurement of elastic strain deep within the bulk of crystalline engineering materials (Kisi and Howard, 2012). For many years, both 'point-wise' and through-thickness measurements of strain have been possible using neutrons — the latter relying on Bragg-edge analysis (Santisteban, 2002a).

Strain tomography has the potential to significantly impact how experimental mechanics is carried out. This technique has applications in the characterisation of residual stresses in conventionally manufactured components and may also aid in the development of novel manufacturing techniques. One example is metal 3D printing, where the printing process can lock-in residual strains that can have a profound impact on the effective strength and service life of components; these effects must be understood to advance the technology (Megahed, 2016).

Over the past decade, advances in instrument and detector technology have allowed for Bragg-edge neutron transmission strain imaging, where hundreds of thousands of these through-thickness transmission strain measurements can be performed simultaneously, and a high-resolution image of the through-thickness normal strain is constructed from a single exposure of a sample (Santisteban, 2002b).

Our research group made several significant contributions to the Bragg-edge neutron strain tomography problem — reconstruction of the full strain tensor distribution over an entire sample geometry from these images. While analogous to conventional CT, Bragg-

Our research group made several significant contributions to the Bragg-edge neutron strain tomography problem...

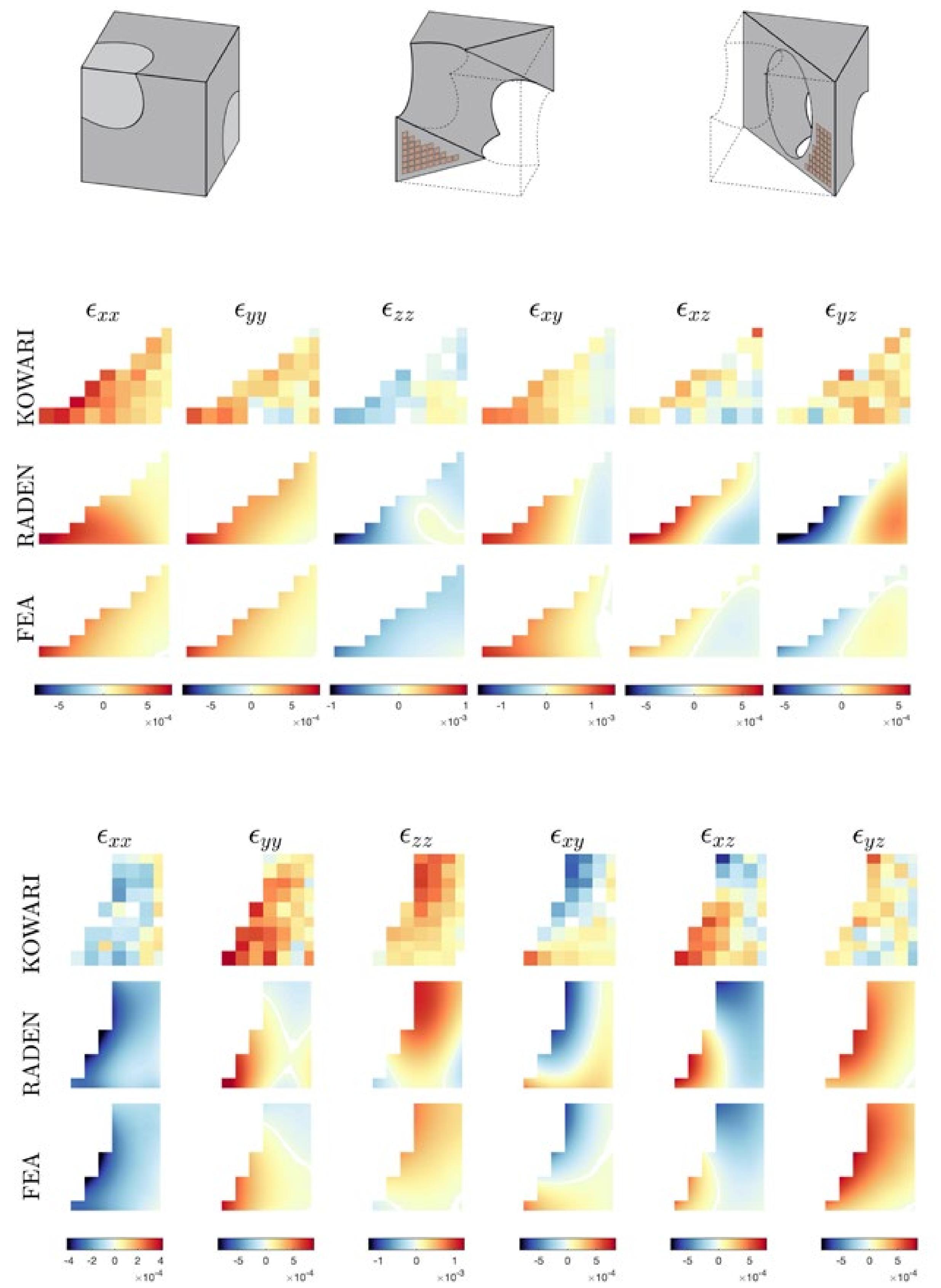

Figure 1: The capstone experiment of this project was the reconstruction of the complete triaxial strain field in a 'cube and plug' shrink-fit sample (shown top). The internal strain field arose from the interference between the steel cube outer and titanium plug. The reconstructed field from the Bragg-edge transmission measurements performed on the RADEN instrument is shown against point-wise validation measurements performed on the KOWARI instrument and finite-element (FEA) predictions on two key cross-sections (shown centre and bottom). Results and images from (Hendriks, 2019b).

edge neutron strain tomography represents a significantly more challenging problem, owing largely to two major challenges: (1) reconstruction of the full strain tensor from average measurements of the through-thickness normal component represents a so-called ‘rich’ tomography problem, where higher-dimensional information is recovered from lower-dimensional measurements; and (2) the Bragg-edge strain measurement process is non-injective: infinitely many fields can give rise to the same set of measurements. In other words, without additional physical constraints, it is impossible to reconstruct the correct physical strain field from a particular set of measurements (Lionheart, 2015).

Both our efforts and prior initial efforts centred on developing algorithms for special cases where simplifications in geometry or loading (e.g. axisymmetric/granular systems, or those subject only to in-situ loadings) provided sufficient additional constraints to allow reconstruction (Abbey, 2009; Kirkwood, 2015; Wensrich 2016; Gregg 2017). These approaches were successful but were not appropriate for extension to 3D reconstruction or that of residual strain fields.

We later developed approaches to encode the physical constraint of equilibrium in our algorithms, allowing general tomographic reconstruction of residual strain – the most general form of the problem (Jidling, 2018; Gregg, 2018; Hendriks, 2019a; Hendriks, 2019b).

Throughout the project, experimental data was crucial to test and validate our reconstruction algorithms. Bragg-edge imaging was performed on the RADEN instrument (Shinohara, 2015) at the Japan Proton Accelerator Research Complex (J-PARC), using the current state-of-the-art TimePix neutron detector (Tremsin, 2012). To validate the reconstructions, conventional point-wise neutron strain scans were performed on the KOWARI diffractometer (Kirstein, 2009) within ANSTO.

This project involved a multidisciplinary and international team of researchers. Dr Johannes Hendriks and Dr Alexander Gregg both completed their doctoral studies under the supervision of A/Prof Christopher Wensrich at the University of Newcastle. Dr Vladimir Luzin of ACNS at ANSTO was central to the validation studies completed on the KOWARI diffractometer, and Dr Takenao Shinohara the Bragg-edge transmission experiments on the RADEN instrument at J-PARC. Dr Anton Tremsin (University of California, Berkely) developed the TimePix detector that captured the Bragg-edge images from which our reconstructions were based, and Dr Oliver Kirstein (ESS) provided expertise and support throughout the imaging and validation experiments and the project in general. This work is supported by the Australian Research Council through a Discovery Project Grant (DP170102324). Access to the RADEN and KOWARI instruments was made possible through the respective user access programs of J-PARC and ANSTO. The authors also thank AINSE Limited for providing financial assistance (PGRA) and support to enable work on this project.

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Imaging the invisible: observing polymer brushes using neutron reflectometry

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A polymer brush is a surface covered with densely tethered polymer chains. When placed in a suitable solvent, these tethered polymers extend into solution, forming a brush-like structure (Figure 1).

Polymer brushes are ubiquitous in natural and human-made systems; they lubricate kneecaps (Jay, 2014), stabilise drug particles (Zhu, 2010), and prevent bacteria from growing on medical devices (Kim, 2015). These lubricating and antifouling properties stem from the diffuse 'brushy' structure of these interfaces (Chen, 2017).

The dependence of properties on structure creates an opportunity: constructing brushes from polymers that change their structure in response to environmental changes (i.e., temperature, pH) results in interfaces with switchable properties (Johnson, 2019). These responsive polymer brushes can control the pore size in filtration membranes, enable the controlled release of pharmaceuticals, serve as nano-actuators, or create self-cleaning surfaces (Chen, 2017). If we can understand both the creation and behaviour of these responsive brushes, the potential applications are vast.

One of the keys to realising these applications is resolving the structure of these interfaces. Unfortunately, brushes are hard to see - they are thin (100 nanometers or so), have similar optical properties to water, and are located at the solid-liquid interface, which is difficult to access. Neutron reflectometry is a technique that is uniquely well-suited to observing these interfaces. The output from this technique is a reflectometry profile, which contains information regarding the structure of the reflecting interface.

This reflectometry profile cannot be directly transformed into the interfacial structure. Instead, we realise the structure by optimising a theoretical reflectometry profile, calculated from a model of the interface of interest, against the collected data. In this project, the Platypus neutron reflectometer at ANSTO has

Our work marks the first direct observation of the structure of a growing brush...

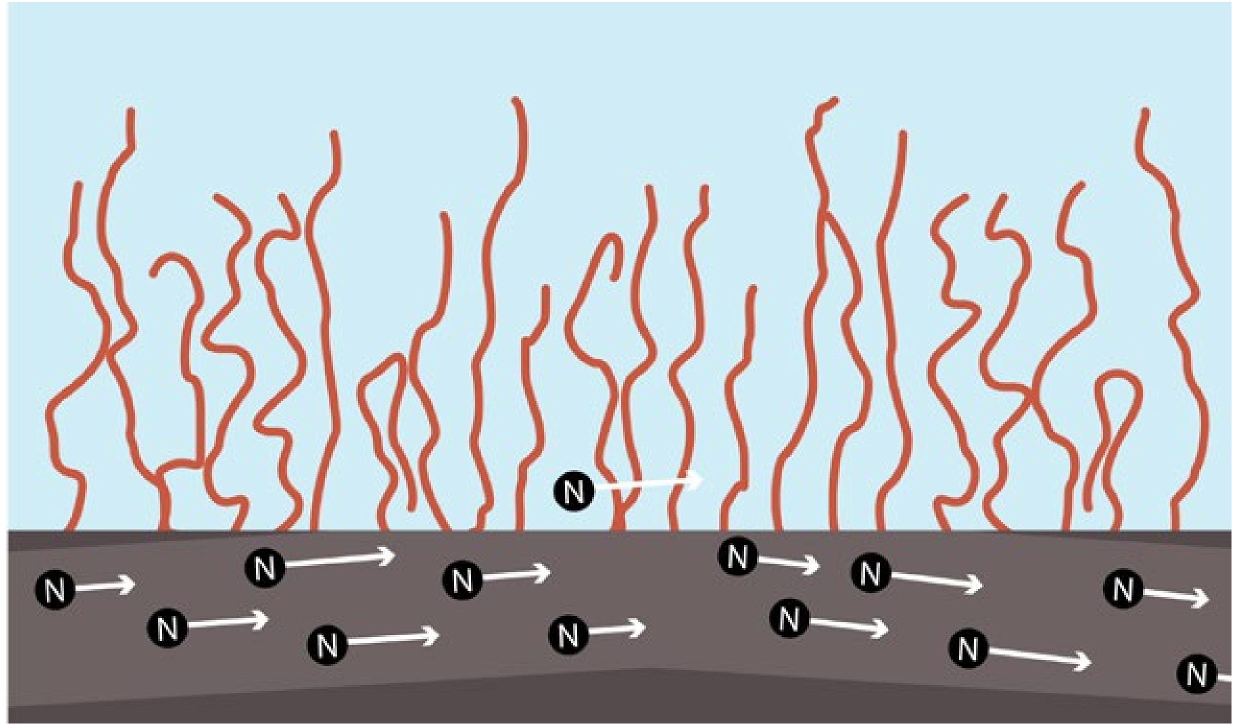

Figure 1: Schematic of the neutron reflectometry experiment on a polymer brush. Neutrons are highly penetrating, so can access the solid-liquid interface by travelling through the solid substrate.

helped push the boundaries of this technique to improve our ability to observe, and hence understand, polymer brushes.

However, we are faced with a challenge when analysing neutron reflectometry data: what model do we use to describe the polymer brush during the analysis? After all, if the structure is known, there is no reason for the experiment. To answer this challenge, we created a freeform model that allows us to derive polymer structures without knowing anything about them. This model is built within the *refnx* package (Nelson, 2019), which enables us to perform sophisticated statistical analyses (Bayesian statistics using Markov chain Monte Carlo) to determine how confident we are in the final structure. Figure 2 contains an example of the range of brush structures which this method can create.

We describe the structures with volume fraction profiles, which show the volume fraction of polymer decays as the perpendicular distance from the surface increases. We can compare these experimental volume fraction profiles to theoretical profiles to better understand (Johnson, 2019) and exploit polymer behaviour.

One way of creating polymer brushes is through a 'grafting-from' polymerisation, whereby polymers are grown directly from surface-bound initiators. The most widely used method for grafting-from approaches is Atom Transfer Radical Polymerisation (ATRP) due to its simplicity and versatility. Prior work indicates the presence of a dense layer adjacent to the substrate (Figure 2) for brushes synthesised via ATRP (Johnson, 2019), the origin of which we sought to understand by observing the construction of a grafted-from polymer brush (Figure 3).

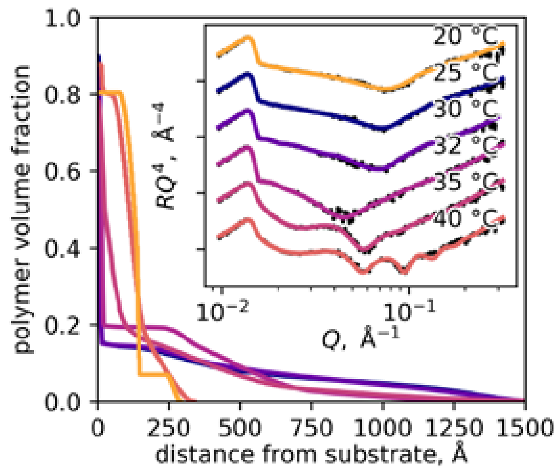

Figure 2: The structure of a thermoresponsive polymer brush, as determined via neutron reflectometry. As the temperature is increased from 20 to 40 °C, the brush undergoes a swollen (purple) to collapsed (orange) transition. Reflectometry data (black error bars) along with the theoretical reflectometry profiles generated by the brush structures (coloured lines) is inset.

In this experiment, we made reflectometry measurements over short time frames (1 minute), which allowed us to observe the evolution of the brush layer nanometer by nanometer. Our work marks the first direct observation of the structure of a growing brush, and finds that the previously observed interior layer is a dense polymer layer that forms in the initial stages of the polymerisation. Better understanding the formation of grafted-from polymers allows us to optimise synthesis conditions to create interfaces with better functionality.

No scientific endeavour would be possible alone. I am grateful to have worked extensively with the group of Prof. Erica Wanless and Prof. Grant Webber from the University of Newcastle: Timothy Murdoch, Ben Humphreys, Edwin Johnson and Hayden Robertson. Reflectometry experiments would have been duller without our resident instrument scientist and my ANSTO co-supervisor Dr. Andrew Nelson. He is the author of the *refnx* package and has been instrumental in the development of our freeform modelling approach. None of this work would have been possible without the constant guidance and encouragement of my supervisor A/Prof. Stuart Prescott. This research would not have been possible without beamtime granted by ANSTO and funding from the Australian Government and AINSE (RTP and PGRA scholarships, respectively).

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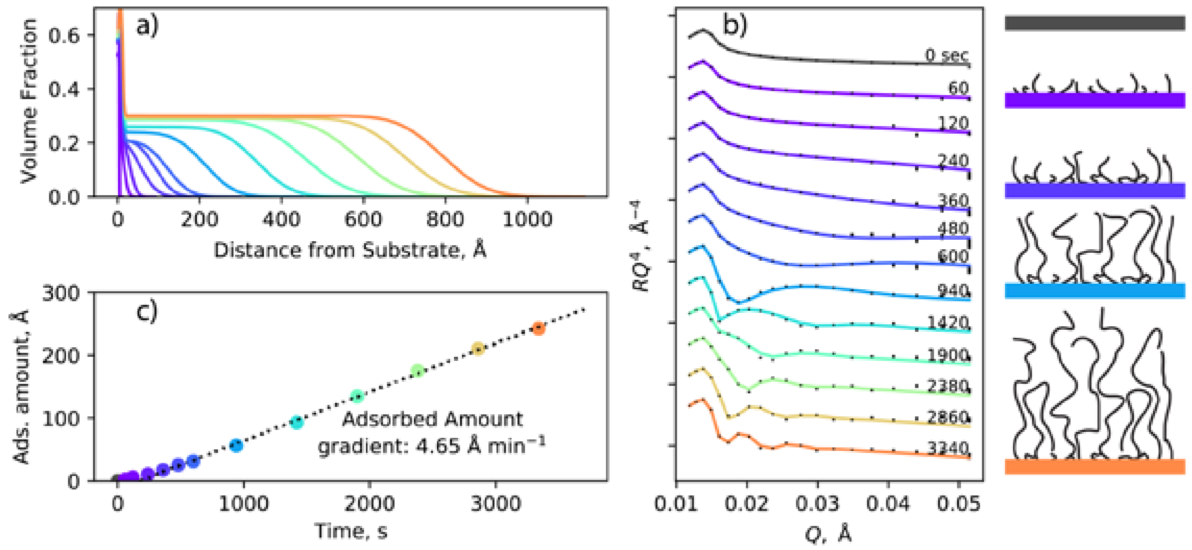

Figure 3: Observation of the in-situ synthesis of a polymer brush using reflectometry. a) Polymer volume fraction profiles that are optimised against b) collected reflectometry data, showing c) the linear growth of the polymer layer over time. On the right of the figure, a schematic of the interior layer formation and subsequent brush growth is shown.

Nanoplastic toxicology at the interface

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Plastic waste is ubiquitously spread across the world. While much of this waste is in bulk form, the smaller analogues – microplastics and nanoplastics – raise significant health concerns.

Our present understanding, however, does not allow for accurate risk assessments and management. Thus, plastic toxicology research has recently focused on documenting impacts on biological organisms (Koelmans et al., 2015). Increasingly, there is also interest in identifying the chemical and biological bases behind the observed effects.

An exploration of surface characteristics that drive interactions between nanoplastics and biological systems is necessary. Key amongst these is the formation of the protein corona – a complex formed on the nanoplastic surface when in contact with biological fluids (Lesniak et al., 2012). This aspect is considered infrequently; neither the formation nor the structure of these complexes are understood well, particularly at interfacial level. Hence, we took a multi-fold approach to understanding this complicated problem: to understand the nanoplastic/protein corona complex at a molecular scale, assess their biological impact (using cells), and corroborate the results with interfacial understanding using a lipid bilayer.

We first established an interfacial understanding of complex formation between polystyrene nanoplastics and proteins (human serum albumin and lysozyme) and investigated different structural motifs of protein corona complexes. Their toxicological impact was then studied by introducing these established systems to *in vitro* cell lines (human alveolar epithelial, A549 cells) and lipid bilayer (POPC and cholesterol).

...establishing the link between molecular level interactions and biological consequences.

We investigated the structure of nanoplastic/protein corona complexes at ANSTO's Australian Centre for Neutron Scattering (ACNS) using the Bilby Small Angle Neutron Scattering (SANS) and Kookaburra Ultra Small Angle Neutron Scattering (USANS) instruments. With these studies (Kihara et al., 2019, 2020) two structural motifs of protein coronae were identified and evaluated – soft, and hard.

Soft corona complexes adopted a structure where the nanoplastics were surrounded by a loose protein layer (~2-3 protein molecules thick), with enhanced intermolecular interactions. Hard corona complexes formed fractal-like aggregates, and the secondary structure of corona proteins were found to unfold partially. Importantly, nanoplastic size affected the structures of both the protein corona and the intrinsic protein: more significant conformational change was observed in the hard corona proteins around smaller nanoparticles compared to the larger ones, due to stronger self-association forces holding the complex together. This also implied that protein-dependent biochemical processes were more likely to be disrupted by smaller nanoplastics.

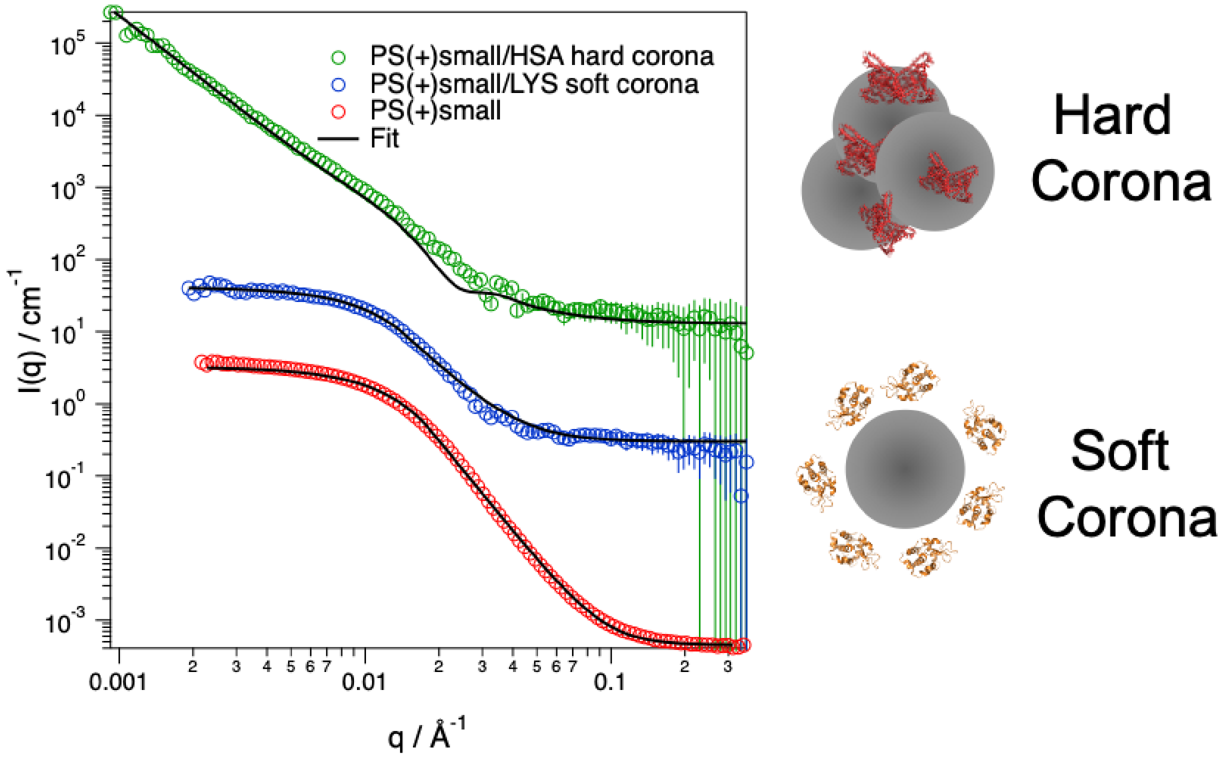
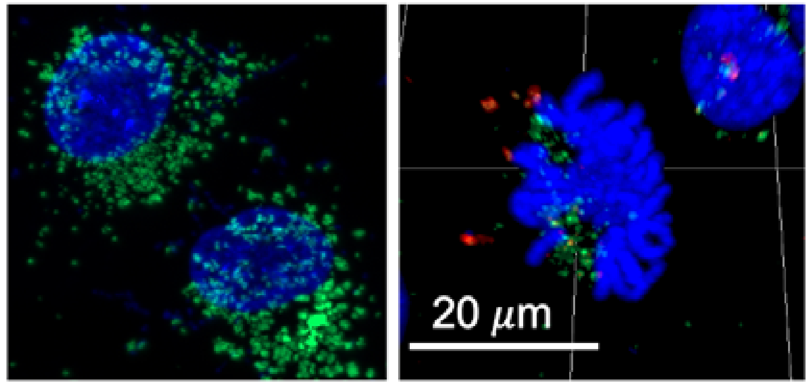


Figure 1: Bilby SANS profiles of polystyrene nanoplastics with hard (green), soft (blue), or without (red) protein corona. The illustration on the right show the structures based on the fitting of the profiles using core-shell (for soft) and core-shell fractal models (for hard). For the SANS profiles of nanoplastics with protein corona, the neutron signals of nanoplastics were contrast matched so they effectively look only into protein corona.

We then introduced these nanoplastics, with and without the protein corona, to human alveolar epithelial (A549) cells in order to test cytotoxicity and cellular uptake. Bare polystyrene (PS) nanoplastics caused mild cytotoxicity (~20%) but reduced when they were precoated with protein coronae. The extent of this reduction was more apparent with soft corona than with hard corona. This comparatively harmful feature of hard corona complex agrees with the known correlation between the disruptive nature of fractal morphology to some cellular environments (Bakand et al., 2012). Further, we confirmed cellular uptake by fluorescence microscopy (Figure 2a). In rare cases, small PS nanoplastics (20 nm) were found in the vicinity of chromosomes (Figure 2b) without a nuclear membrane; however this was absent for larger nanoplastics (200 nm).

There were two likely uptake mechanisms for the observed cellular uptake - endocytosis and trans-membrane diffusion (Beddoes et al., 2015). For trans-membrane diffusion to occur, the lipid bilayer would require severe disruption, especially for nanoplastics of the sizes tested (20 and 200 nm). However, the disruption was limited to the hydrophilic headgroup, thus excluding the possibility of trans-membrane diffusion.

Overall, this work identified and structurally evaluated soft and hard protein coronae around polystyrene nanoplastics. The presence of protein corona of different types had different impacts on cytotoxicity and membrane disruption. These findings contribute to the literature surrounding nanoplastic toxicity by



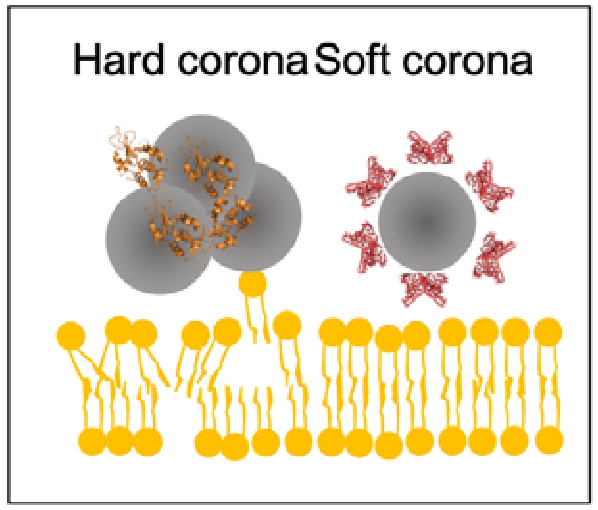


Figure 2: Illustration of cellular interactions with nanoplastics with protein coronae. The fluorescence images show the PS nanoplastics (green) taken up by A549 cells (a) and in the vicinity of chromosomes (b). The extent of membrane disruption was evaluated using lipid bilayer and neutron reflectometry (c, image not to scale).

establishing the link between molecular level interactions and biological consequences.

We would like to thank AINSE for providing support through a Postgraduate Research Award, funding beamtime trips, and symposia/conferences. This project was also supported and inspired by a number of researchers; Prof. John White (ANU) for inspiring me to pursue the work, and Dr Laura Domigan and Dr Manmeet for in vitro experiments. Importantly, we would also like to acknowledge enormous help by Dr Andrew Whitten, Dr Stephen Holt, and Dr Jitendra Mata for conducting neutron experiments and data analysis.

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Stabilising spinel structured lithium-ion battery electrode materials

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The increasing requirements of rapidly-evolving technologies have stimulated the development of next-generation high-performance lithium-ion batteries (LIBs).

The limited energy density, around 500 Wh kg^{-1} of the $LiCoO_2$ electrode in current commercial LIBs, make them less competitive over other energy storage systems. Thus, worldwide research efforts have targeted the exploration of high-energy-density electrodes.

Spinel structured $LiNi_{0.5}Mn_{1.5}O_4$ (LNMO) is one of the most promising candidate materials to replace $LiCoO_2$, due to its high operating voltage of 4.7 V vs. Li, with a high energy density of up to 650 Wh kg^{-1}, low fabrication cost, and low environmental impact. However, the short cycle life of LNMO caused by severe capacity decay during cycling limits its wider application and further commercialization.

Our team proposed a site-selective doping strategy to enhance the structural stability of the spinel LNMO and achieved long battery life. We considered the similar ionic radii of Mg ions at tetrahedral (8*a*) and octahedral (16*c*) crystallographic sites within LNMO with *Fd-3m* space group symmetry (0.57 and 0.72 Å, respectively), and opted to selectively dope Mg ions onto both these sites through a facile solid-state reaction. We used aberration-

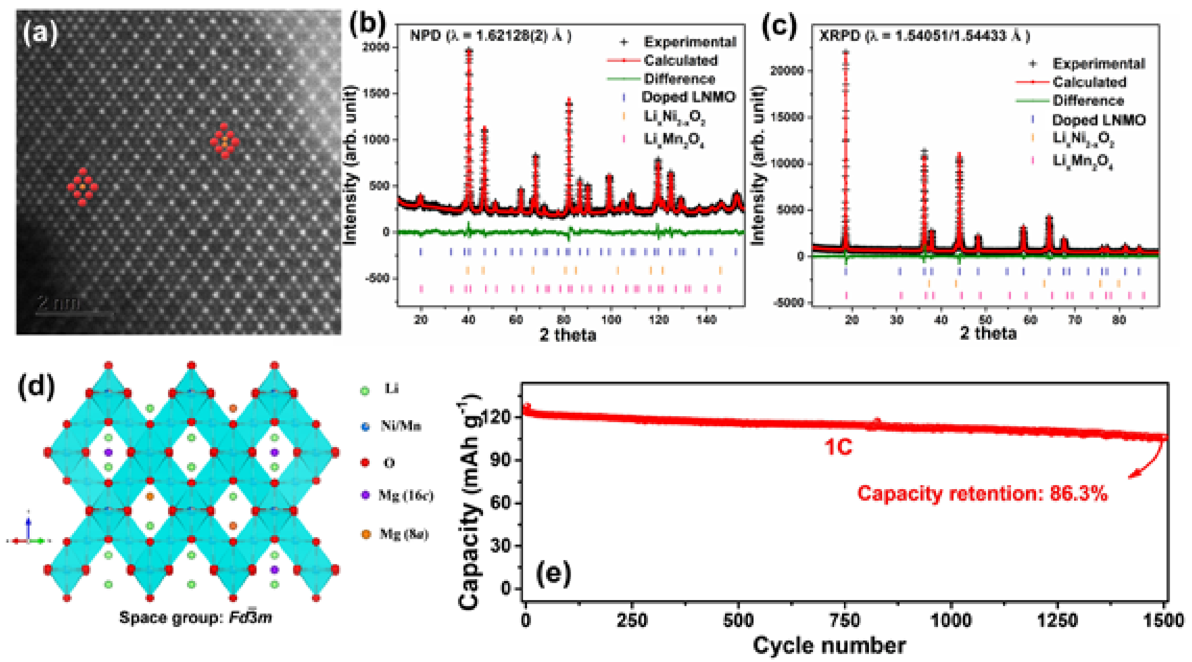

Figure 1: Typical STEM HAADF image (a), joint Rietveld refinement profiles using NPD (b) and XRPD (c) data, crystallographic structure (d), and cycle performance at 1C (e) of Mg-doped LNMO.

corrected scanning transmission electron microscopy (STEM) and high-angle annular dark-field (HAADF) imaging (Figure 1a) to confirm the occupation of Mg at 16*c* and 8*a* sites.

Rietveld refinement analysis performed jointly against both neutron powder diffraction (NPD) (Figure 1b) and X-ray powder diffraction (XRPD) (Figure 1c) data enabled the determination of the site occupancy factor of Mg at 16*c* and 8*a* sites to be 0.3(2)% and 0.7(3)%, respectively, with the refined crystal structure schematically illustrated in Figure 1d. In the typical spinel structure, Li and O occupy 8*a* and 32*e* crystallographic sites, respectively, and Ni and Mn share octahedral 16*d* sites. The introduced Mg is found at both tetrahedral (brown, 8*a*) and octahedral (purple, 16*c*) sites. Importantly, the Mg-doped LNMO exhibits excellent extended-long-term electrochemical performance (Figure 1e), retaining 86.3% of its initial capacity after 1500 cycles at 1 C, demonstrating great commercial potential.

This work pioneers an atomic-doping engineering strategy... that may be applied more generally in battery research...

The origin of the outstanding electrochemical performance of the site-selective-doped LNMO was explored using *in operando* synchrotron-based XRPD. Figure 2a and 2b show the time-resolved diffraction data of coin cells containing undoped LNMO and Mg-doped LNMO, respectively, as a contour plot with intensity in colour, alongside the corresponding charge-discharge curves. The undoped LNMO undergoes both solid-solution and two-phase reaction during the electrochemical process, with the two-phase reaction evidenced by the weak reflection at around 8.54° in the data, corresponding to the $Ni_{0.25}Mn_{0.75}O_2$ rock-salt phase.

Conversely, the Mg-doped LNMO only experiences a solid-solution reaction during cycling, with the 111 reflection of the spinel structure shifting continuously to higher angles during charge and migrating reversibly back to lower angles during discharge. Notably, no reflection of the rock-salt phase was found during either charge or discharge, indicating the absence of two-phase behaviour in the Mg-doped LNMO.

The role of the Mg dopant in changing the mechanistic behaviour of the electrode and achieving excellent LIB performance is schematically illustrated in Figure 2c. At the highly-delithiated state, Mg at tetrahedral and octahedral sites structurally stabilize the material, prohibiting the partially-irreversible two-phase behaviour of LNMO that leads to cycle decay. The Mg mitigates against the dissolution of other transition metals, preventing the formation of the undesirable rock-salt phase and reducing Jahn-Teller distortion.

This work pioneers an atomic-doping engineering strategy for the modification of electrode performance that may be applied more generally in battery research, where dopants may be used strategically to address specific electrode issues. Additionally, these findings will also facilitate the development of high-energy-density electrode materials that accelerate the commercialization of next-generation LIBs.

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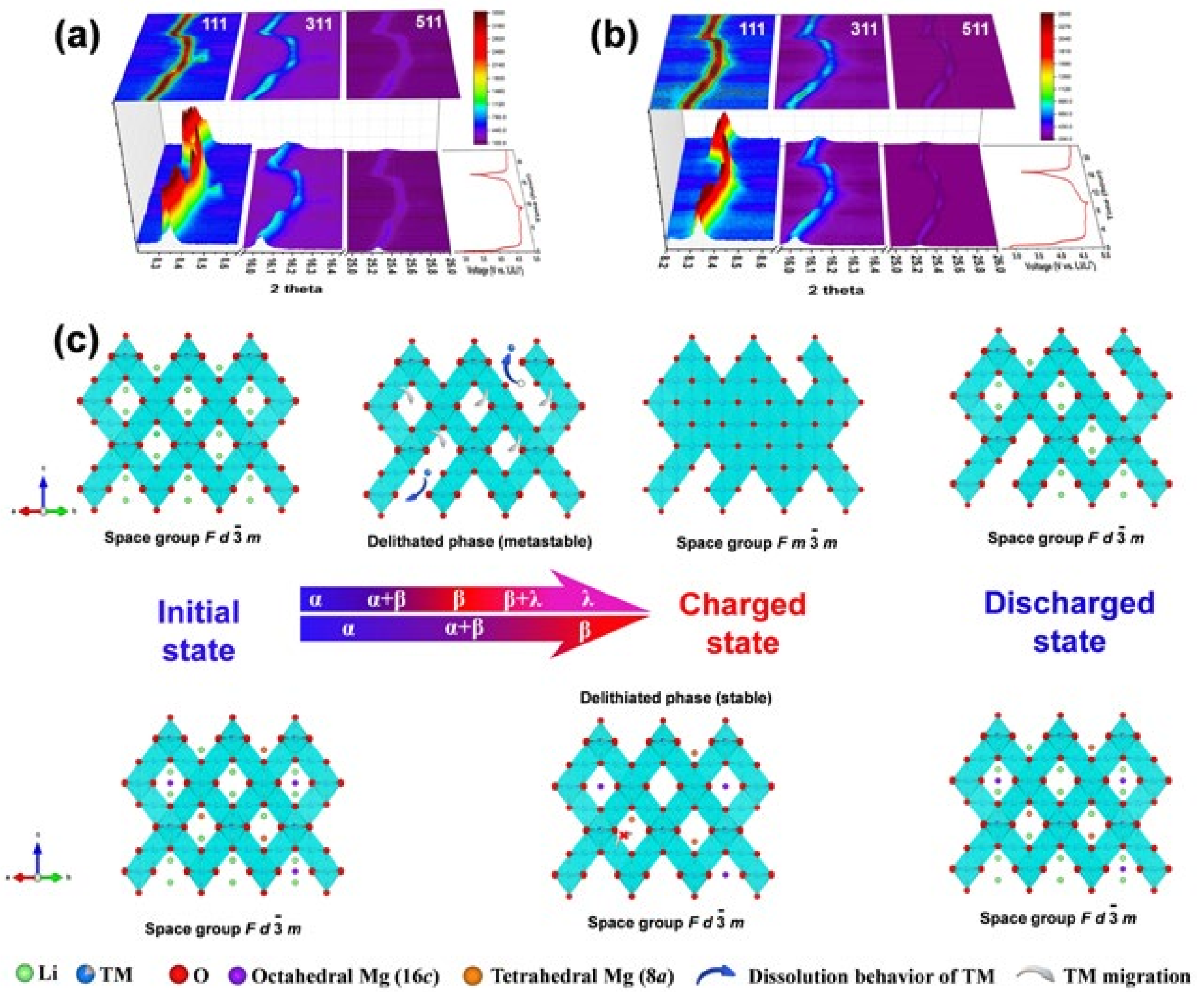

Figure 2: In operando synchrotron XRPD data in a selected 2θ region shown as a contour plot with intensity in colour, the legend for which is shown inset, for undoped LNMO (a) and Mg-doped LNMO, where the evolution of LNMO 111, 311, and 511 reflections can be seen along with the corresponding charge/discharge curve, illustration of the structural changes and phase evolution of undoped LNMO and Mg-doped LNMO during charge and discharge (c), where α, β, λ stand for the uncycled LNMO, delithiated LNMO, and rock-salt phase, respectively. The octahedra containing Ni/Mn are shaded in cyan.

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Nanoparticles and liquid crystals: the effects of different variables on structure and rheology

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Nanoparticles and liquid crystals (LCs) are forms of matter with distinct properties, yet are united by a common length-scale; they have drawn interest for a wide variety of nanotechnology applications.

Individually, each component can create deceptively complex systems with interesting structural and rheological properties, both naturally and artificially. When mixed, these materials not only present new bulk properties, but can also influence one another in unanticipated ways.

While much research has been undertaken in utilising both materials in tandem to create new systems for medicines, paints, and other applications, there is little work being conducted on how the properties of nanoparticles affect the physicochemical properties of any LC they are added to, and thus the resultant hybrid material. This project aimed to provide a holistic framework to answer this question, investigating how the size, shape, surface chemistry, and concentration of nanoparticles can affect the structural and rheological properties of LCs.

Irrespective of concentration, shape, size, and surface chemistry, results from small-angle scattering of neutrons and X-rays (SANS/SAXS) and polarising light microscopy (PLM) suggested that nanoparticles in LC systems typically aggregate at the boundaries between LC domains. It was inferred that these aggregates, usually of a size several orders of magnitude larger than the correlative distances of the LC, act as defects. In turn, these disrupt the longer-range order of an LC system and decrease the average domain size (see Figure 1).

When the surface chemistry and size of the nanoparticles were changed, so was the material's response to shear, likely due to changes in the shape, size, and composition of the aggregates. Nevertheless, in all examined

...a holistic framework to... how the size, shape, surface chemistry, and concentration of nanoparticles can affect the structural and rheological properties of LCs.

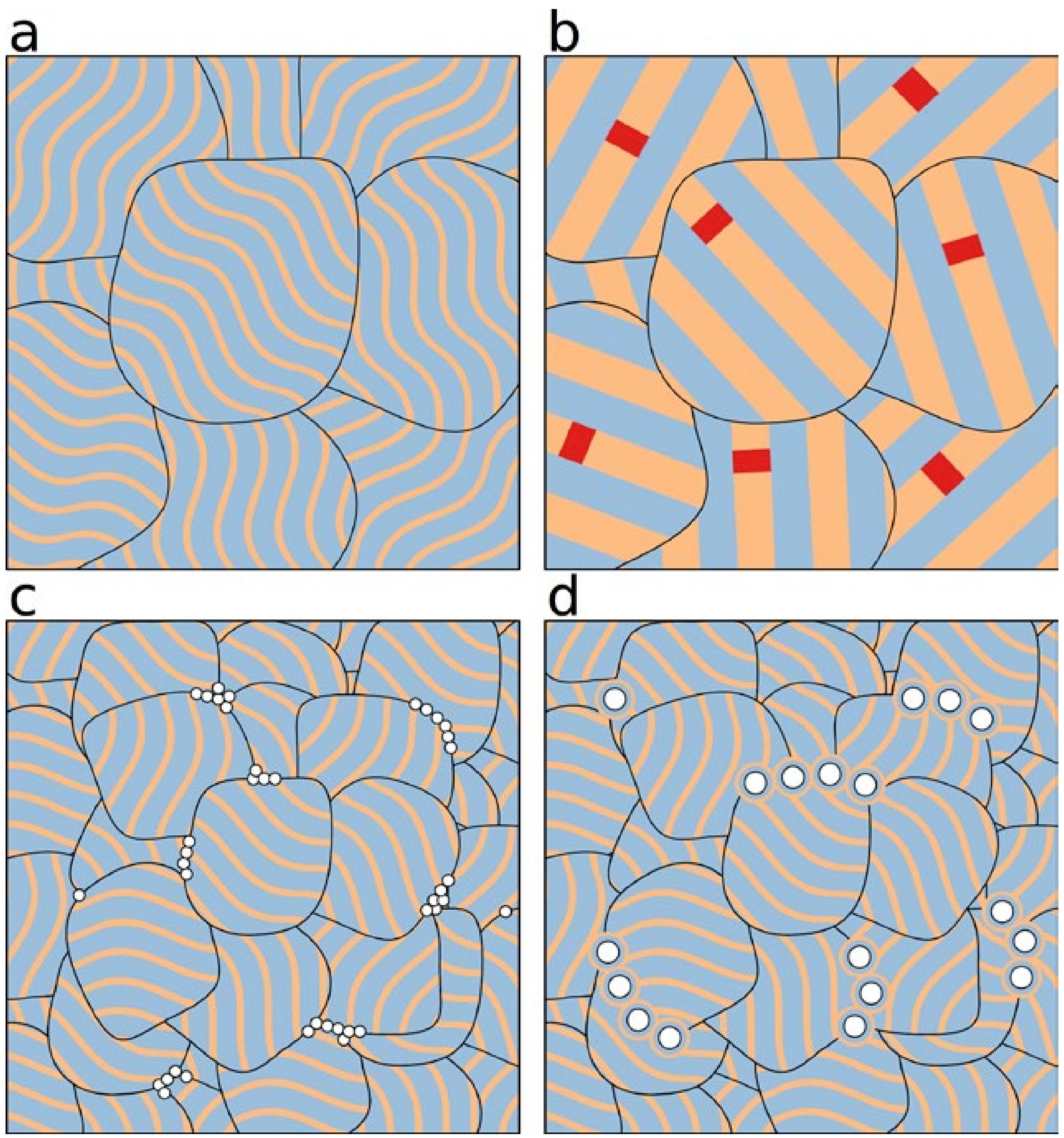

Figure 1: Simplified microstructure of examined lamellar liquid crystal (LC) systems, where orange represents surfactant/oil bilayers, blue represents water, and black lines represent domain boundaries. (a) Domains of an LC with flexible bilayers. (b) An LC with added oleic acid (red). The bilayers are more rigid, which increases ordering, but also contain oleic acid 'defects' which reduce ordering. Interlamellar spacing is also increased due to thicker bilayers. (c) An LC with added 10 nm silica particles. The silica nanoparticles form larger structures at domain boundaries and cause a reduction in the size of domains without affecting the bilayer structure. (d) An LC with added 20 nm silica particles. As with 10 nm particles, the silica forms larger structures, which cause a reduction in LC domain size, though these silica structures are easily deformable, likely due to a surfactant coating around the larger particles.

systems the LCs – including lamellar, cubic, and hexagonal structures – were shear-thinning, and their viscoelasticity rose upon the incorporation of nanoparticles (Marlow et al., 2018).

Nanoparticles were also found to affect both thermal and rheological stability of different LC phases, typically by causing or preventing certain phase transitions. These changes in stability differed depending on the size and surface chemistry of the particles, and were likely kinetic, rather than thermodynamic, in nature. After shear was removed, recovery of the initial state was dependent on the nanoparticles present, indicating their ability to template or induce certain phases and therefore their potential suitability as formulation stabilisers or cryoprotectants (Marlow et al., 2019).

In a micellar system, it was shown that increased surfactant concentration can cause a decrease in the average size of nanoparticle aggregates, while aggregates did not affect the structure of micelles. Increasing either nanoparticle or surfactant concentrations led to an increase in viscosity, though the rate of increase as a function of silica concentration was linear, while the increase as a function of surfactant concentration was exponential. This provides a clearer understanding of how viscoelasticity of LC systems, important in applications such as cosmetics, can be tailored by changing the concentration of either nanoparticles and/or surfactant.

As surfactant concentration was increased, leading to formation of a hexagonal liquid crystal, it is likely that aggregates were again present at domain boundaries, however there was no apparent decrease in LC order due to their presence. This indicates that just as nanoparticles can be used to alter the properties of some LC systems, they do not do so universally, and therefore care must be taken when designing such systems. This also indicates the possibility of applications where nanoparticles are desired for certain properties (e.g. to be delivered inside the body via a cubosome) but not for others (e.g. to not affect the drug release properties of the cubosome).

This research has served to advance knowledge within the fields of both nanoparticles and LCs, providing a framework to understand how various factors involved can affect structural and rheological properties

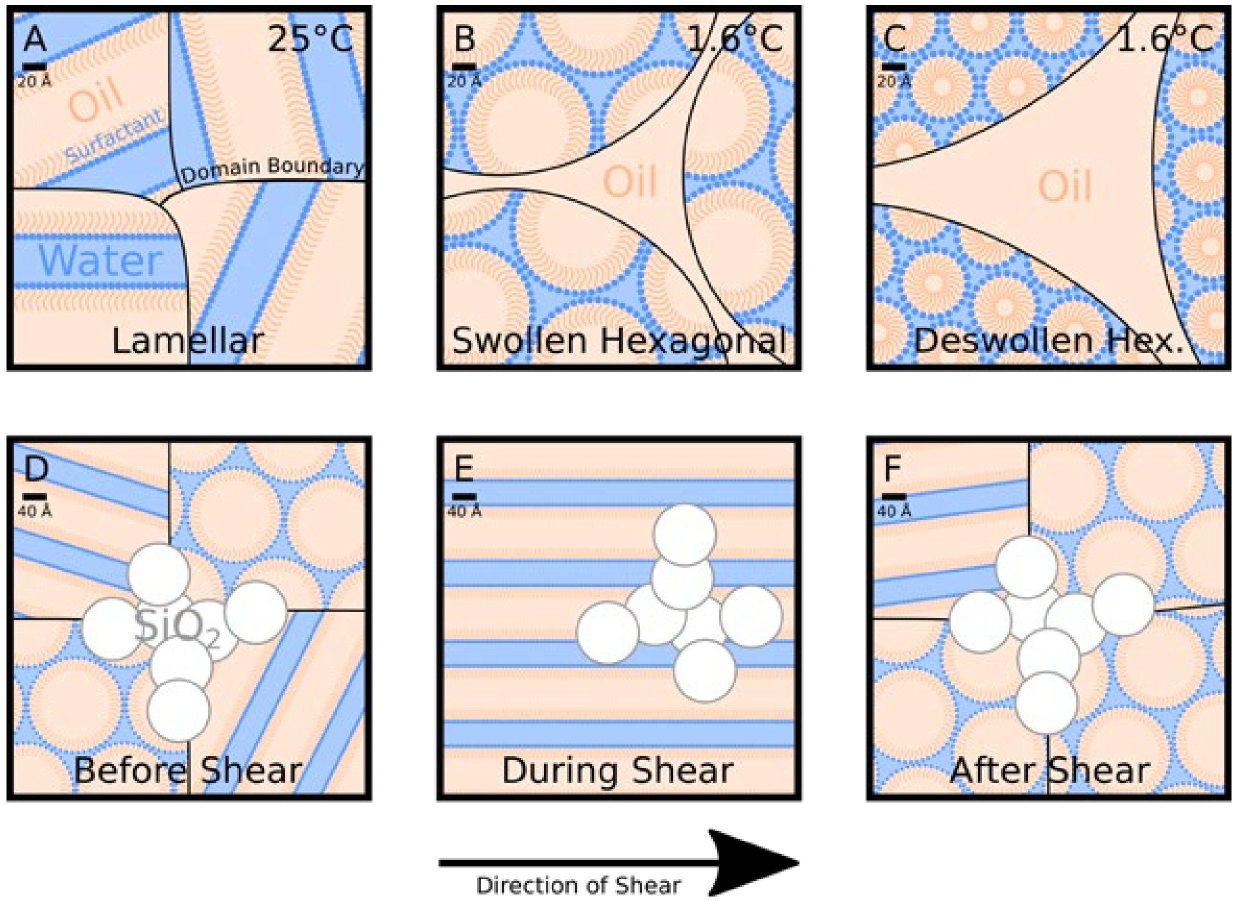

Figure 2: Simplified representations of the microstructures of the examined LC. Light blue regions represent water, orange represents p-xylene, 10 nm silica nanoparticles are shown as white circles, the solid black lines represent domain boundaries, and the dark blue circles with deep orange tails represent individual surfactant (Triton X-100) molecules. Depicted are the lamellar phase of the LC at 25.7 °C (A), and two hexagonal phases at 1.6 °C (B-C), the oil-swollen and de-swollen respectively. Also shown is the same LC with 10 nm silica particles (hydrophobic or hydrophilic) at room temperature (20 °C) before, during, and after shear (D-F). Note that for the same system without oil, the alternating layers in a lamellar system would be water and surfactant bilayers, while in the de-swollen hexagonal phase there would be no oil remaining in the hexagonal array or at domain boundaries.

of a final system. This allows a more reasoned approach to designing these systems for their various applications, while also identifying potential pathways for further research to bolster this understanding.

This research was supported by an Australian Government Research Training Program stipend, as well as a Postgraduate Research Award from AINSE Ltd. It would not have been possible without the experimental work and expertise of all of the authors, especially my supervisors A/Prof Rico Tabor and Dr Toby Bell, and instrument scientists Dr Liliana de Campo (SANS/USANS), Dr Anna Sokolova (SANS), and Dr Robert Knott (SAXS). This work was primarily conducted on both the land belonging to the Kulin Nation and the Dharawal nation. I would like to pay my respects to Elders past and present.

References:

Marlow, J B, McCoy, T M, Ho, C Q, de Campo, L, Knott, R, Bell, T D M & Tabor, R F 2019, 'Tuning the structure, thermal stability and rheological properties of liquid crystal phases via the addition of silica nanoparticles.' *Physical Chemistry Chemical Physics*, vol. 21, pp. 25649–25657.

Marlow, J B, Pottage, M J, McCoy, T M, de Campo, L, Sokolova, A, Bell, T D M & Tabor, R F 2018, 'Structural and rheological changes of lamellar liquid crystals as a result of compositional changes and added silica nanoparticles.' *Physical Chemistry Chemical Physics*, vol. 20, pp. 16592–16603.

Outreach Activities

January 2020

High Commission of Canada in Australia | Canberra, ACT, Australia

Michelle Durant met with representatives of the High Commission of Canada in Australia.

Embassy of France in Australia | Canberra, ACT, Australia

Michelle Durant met with representatives of the Embassy of France in Australia to discuss the SAAFE program.

University of Canberra | Canberra, ACT, Australia

Michelle Durant met with approximately 25 staff and students of the University of Canberra and provided an overview presentation on AINSE and ANSTO.

February 2020

Fukui International Meeting on Human Resource Development for Nuclear Energy in Asia 2020 | Fukui, Japan

Michelle Durant attended this conference as a representative of AINSE and ANSTO.

Southern Sydney Innovation and Entrepreneurship Roundtable | Georges River Council, Hurstville, NSW, Australia

Michael Rose attended this roundtable meeting on behalf of AINSE.

Embassy of France in Australia | Canberra, ACT, Australia

Michelle Durant met with representatives of ANSTO and the Embassy of France in Australia for the signing of the SAAFE Memorandum of Understanding.

2020 Universities Australia Conference | Canberra, ACT, Australia

Michelle Durant and Michael Rose attended this conference on behalf of AINSE. AINSE promoted its programs and activities at an exhibitor booth.

May 2020

New Zealand Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from Massey University, University of Otago, Victoria University of Wellington, and University of Waikato.

Queensland Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from Queensland University of Technology, The University of Queensland, Griffith University, University of the Sunshine Coast, and James Cook University.

Victoria Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from Federation University, Victoria University, Deakin University, The University of Melbourne, Monash University, and La Trobe University.

Metropolitan NSW Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from University of NSW, University of Sydney, UTS, Western Sydney University, and the University of Wollongong.

Cup of Tea with the AINSE MD Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from University of NSW and University of Otago.

NT, SA and Tasmania Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from The University of Adelaide, Flinders University, The University of Tasmania, and University of South Australia.

ACT and Regional NSW Member Meeting | Virtual Meeting

Michelle Durant met with AINSE Councillors from University of Canberra, Southern Cross University, and University of New England.

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

Attended by 33 Australian and New Zealand university representatives, in addition to representatives from ANSTO, CSIRO and AINSE.

June 2020

New Zealand AINSE Symposium | Virtual Event

Michelle Durant and AINSE staff hosted a symposium for students and researchers. There were 46 attendees from the following AINSE member institutions: ANSTO, The University of Auckland, University of Canterbury, Massey University, and University of Otago, Victoria University of Wellington and the University of Waikato.

Victoria AINSE Symposium | Virtual Event

Michelle Durant and AINSE staff hosted a symposium for students and researchers. There were 48 attendees from the following AINSE member institutions: ANSTO, CSIRO, Deakin University, Federation University, Flinders University, The University of Melbourne, Monash University, RMIT University, Swinburne University of Technology, Victoria University, and The University of Queensland.

July 2020

WA, NT, SA and Tasmania AINSE Symposium | Virtual Event

Michelle Durant and AINSE staff hosted a symposium for students and researchers. There were 58 attendees from the following AINSE member institutions: The University of Adelaide, Monash University, Flinders University, The University of South Australia, Curtin University, RMIT University, The University of Western Australia, The University of Tasmania, Murdoch University, and ANSTO.

Queensland, ACT and Regional NSW AINSE Symposium | Virtual Event

Michelle Durant and AINSE staff hosted a symposium for students and researchers. There were 31 attendees from the following AINSE member institutions: The Australian National University, University of Canberra, Griffith University, The University of New South Wales, The University of Queensland, CQ University, The University of New England, Monash University, Southern Cross University, and ANSTO.

August 2020

STA Superstars of STEM 2020 Launch | Virtual Event

Michelle Durant attended the launch alongside 66 other representatives from Science and Technology Australia (STA) and STA member organisations.

September 2020

University of Technology Sydney Student Careers Symposium | Virtual Event

Michelle Durant participated in a 2.5 hour panel discussion hosted by UTS Environmental Science students, alongside an ANSTO representative and the CEO of a leading QLD environment consultancy firm.

AINSE Online Symposium featuring Metropolitan NSW Scholars | Virtual Event

Michelle Durant and AINSE staff hosted a symposium for students and researchers. There were 58 attendees from the following AINSE member institutions: The University of Sydney, Swinburne University, Murdoch University, Griffith University, Western Sydney University, Southern Cross University, Charles Sturt University, The University of Wollongong Macquarie University, Monash University, La Trobe University, Deakin University, RMIT University, Flinders University, The University of Auckland, The University of New England, The University of Melbourne, Macquarie University, Federation University, CSIRO, and ANSTO.

64th IAEA General Conference: Nuclear Human Resource Development in Asian Countries Embarking on a Nuclear Power Programme | Virtual Event

Michael Rose represented AINSE, and acted as the representative for Australia, in attending the side event of the 64th IAEA General Conference to report on the last 10 years of activities by the Fukui International Human Resources Development Centre for Atomic Energy. A total of 105 delegates attended the event.

October 2020

BLiSS*Adelaide 2020 Virtual Conference | Virtual Event

Michelle Durant and Michael Rose attended on behalf of AINSE, providing student attendees with an overview of available opportunities with ANSTO and AINSE. AINSE was a Gold Sponsor of BLiSS*Adelaide 2020.

November 2020

AINSE-ANBUG Neutron Scattering Symposium (AANSS) 2020 | Virtual Event

Michael Rose served on the organising committee and attended the AANSS2020 event on behalf of AINSE. Michelle Durant participated in the opening of the symposium alongside ANSTO representatives, providing attendees with an overview of AINSE opportunities.

NSW Vice Chancellors Executive Meeting | Virtual Meeting

Michelle Durant presented an overview of AINSE to the NSW Vice Chancellors.

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

Attended by 35 Australian and New Zealand university representatives, in addition to representatives from ANSTO, CSIRO and AINSE.

National Science Week, Instagram and AINSE Alumni Forums

From 15-23 August 2020, AINSE joined the Australian scientific community in the annual celebration of National Science Week. AINSE celebrated this year's National Science Week with the launch of a new AINSE Instagram account. The new platform was used to promote the work of ten AINSE scholars throughout the week; their high-impact research was also featured in a series of short articles hosted on the AINSE website.

In September 2020, AINSE launched two new Alumni Forum networks on LinkedIn and Facebook. These Alumni Forums aim to build a connection between different generations of AINSE scholars, and to keep both past and present AINSE scholars up-to-date with current AINSE- and ANSTO-related events and opportunities, and other items of interest in the areas of nuclear science & engineering and related research fields.

Meetings and Committees

AINSE Council

Member Organisations and Representative at Council

Two Meetings of Council were held in 2020. There was an Annual General Meeting held on 20 May and a General Meeting held on 25 November.

(b) denotes AINSE Board Member.

MEMBER CODE	ORGANISATION	MEMBERSHIP COMMENCED	COUNCILLOR	MEETINGS ATTENDED
ADE	The University of Adelaide	1958	Prof. Chris Sumby	2
AKL	The University of Auckland	1995	Prof. Jadranka Travas-Sejdic	2
ANS	ANSTO	1958	Prof. Andrew Peele (b)	2
			Roslyn Hatton (b)	2
			Dr. Suzanne Hollins (b)	2
ANU	The Australian National University	1958	Dr. Anton Wallner	0
			Dr. Tibor Kibedi	1
CAN	University of Canterbury	2005	Dr. Vladimir Golovko	2
CBR	University of Canberra	1996	Prof. Duanne White	2
CDU	Charles Darwin University	1995	A/Prof. Krishnan Kannoorpatti	2
CQU	CQUniversity	1991	Dr. Nathan Brooks-English	2
CSI	CSIRO	2010	Prof. Aaron Seeber	2
CSU	Charles Sturt University	1995	Dr. Celia Barril	1
CUR	Curtin University	1989	Prof.Craig Buckley	1
DEA	Deakin University	1997	Prof. Aaron Russell	0
			Prof. Lingxue Kong	1
FED	Federation University Australia	1997	A/Prof. Kim Dowling	2
FLI	Flinders University	1966	Prof. Claire Lenehan	1
GRI	Griffith University	1975	Prof. Evan Gray	2
JAM	James Cook University	1970	A/Prof. Scott Smithers	2
LAT	La Trobe University	1966	Prof. Chris Pakes	1
MAC	Macquarie University	1966	Prof. Bridget Mabbutt	1
			A/Prof. Tracy Rushmer	1
MAS	Massey University	2014–2017 (rejoined 2018)	Prof. Richard Haverkamp	2
MEL	The University of Melbourne	1958	A/Prof. Colette Boskovic	2
MON	Monash University	1961	Julie Rothacker	2
MUR	Murdoch University	1985–1997 (rejoined 1998)	A/Prof. Aleks Nikoloski	1
NCT	The University of Newcastle	1965	Dr. Grant Webber	1
NSW	The University of New South Wales	1958	A/Prof. John Stride	2
OTA	University of Otago	2007	A/Prof. Christopher Moy	2
QLD	The University of Queensland	1958	Prof. Ian Gentle (b) (President)	2
QUT	Queensland University of Technology	1992	Prof. Godwin Ayoko	2
RMI	RMIT University	1988	Prof. Gary Bryant	2
SCU	Southern Cross University	1994	Prof. Bill Boyd (b)	1
			Dr Renaud Joannes-Boyau	0

MEMBER CODE	ORGANISATION	MEMBERSHIP COMMENCED	COUNCILLOR	MEETINGS ATTENDED
SWI	Swinburne University of Technology	1991	Prof. Saulius Juodkazis	2
SYD	The University of Sydney	1958–2015 (rejoined 2017)	A/Prof. Margaret Sunde	1
TAS	University of Tasmania	1958	A/Prof. Zanna Chase	1
UNE	The University of New England	1958	Dr. Brendan Wilkinson	2
USA	University of South Australia	1991	Prof. Enzo Lombi	1
USC	University of Sunshine Coast	2010	Prof. Roland De Marco (b)	2
			Dr. Rezwanul Haque	2
UTS	University of Technology Sydney	1988	Prof. Michael Cortie	2
UWA	The University of Western Australia	1958	Prof. Rob Atkin	2
UWS	Western Sydney University	1993–2016 (rejoined 2020)	Prof. Kevin Dunn	0
VAC	The Vacuum Society of Australia	2018	Dr. Anton Stampfl	0
VIC	Victoria University	2019	A/Prof. Khalid Moinuddin	2
VUW	Victoria University of Wellington	2010	Prof. David Harper	2
WAI	The University of Waikato	2011	A/Prof. Graham Saunders	2
WOL	University of Wollongong	1975–2014 (rejoined 2016)	Prof. William Price	2
	AINSE		Michelle Durant, Managing Director	2
	Independent Director		Helen Liossis (b)	2
	Independent Director		Dr. Leonie Walsh (b)	1

Alternate Representatives and Other Attendees at Council

MEMBER CODE	ORGANISATION		REPRESENTATIVE	MEETINGS ATTENDED
DEA	Deakin University		Dr. Ludovic Dumee	1
FLI	Flinders University		A/Prof.Ingo Koeper	1
UWS	Western Sydney University		Prof. Michail (Mike) Kagioglou	1
			Prof. Eileen McLaughlin	1

OTHER ATTENDEES		REPRESENTATIVE	MEETINGS ATTENDED
AINSE		Kim Shields (Minutes Secretary)	2
AINSE		Dr Michael Rose (Zoom Monitor)	2
Delante Accountants & Business Advisors Pty Ltd		David Aston (AINSE Auditor)	1

Seven private members were invited to attend.

AINSE Board Meetings

Eight Board Meetings were held in 2020.

EXECUTIVE MEMBER	OFFICE/POSITION	ORGANISATION	MEETINGS ATTENDED
Prof. Ian Gentle	President, University Representative	The University of Queensland	8
Michelle Durant	Managing Director	AINSE	8
Helen Liossis	Independent Director	Independent	8
Dr. Leonie Walsh	Independent Director	Independent	8
Roslyn Hatton	ANSTO Representative	ANSTO	8
Dr. Suzanne Hollins	ANSTO Representative	ANSTO	8
Prof. Andrew Peele	ANSTO Representative	ANSTO	7
Prof. Roland De Marco	University Representative	University of the Sunshine Coast	8
Prof. Bill Boyd	University Representative	Southern Cross University	8

AINSE Winter School Planning Committee

Dr. Dhriti Bhattacharyya	ANSTO	Dr. Madhura Manohar	ANSTO
Dr. Helen Brand	ANSTO	Dr. Jitendra Mata	ANSTO
Dr. Paul Callaghan	ANSTO	Prof. Garry McIntyre	ANSTO
Lillian Caruana	AINSE	Dr. Daniel Oldfield	ANSTO
Dr. Tom Cresswell	ANSTO	Laura Owen	AINSE
Dr. Justin Bryan Davies	ANSTO	Gita Rahardjo	ANSTO
Rod Dowler	ANSTO	Dr. Michael Rose	AINSE
Michelle Durant	AINSE	Dr. Mitra Safavi-Naeini	ANSTO
Daniela Fierro	ANSTO	Dr. Jamie Schulz	ANSTO
Dr. Benjamin Fraser	ANSTO	Dr. Katie Sizeland	ANSTO
Patricia Gadd	ANSTO	Dr. Gordon Thorogood	ANSTO
Prof. Mihail Ionescu	ANSTO	Dr. Alan Xu	ANSTO
Prof. Michael James	ANSTO	Atun Zawadzki	ANSTO
Dr. Mitchell Klenner	ANSTO		

AINSE Gold Medals

AINSE Gold Medals are awarded by the AINSE Council for excellence in research based on publications over the last five years which acknowledge AINSE support. In May 2020, AINSE Alumni Dr. Cynthia Isley and Dr. Gabriel Murphy were presented with AINSE Gold Medals in recognition of their outstanding research achievements.

Dr. Isley, Postdoctoral Research Fellow at Macquarie University and former AINSE Research Award Scholar, received a Gold Medal for her PhD research concerning the sources and health impacts of particle air pollutants in Suva, Fiji. As a direct result of this work, the Fijian government have funded ongoing air quality sampling to monitor the emissions identified from waste burning, diesel combustion, and other pollutant sources.

Dr. Gabriel Murphy, former AINSE PGRA Scholar and SAAFE Scholar now based at Forschungszentrum Jülich in Germany, completed his doctoral studies at the University of Sydney on the condensed matter chemistry of crystalline strontium oxide, a material with applications to fuel reprocessing in the nuclear fuel cycle. During this work, Dr. Murphy developed new techniques for *in-situ* studies of the reduction of uranium oxides.

AINSE President Ian Gentle and AINSE Managing Director Michelle Durant awarded the Gold Medals to Dr. Isley and Dr. Murphy at an online ceremony in the presence of invited family members, research collaborators, and AINSE Councillors.

At the General Meeting of AINSE in November 2020, members voted to award Stephanie Anna Florin from the University of Queensland with an AINSE Gold Medal for outstanding PhD research, and Prof. Neil Saintilan from Macquarie University with an AINSE Gold Medal for outstanding research.

AINSE Specialist Committees

The AINSE Managing Director is an ex-officio (non-voting) member of all Committees. Committees met in May, August and October. Committee members are listed, (c) indicates 'AINSE Councillor'.

Archaeology, Geosciences and Environmental Sciences Committee (AGES)

Dr Craig Sloss (Convenor)	Queensland University of Technology
A/Professor Paul Augustinus	The University of Auckland
Dr Dioni Cendon Sevilla	ANSTO
Dr Agathe Lise-Pronovost	La Trobe University
Dr Karina Meredith	ANSTO
Dr Lynda Petherick	Victoria University of Wellington
Dr Greg Skrzypek	The University of Western Australia

Biomedical Science and Biotechnology Committee (BBS)

Professor Elena Ivanova (Convenor)	Swinburne University of Technology
Dr Benjamin Blyth	Peter MacCallum Cancer Centre
Dr Ben Fraser	ANSTO
A/Professor Michael Hay	University of Auckland
Dr Ingo Koeper	Flinders University
Dr Guo Jun Liu	ANSTO
Dr Mark Tobin	ANSTO (Australian Synchrotron)

Materials Science and Engineering Committee (MSE)

Dr Ludovic Dumee (Convenor)	Deakin University
Dr Aleks Nikoloski (c)	Murdoch University
Dr Kirrily Rule	ANSTO
A/Professor Graham Saunders (c)	University of Waikato
Dr Anna Sokolva	ANSTO
Dr Victor Streltsov	University of Melbourne

Postgraduate Research Award (PGRA) Committee

Professor Bill Boyd (Convenor)	Southern Cross University
Dr Craig Sloss	Queensland University of Technology
Professor Elena Ivanova	Swinburne University of Technology
Dr Ludovic Dumee	Deakin University

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 2020

Contents

Your Directors present their report on AINSE Limited (AINSE) for the financial year ended 31 December 2020.

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
Ms Helen Liossis
Professor Roland De Marco
Ms Roslyn Hatton
Dr Suzanne Hollins
Professor Andrew Peele
Professor William Boyd
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, Industry, other member organisations and major nuclear science and associated facilities.

AINSE's short-term objectives are to:

- Offer Honours, 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
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Director's Report
For the Financial Year Ended 31 December 2020

STRATEGIC PLAN (2019 – 2023)

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 the nuclear science; engineering and related research fields 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. Facilitate research collaboration through networking and expanding opportunities nationally and internationally.

- Play a key role in supporting research collaboration and networking opportunities.
- Explore targeted international opportunities.

2. Create a large pipeline of skilled students/graduates by facilitating new opportunities for the next generation of students with an interest in nuclear science and engineering and related research fields.

- Support the next generation of students by facilitating new opportunities nationally and internationally.
- Work with Universities for continued improvement of existing programs and identify new opportunities to enhance learning for students.

3. Be a visible and respected brand with strong targeted global 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 and Industry partners.
- Effectively communicate AINSE's purpose to a wide range of different stakeholders.

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

- Liaise with local, national and international policy makers to influence and communicate future priorities.
- Manage and protect AINSE's information assets.

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

- Diversify AINSE's membership and stakeholder base, while recognising the importance of existing membership.
- Seek new opportunities for funding beyond AINSE's traditional sources.
- Develop links with the philanthropic community.

The Australian Institute of Nuclear Science and Engineering
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Director's Report
For the Financial Year Ended 31 December 2020

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.
38 years' experience in academia and scientific research and research management.
BSc (Hons), PhD, MRACI.

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

Helen Liossis – Independent Director.
Board member since January 2018.
Over 30 years' experience in senior finance roles (including Chief Operating Officer, Head of Corporate Strategy, Head of Investor Relations and other senior executive roles) and has led science research and innovation teams.
BBus (Accounting and Economics), MBA, CPA, GAICD.

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, and clean technology.
BSc, MSc, MBA (Exec), GAICD, FTSE, HonDUni (Swin)

Roland De Marco – University Representative Director.
Board Member since August 2018.
30 years' experience in CSIRO, academia, scientific research as well as research leadership, management, and governance.
BSc, MSc, PhD, FRACI, FQAAS, MEUAS

William Boyd – University Representative Director.
Board Member since August 2019.
39 years' experience as a university academic, research scholar and university lecturer, UK & Australia, with research activity also in SE Asia, New Zealand and Spain.
BSc(Hons), PhD, GradCertMgtComms, MEdLead(HE), DSc, GradCertHigherEd(TL)

Roslyn Hatton – ANSTO Representative Director.
Board Member representing ANSTO since December 2014.
Independent Board Member from August 2012 until September 2014.
27 years in public (ANAO) and private (Ernst & Young) sector audit and 8 years at the Commonwealth Bank in a financial accounting role.
Deputy Chief Financial Officer at ANSTO.
BComm (Accounting, finance and information systems) UNSW FCA.

The Australian Institute of Nuclear Science and Engineering
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Director's Report
For the Financial Year Ended 31 December 2020

Information on Directors continued

Suzanne Hollins – ANSTO Representative Director.
Board member since May 2018.
23 years' experience in scientific research and research management.
Head of Research at ANSTO.
BSc(Hons), PhD.

Andrew Peele – ANSTO Representative Director.
Board member since February 2018.
28 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), MAIP, FTSE.

The Australian Institute of Nuclear Science and Engineering
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Director's Report
For the Financial Year Ended 31 December 2020

Meetings of Directors

During the financial year, 8 meetings of directors were held. Attendances by each director were as follows:

	Number eligible to attend	Number attended
Professor Ian Gentle	8	8
Ms Michelle Durant	8	8
Ms Helen Liossis	8	8
Professor Roland De Marco	8	8
Ms Roslyn Hatton	8	8
Dr Suzanne Hollins	8	8
Professor Andrew Peele	8	7
Professor William Boyd	8	8
Dr Leonie Walsh	8	8

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 2020, the total amount that members of AINSE are liable to contribute if AINSE was wound up would be $500 (2019: $530).

Auditors Independence Declaration

The lead auditor's independence declaration for the year ended 31 December 2020 has been received and can be found on page 69 of the report.

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

Director Michelle Durant

Director Suzanne Hollins

Dated this 26th day of March 2021

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
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Auditor's Independence Declaration to the Directors
For the Financial Year Ended 31 December 2020

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 2020 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 26/3/2021

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 2020

	Note	2020 $	2019 $
Revenue	2	1,661,654	1,678,120
External grants	2	200,349	266,684
Cash Flow Boost (COVID-19 Government Support)	2	100,000	-
Other income	2	29,282	68,896
Total income		1,991,285	2,013,700
Employee benefits expense		(670,985)	(582,117)
Depreciation expense	3	(14,242)	(3,587)
Audit, legal and consultancy expense		(26,454)	(22,395)
AINSE Awards		(919,279)	(1,194,687)
Other expenses		(83,179)	(223,740)
Total Expenses		(1,714,139)	(2,026,526)
Surplus/(deficit) before income tax		**277,146**	**(12,826)**
Income tax expense		-	-
Surplus/(deficit) for the year		**277,146**	**(12,826)**

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
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Statement of Financial Position
As At 31 December 2020

	Note	2020 $	2019 $
ASSETS			
CURRENT ASSETS			
Cash and cash equivalents	4	4,311,732	3,643,339
Trade and other receivables	5	162,858	239,742
Other	6	20,655	60,674
TOTAL CURRENT ASSETS		4,495,245	3,943,755
NON-CURRENT ASSETS			
Property, plant & equipment	7	69,107	52,145
TOTAL NON-CURRENT ASSETS		69,107	52,145
TOTAL ASSETS		**4,564,352**	**3,995,900**
LIABILITIES			
CURRENT LIABILITIES			
Trade and other payables	8	1,057,762	782,051
Employees provisions	9	80,660	73,943
TOTAL CURRENT LIABILITIES		1,138,422	855,994
NON-CURRENT LIABILITIES			
Employees provisions	9	35,696	26,818
TOTAL NON-CURRENT LIABILITIES		35,696	26,818
TOTAL LIABILITIES		**1,174,118**	**882,812**
NET ASSETS		**3,390,234**	**3,113,088**
EQUITY			
Awards reserve	12	885,475	818,924
Accumulated surplus		2,504,759	2,294,164
TOTAL EQUITY		**3,390,234**	**3,113,088**

The Australian Institute of Nuclear Science and Engineering
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Statement of Changes in Equity
For the Financial Year Ended 31 December 2020

	Awards Reserve $	Accumulated Surplus $	Total $
Balance at 1 January 2019	736,769	2,389,145	3,125,914
Net surplus/(deficit) attributable to AINSE	-	(12,826)	(12,826)
Transfers to and from awards reserve	82,155	(82,155)	-
Balance at 31 December 2019	818,924	2,294,164	3,113,088
Net surplus/(deficit) attributable to AINSE	-	277,146	277,146
Transfers to and from awards reserve	66,551	(66,551)	-
Balance at 31 December 2020	885,475	2,504,759	3,390,234

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 2020

	2020 $	2019 $
CASH FLOWS FROM OPERATING ACTIVITIES		
Receipts from operations	1,935,733	1,826,600
Receipts from grants	610,748	526,075
Interest received	22,205	68,413
Award related payments	(1,003,753)	(1,157,597)
Payments to suppliers and employees	(874,427)	(1,077,433)
Net cash generated from operating activities	690,506	186,058
CASH FLOWS FROM INVESTING ACTIVITIES		
Proceeds from sale of property, plant and equipment	9,091	-
Payment for property, plant and equipment	(31,204)	(44,377)
Net cash used in investing activities	(22,113)	(44,377)
Net increase / decrease in cash held	668,393	141,681
Cash and cash equivalents at beginning of financial year	3,643,339	3,501,658
Cash and cash equivalents at end of financial year	4,311,732	3,643,339

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

AINSE applies the Australian Accounting Standards – Reduced Disclosure Requirements as set out in AASB 1053: Application of Tiers of Australian Accounting Standards and AASB 2010-2: Amendments to Australian Accounting Standards arising from Reduced Disclosure.

The financial statements are general purpose financial statements that have been prepared in accordance with Australian Accounting Standards – Reduced 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.

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 19 March 2021 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 2020

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 the entity 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, the Entity:

- 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. The Entity:

- 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, the entity 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.

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 2020

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 2020

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 entity'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.

Description of 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.

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 2020

	Note	2020 $	2019 $
Note 2 – Revenue and Other Income			
Revenue			
Payments from members		1,243,454	1,239,920
ANSTO promotion fee		418,200	438,200
		1,661,654	1,678,120
External grants	13	200,349	266,684
		1,862,003	1,944,804
Other income			
Conference registrations		-	-
Sponsorships		-	-
Interest received		20,191	65,951
Other income		9,091	2,945
Cash Flow Boost (COVID-19 Government Support)		100,000	-
		129,282	68,896
Total revenue and other income		1,991,285	2,013,700

Note 3 – Surplus for the Year

The surplus for the year has been determined after charging as expenses:

		2020 $	2019 $
Depreciation of property, plant and equipment		14,242	3,587
Bad and doubtful debts		-	-

		2020 $	2019 $
Note 4 – Cash and Cash Equivalents			
Cash at bank		4,310,732	3,642,339
Cash on hand		1,000	1,000
Total cash and cash equivalents		4,311,732	3,643,339
Note 5 – Trade and Other Receivables			
Trade receivables		45,825	87,617
Less: Provision for impairment		-	-
		45,825	87,617
Other receivables		117,033	152,125
Total trade and other receivables		162,858	239,742
Note 6 – Other Current Assets			
Accrued interest		1,566	3,581
Prepayments		19,089	57,093
Total other current assets		20,655	60,674

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 2020

	Note	2020 $	2019 $
Note 7 – Property, Plant and Equipment			
Plant and equipment – cost		22,319	17,300
Less: Accumulated depreciation		(11,007)	(8,792)
		11,312	8,508
Furniture and fittings – cost		58,547	32,362
Less: Accumulated depreciation		(18,377)	(10,850)
		40,170	21,512
Motor vehicles – cost		22,500	68,113
Less: Accumulated depreciation		(4,875)	(45,988)
		17,625	22,125
Total property, plant and equipment		69,107	52,145

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 2020	8,508	21,512	22,125	52,145
Additions	5,019	26,185	-	31,204
Depreciation	(2,215)	(7,527)	(4,500)	(14,242)
Balance at 31 December 2020	11,312	40,170	17,625	69,107

	Note	2020 $	2019 $
Note 8 – Trade and Other Payables			
Trade and other payables		10,156	40,519
Contract liabilities	13	1,035,818	732,759
Employees – accrued salary and wages		11,788	8,773
Total trade and other payables		1,057,762	782,051

	2020 $	2019 $
Note 9 – Employee Provisions		
CURRENT		
Annual leave	50,252	44,890
Long service leave	30,408	29,053
	80,660	73,943
NON-CURRENT		
Long service leave	35,696	26,818
	35,696	26,818
Total employee provisions	116,356	100,761

Note 10 – Key Management Personnel Compensation

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

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

	2020 $	2019 $
Key management personnel compensation	224,385	212,845

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.

	2020 $	2019 $
Note 12 – Awards Reserve		
Opening balance at 1 January	818,924	736,769
Transfer to and (from) awards reserve	66,551	82,155
Balance as at 31 December	885,475	818,924

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 2020

	2020 $	2019 $
Note 13 – External Grants		
GRANTS REVENUE		
New Fund	95,000	153,045
Continuing Residential Student Scholarship Funding	89,681	79,426
Women in STEM and Entrepreneurship (WISE)	1,000	10,000
Scholarship AINSE ANSTO French Embassy (SAAFE)	14,668	24,213
	200,349	266,684
Contract Liabilities		
New Fund	1,014,274	702,275
Scholarship AINSE ANSTO French Embassy (SAAFE)	21,544	30,484
	1,035,818	732,759

Note 14 – 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:

	2020 $	2019 $
Financial Assets		
Cash and cash equivalents	4,311,732	3,643,339
Trade and other receivables	162,858	239,742
Total financial assets	4,474,590	3,883,081
Financial Liabilities		
Trade & other payables	1,057,762	782,051
Total financial liabilities	1,057,762	782,051

Note 15 – Events after the Reporting Date

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

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 2020

Note 16 – COVID-19 Considerations

The Directors have considered the consequences of COVID-19 and other events and conditions, and it has determined that they do not create a material uncertainty that casts significant doubt upon the entity's ability to continue as a going concern.

The Directors are continuing to assess the ongoing impact of COVID-19 on the operations of the Entity. This includes reviewing ongoing budgets and cashflow forecasts, developing other strategies to maintain and enhance engagement with its members.

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 2020

The Directors of AINSE Limited (AINSE) declare that:

1. The financial statements and notes, as set out on pages 70 to 84 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 – Reduced Disclosure Requirements, and

   (b) give a true and fair view of the financial position as at 31 December 2020 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 Suzanne Hollins

Dated this 26th day of March 2021

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 2020

Audit Opinion

Opinion

We have audited the financial report of AINSE Limited (AINSE), which comprises the statement of financial position as at 31 December 2020, 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.*

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 2020 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 2020

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 26/3/2021

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 2020

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 management.

- Conclude on the appropriateness of management's 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.

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 2020

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 2020.

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 26/3/2021

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 2020

		2020 $		2019 $
Operating Revenue				
Payments from Members		1,243,454		1,239,920
ANSTO Promotion Fee		418,200		438,200
External Grants		200,349		266,684
Interest Received		20,191		65,951
Cash Flow Boost (COVID-19 Government Support)		100,000		-
Other Income		9,091		2,945
Total Operating Revenue		1,991,285		2,013,700
Operating Expenses				
Wages & Salaries		552,637		453,972
Superannuation		82,395		65,557
AINSE Awards				
Postgraduate Awards				
ANSTO Facility Consumables	4,199		2,500	
Travel & Accommodation	51,475		159,996	
Stipends	823,494		754,374	
		879,168		916,870
Research Awards				
AINSE Supported Facility	-		2,475	
Early Career Researcher Grant	30,000		100,000	
		30,000		102,475
Conference Support		3,335		33,016
Events and Schools		10,111		175,342
Publication & Promotions		8,693		15,369
Meetings & Committees		1,182		81,214
AINSE Secretariat				
Administration & Staff Training	7,908		8,664	
Audit Fees	22,726		22,395	
Bank Charges	197		(85)	
Books & Software	5,061		5,137	
Contractors – Office Staff	35,953		62,588	
Credit Card Expense	130		31	
Depreciation	14,242		3,587	
Entertaining	-		619	
FBT Expense & Payments	2,121		3,224	
Insurance	15,520		7,839	
Legal expense	3,728		-	
Miscellaneous	29,388		31,639	

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 2020

		2020 $		2019 $
Office Supplies	1,783		7,119	
Postage & Telephone	3,242		1,003	
Staff Recruitment	312		2,294	
Travel & Accommodation	290		12,497	
Vehicle Expenses	4,017		14,160	
		146,618		182,711
Total Operating Expenses		1,714,139		2,026,526
Surplus/(deficit) for the Year		277,146		(12,826)

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

Student funding opportunities in 2021:

AINSE Honours Scholarships
A stipend of A$5,000 to support Honours (or Honours-equivalent) students who are undertaking research at ANSTO or processing data collected from ANSTO facilities.
Applications open: 1 December 2020 – 15 March 2021

Postgraduate Research Awards (PGRA)
Up to A$8,250 per annum awarded as a top-up stipend for PhD students undertaking research associated with nuclear science and its applications. Also includes fully-funded travel and accommodation to access ANSTO's research facilities.
Applications open: 1 February 2021 – 15 April 2021

Residential Student Scholarship (RSS)
A top-up scholarship for students spending an extensive amount of their PhD time at ANSTO facilities. Up to A$7,500 stipend and A$5,000 travel support per annum.
Applications open: 15 April 2021 – 31 May 2021

Early Career Researcher Grant (ECRG)
A grant of A$10,000 to support Early-Career Researchers who are in the first five years of their postdoctoral career and are working in collaboration with ANSTO.
Applications open: 1 May 2021 – 31 July 2021.

Scholarship AINSE ANSTO French Embassy (SAAFE)
Funding to support Early Career Researchers at PhD and postdoctoral levels to travel from Australia to France - and from France to Australia - to initiate sustainable research networks to to foster research collaborations between France and Australia in nuclear science and engineering.

Applications open: 1 May 2021

Conference Travel Support
For student travel to domestic or international conferences where the student will present AINSE-supported research
Applications open: year-round

AINSE Events Calendar for 2021:

25th AINSE Winter School (July 5-9)

For senior undergraduate STEM students.

Go hands-on with Australian landmark research infrastructure, guided by leading ANSTO researchers, at an intensive week-long Winter School at ANSTO's Sydney campus. Due to COVID-19, this will be an online-only event in 2021.

Nominations received:1 March 2021 – 31 May 2021.

AINSE Postgraduate Orientation Week (Nuclear Science Week, October)

For AINSE honours & postgraduate scholarship recipients.

Network with fellow early-career researchers from across Australia and New Zealand, meet your project co-supervisors and take general and site-specific tours of the facilities at ANSTO's Sydney campus. Flights, meals and accommodation included. Due to COVID-19, this will be an online-only event in 2021

Open to all Honours, PGRA, RSS and SAAFE recipients.

5th AINSE Women in STEM and Entrepreneurship (WISE) School (November 30–December 3)

For first-year female undergraduate STEM students.

Travel to ANSTO's Sydney campus to meet established researchers and entrpreneurs, network with fellow first-year students from across Australia and New Zealand, and engage in a year-long mentorship program with AINSE and ANSTO staff. Flights, meals and accommodation included. Due to COVID-19, this will be an online-only event in 2021.

Nominations received: 1 August 2021 – 15 October 2021.

Visit ainse.edu.au to see other AINSE-supported events and conferences in 2021.

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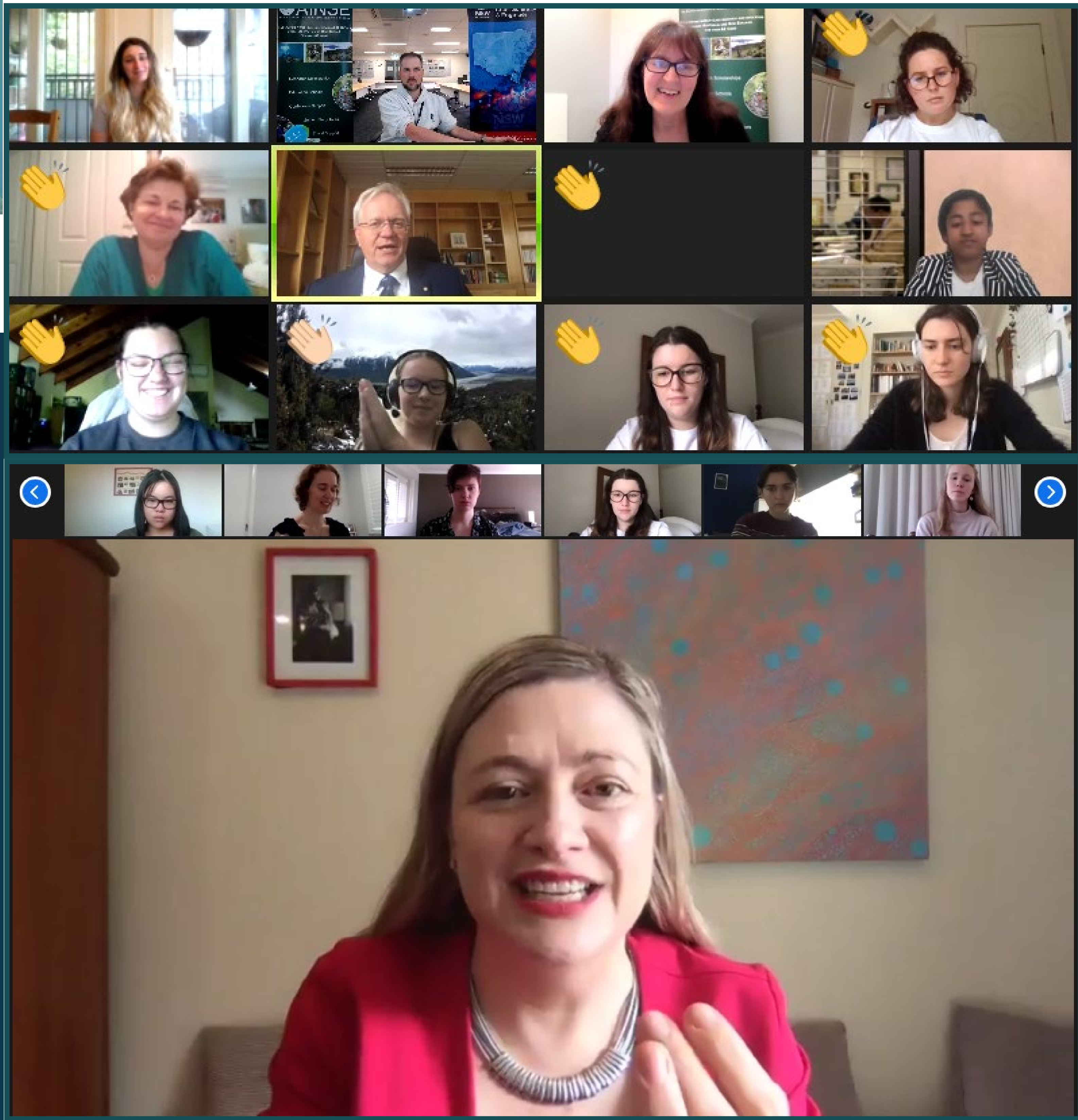
ABN 18 133 225 331



WISE School

Women in STEM and Entrepreneurship

Inspiring and supporting the next generation of female leaders in STEM

In the first week of December 2020, 57 students from 27 AINSE member universities across Australia and New Zealand connected online with a host of remarkable STEM leaders at the fourth annual AINSE Women in STEM and Entrepreneurship (WISE) School.

AINSE received funding support from ANSTO and the Office of the NSW Chief Scientist & Engineer to host the online 2020 WISE School, which focuses on Women in STEM and their career opportunities in STEM generally, and within nuclear science and engineering in particular. Due to the COVID-19 pandemic, the 2020 WISE School was run as an entirely-online event.

The WISE School opened on December 1 with a unique Acknowledgement of Country by ANSTO's Brett Rowling who, alongside AINSE Managing Director Michelle Durant, shared a brief overview of over 60,000 years of research in Australia and on the lands that now host ANSTO's three campuses. Michelle Durant then formally opened the School, speaking briefly about her career experiences and sharing an overview of AINSE and the invaluable opportunities it provides to postgraduate students and early-career researchers.

"Hearing about the inspiring journeys ...helped me feel seen as a woman in STEM, and I feel more empowered to make myself visible and pave the way for change." - 2020 WISE Student

The 2020 WISE cohort spent three days engaging with a diverse group of role-model scientists, engineers and distinguished guests, participating in panel discussions with the 2019 WISE students and representatives from the nandin Innovation Centre, and networking with their new mentors from ANSTO and AINSE. Students were also taken on a virtual tour of ANSTO's landmark research facilities by the ANSTO Discovery Centre, presenting them with a behind-the-scenes look at the OPAL Multipurpose Reactor, Australian Synchrotron, Australian Centre for Neutron Scattering, and Centre for Accelerator Science.

Throughout the WISE School, a diverse group of guest speakers shared personal stories and lessons learned on their own career paths from first-year undergraduates to recognised leaders in STEM and Entrepreneurship, providing students with invaluable insights into overcoming a diverse range of personal and academic challenges that can occur on the path to success. Keynote speakers included Kylie Walker, Chief Executive Officer of the Australian Academy of Technology and Engineering, Prof. Tanya Monro, Australia's Chief Defence Scientist, and Prof. Brian P. Schmidt, Australia's Nobel Laureate and Vice Chancellor and President of the Australian National University.

p.93, above: Nobel Laureate Prof. Brian P. Schmidt addressing the WISE cohort and staff from AINSE and ANSTO regarding his ongoing career journey from undergraduate student to Nobel Prize winner and beyond; below: Australia's Chief Defence Scientist Prof. Tanya Monro presenting her journey in STEM to the 2020 WISE cohort via videoconference.

Other outstanding speakers who shared their personal stories with the 2020 WISE students included Lt Col. Jasmin Diab, Dr. Liz Allen, Laureate Prof. Veena Sahajwalla, A/Prof. Sophie Primig, Dr. Katie Sizeland, Katrina Van de Ven, Prof. Anna Paradowska, Gina Pearse, Lisa Stojanovski, Science Communicator; Dr. Anna Lintern, and Dr. James Christian.

In addition, students were able to engage with a panel of representatives from ANSTO's nandin Innovation Centre to receive excellent entrepreneurial advice from experts Prof. Tim Boyle, Founder and Executive of nandin, ShanShan Wang, CEO and Industrial Designer at Roam Technologies, and Jay Flack, Founder and CEO of Hyron Scientific.

On the final day, students connected with their mentors from AINSE and ANSTO in an online networking event and discussion forum that launched the year-long WISE Mentorship Program. Students will continue to receive guidance and support from their mentors throughout 2021 through a number of online videoconferencing sessions interspersed with a series of regular online discussion topics.

The WISE Mentorship Program is the cornerstone of the AINSE WISE School, allowing the next generation of Women in STEM to connect with established leaders at ANSTO and AINSE, and with past WISE alumni. AINSE are grateful to the 37 staff members who generously volunteered their time to mentor the WISE students and share their expertise regarding STEM career opportunities, and strategies to overcome the challenges that may be encountered on the road from undergraduate studies to an established STEM or entrepreneurial career.

AINSE would also like to extend our gratitude to all our guest speakers for their key efforts in making the 2020 WISE School a success, and thank both ANSTO and the Office of the NSW Chief Scientist & Engineer for their funding support. We look forward to hearing from our 2020 WISE students as their own career journeys continue.

Kylie Walker, CEO of the Australian Academy of Technology and Engineering, addresses the 2020 WISE cohort.

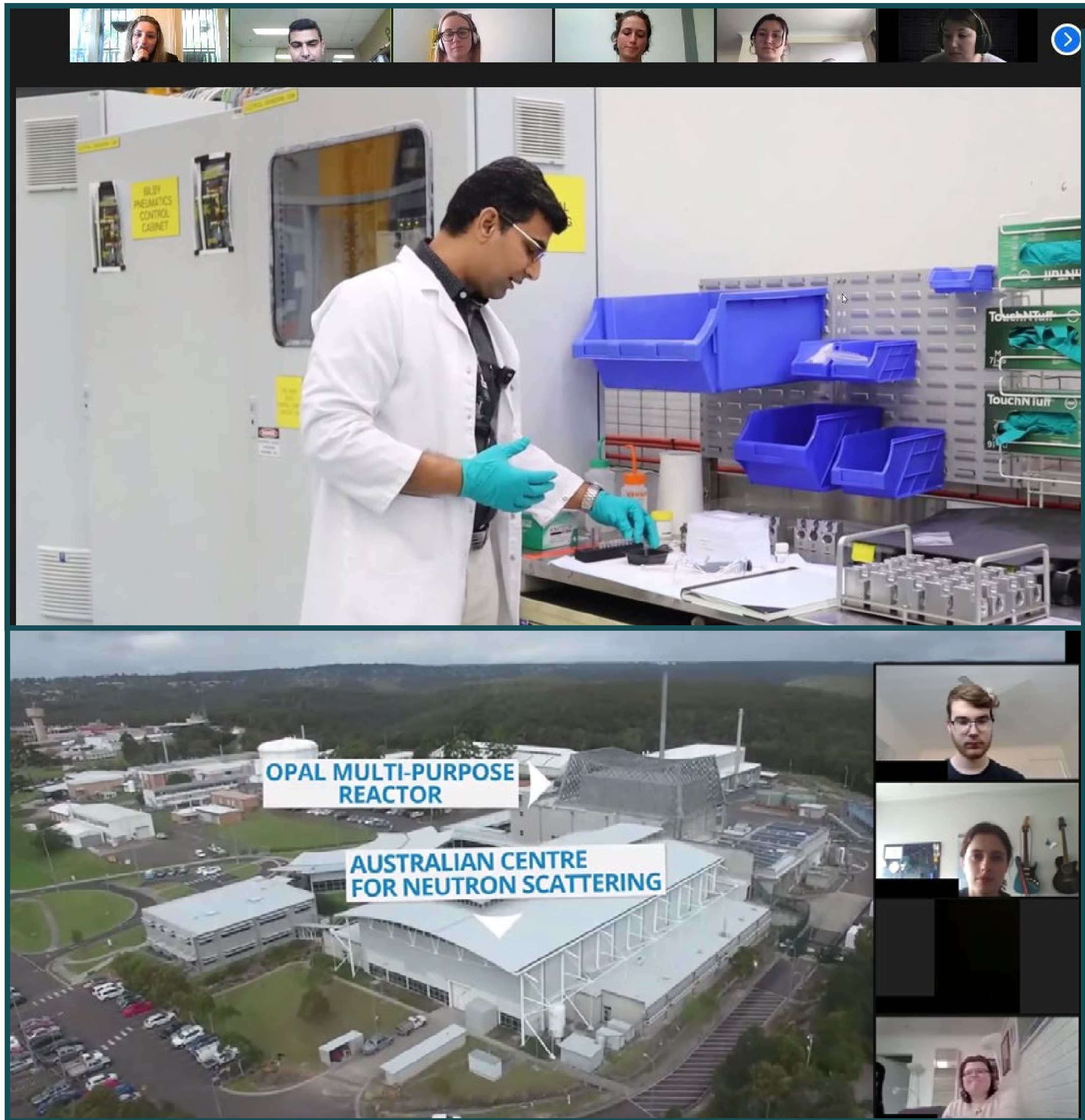
2020 AINSE WISE School Students

Keeleigh Amor	QUT
Eleny Asmare	SWI
Holly Baldock	ADE
Hayley Bandera	QUT
Ellie Bickerton	FLI
Emma Bond	UWA
Madeleine Brooks	CSU
Madeleine Buist	UNE
Laura Café	SYD
Catherine Cheng	NSW
Charmaine Chin	UWA
Natalie Cierpisz	MEL
Alexandrya Clarkson	CAN
Victoria Streeton-Cook	MEL
Lucy Davidson	OTA
Marissa Ellis	ANU
Georgia Esselbach	FLI
Katie Fisher	UNE
Clare Flaherty	ADE
Georgia Gruszewski	DEA
Madison Hall	ANU
Mojgan Hemmati	QUT
Jemma Henneveld	CAN
Melissa Hunt	SCU
Rose Irving	SWI
Barbara Ives	FED
Nia Jones	SWI
Padma Krishnakumar	MUR
Varisara Laosuksri	NSW
Emilia Larkey	JAM
Aimee Lew	AKL
Jessica Longbottom	USA
Linda Losurdo	SYD
Ishika Mahajan	USA
Katrina Marshall	SYD
Grace McNaughton	DEA
Arwen Nugteren	QLD
Taru Panjikar	MON
Maddy Parks	ADE
Paris Pauling	FLI
Robyn Pearce	JAM
Safa Rashid	SYD
Alys Rook	CAN
Vishvi Senerath	FED
Emily Shaw	VIC
Angie Shearman	SCU
Bronwyn Smith	USC
Rachel Stosic	UWS
Sarah Sutcliffe	CDU
Louisa Tedesco	ADE
Natalya Ward	SWI
Anneliese Wild	SCU
Courtney Lara Wilson	CAN
Vivian Wong	MON
Nancy Xu	QLD
Sophie Young	TAS
Carmen Zhou	NSW

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:

Aerospace Engineering	1
Arts	1
Biology	1
Biomedical Science	8
Chemical Engineering	5
Chemistry	7
Civil Engineering	1
Computer Science	1
Dental Science	1
Design	1
Electrical Engineering	2
Engineering	6
Environmental Science	5
Forensic Science	1
Genetics	1
Geology	5
Health Science	2
Law	2
Marine Biology	1
Materials Science	1
Mathematics	5
Nanotechnology	1
Pharmaceutical Science	1
Physics	9
Physiology and Neuroscience	1



Winter School

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

Since 1997, the annual AINSE Winter School has provided senior undergraduate students across Australia and New Zealand with a connection to both ANSTO researchers and Honours and postgraduate research opportunities at ANSTO.

The 24th AINSE Winter School, held during the week of Monday 6th July, saw a record 80 students from 34 AINSE member institutions participate. Due to the COVID-19 pandemic, the 2020 Winter School was run as an entirely-online event for the first time in the school's history.

"This experience makes me want to broaden my field. I never really knew that nuclear science is so diverse and interesting!" - 2020 Winter School Student

On Monday 6th July, students had the opportunity to join the ANSTO Discovery Centre for a virtual tour of ANSTO's unique facilities, including the OPAL multipurpose reactor at Lucas Heights. Students were able to view footage of the reactor in operation while the Discovery Centre team explained precisely how the neutrons produced in OPAL were used to create medical radioisotopes, produce high-quality doped silicon, and deliver neutron beams for use in research across a multitude of scientific fields.

The Winter School was officially opened by AINSE Managing Director Michelle Durant on the morning of Tuesday 7th July, with students joining the school online via the Zoom videoconferencing platform. ANSTO experimental officer Brett Rowling delivered an informative Acknowledgement of Country that provided a history of Australian science over the past tens of thousands of years on the lands around ANSTO campuses.

After the opening, Dr. Simone Richter, Group Executive of ANSTO's Nuclear Science & Technology and Landmark Infrastructure (NSTLI), presented students with an overview of NSTLI platforms and research activities. Students then engaged with ANSTO researchers and research theme leaders through a series of interactive presentations and panel discussions. Over the course of the day, these sessions provided deeper insights into ANSTO's research activities in the Environment, Human Health and Nuclear Fuel Cycle research themes, and the capabilities of the unique research infrastructure supporting these activities. The day concluded with an online social evening to provide students with an opportunity for networking with their like-minded peers across two countries.

The interactive ANSTO Facility Sessions —the central activities of the Winter School—ran throughout Wednesday 8th and Thursday 9th July. These sessions, delivered by ANSTO researchers working within each facility, gave students a unique behind-the-scenes perspective of the research facilities they had learned about on the previous day, including the Australian Synchrotron, Australian Centre for Neutron Scattering, Centre for Accelerator Science, Isotope Tracing in Natural Systems laboratories, and Nuclear Materials and Electron Microscopy laboratories. Students also had the opportunity to hear from representatives from the Women in Nuclear (WiN) Australia Chapter and the Australian Young Generation in Nuclear (AusYGN).

The final evening of the Winter School was devoted to the online Research Roundup Networking Event, which gave students the opportunity to connect with established ANSTO researchers through four rotating sessions, of over 20 simultaneous online meetings , in order to ask detailed questions about ongoing research projects at ANSTO in a small-group setting. The connections formed over the course of the evening have already led to planned collaborations between ANSTO researchers and Winter School students on their Honours and postgraduate research projects, and we look forward to seeing many more collaborations arise out of this evening in the future.

Following this networking event, the Winter School was closed by AINSE president Prof. Ian Gentle and ANSTO CEO Dr. Adi Paterson, who delivered an inspiring address on the need for students to develop professional networks and "embrace the new" as they began their research careers.

AINSE would like to thank all the ANSTO speakers, Facility Session organisers and Research Roundup participants for their key role in making the first online Winter School a success, and we hope to see participating students back at ANSTO for their research projects in the coming years.

p.97, above: Dr. Jitendra Mata, instrument scientist at ANSTO's Australian Centre for Neutron Scattering, leading a virtual facility session for the 2020 Winter School cohort; below: Students undertaking a virtual tour of the OPAL multipurpose reactor and Australian Centre for Neutron Scattering, courtesy of the ANSTO Discovery Centre.

AINSE President Prof. Ian Gentle (2nd row, 2nd column), AINSE Managing Director Michelle Durant (2nd row, 4th column), and ANSTO CEO Dr. Adi Paterson (2nd row, 5th column) address the 2020 Winter School cohort at the close of the online Winter School.

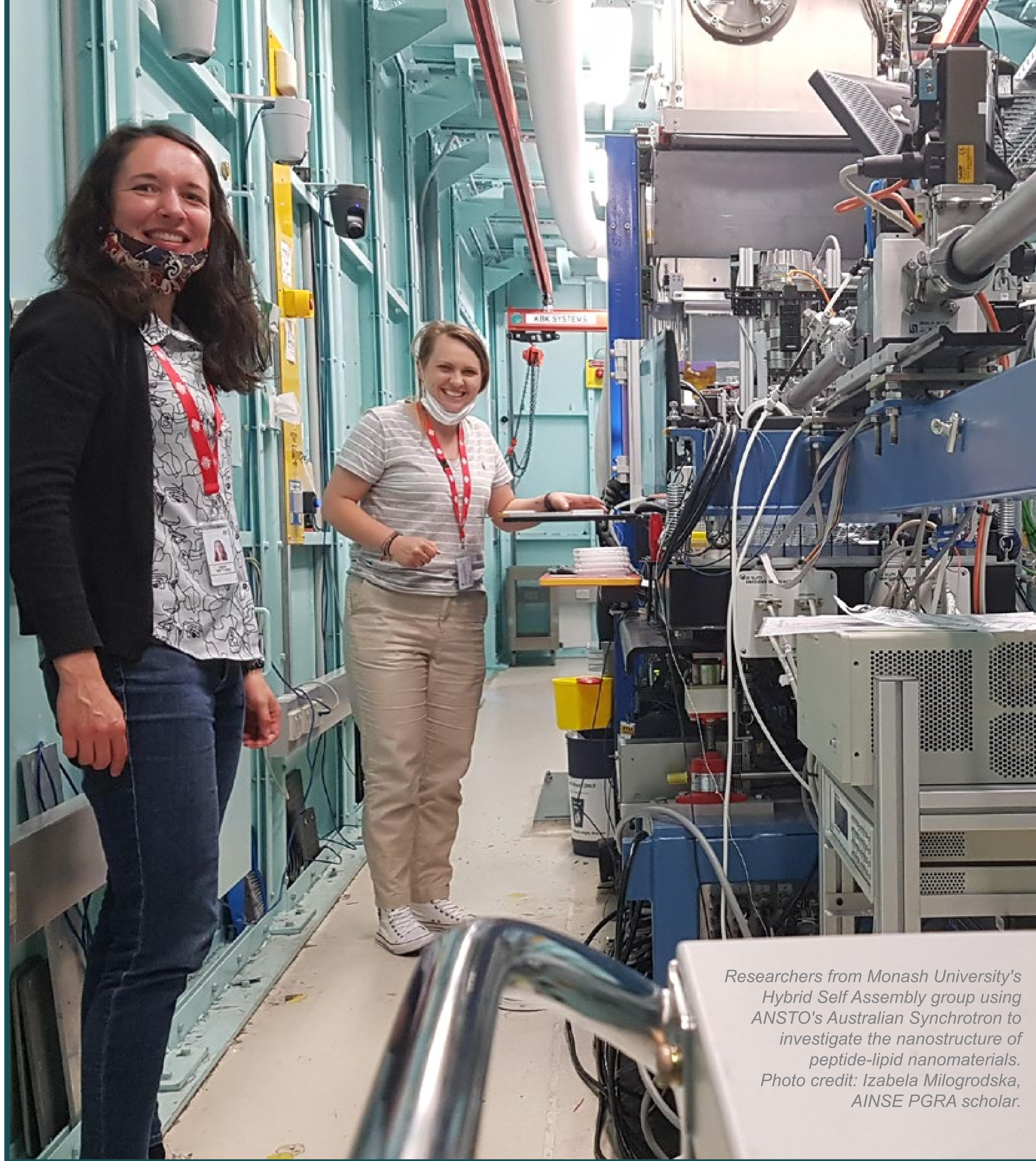
2020 AINSE Winter School Students

Eve Aitken	OTA	Abigail Mann	FLI
Leigha Aitken	SCU	Jaydon Meilak	SWI
Shadab Ali	CUR	Allan Mentor	RMI
Matthew Archer	FED	Kayla Mitrevski	WOL
Jade Audino	MUR	Sarah Morgan	JAM
Mitchell Barclay	QUT	Jack Murphy	ANU
Lewis Batic	JAM	Duc Duy Nguyen	UWS
Talia Bond	GRI	Alma Nicolau	TAS
Joel Bousfield	USA	Timothy Nisbet	NCT
Maria Box	JAM	Thomas Pace	UWS
Dominic Brown	MEL	Samuel Pattinson	CAN
Annabelle Carrington	WAI	John Pene	UWS
Nathan Chow	MON	Rachel Phelan	QLD
Keira Chrystal	MAC	Elsie (Elso) Pieterse	UNE
Adam Corrie	RMI	Aden Priest	ADE
Jacob Coyle	USC	Paarangat Pushkarna	MEL
Alice Dee	OTA	Abirrhami Rajagopal	AKL
Ella Dewilde	QUT	Josh Reid	QLD
Anna Douglas	NSW	Dane Rhook	SYD
Lucinda Duxbury	ADE	Simon Robson	SYD
Tian Lin Fong	AKL	Katherine Rosenthal	QLD
Klyie (Kelly) Foo	USA	Georgina Ryan	MEL
Zac Van Gemert	CSI	Perri-Ann Schmitt	CUR
Michael Greif	CUR	Benjamin Shaw	QUT
Annahlise Hall	AKL	Caitlin Smith	AKL
Jess Hay	DEA	Daniel Smith	SWI
Yi He	ADE	Thiruchenduran Somasundaram	DEA
Selina Ho	QUT	Jamie Steel	CAN
Owen Horoch	MUR	Harrison Stevens	TAS
Ainee Ibrahim	CUR	Samantha Stojanovski	UWS
Joseph Johnson	USC	Roy Styles	RMI
Alicia Jopson	MAS	Tarik Tasci	RMI
Suzannah Keene	SYD	Raya Tasnim	NSW
Samuel Keller	UWA	Nathan Taylor	USA
Gulafsha Khan	CAN	Kirsten Thomas	SYD
Kushagra Khare	VAC/MON	Jakob Valk	ADE
Nguyen Duc Le	DEA	Emily Vukovic	SWI
Corey Lehmann	QLD	Angus Weekes	QUT
Cherina Lugtu	CAN	Fan Yang	MEL
Jonathon Lumley	UWA	Kai-Senn Yee	MAC

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	2
Biochemistry	3
Chemical and Materials Engineering	2
Chemistry	11
Civil Engineering	5
Engineering	2
Environmental Science	2
Geology	3
Medical Science	2
Physics	15



Researchers from Monash University's Hybrid Self Assembly group using ANSTO's Australian Synchrotron to investigate the nanostructure of peptide-lipid nanomaterials. Photo credit: Izabela Milogrodska, AINSE PGRA scholar.

Honours Scholarships

In 2020, AINSE continued its Honours program that first commenced in 2011. This program provides scholarships to a small number of excellent honours students who have a project that utilises the research facilities at ANSTO.

AINSE Honours 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 twenty-four successful students representing twelve universities who were awarded an Honours Scholarship in 2020.

Honours students supported in 2020: **24**

Students supported through an AINSE Honours Scholarship since 2011: **203**

Honours Scholars, and Their Projects, awarded in 2020:

Development of titanate glass-ceramics for actinide immobilization—*in situ* structural and spectroscopic studies.
Aurpa Bhuiyan, The University of New South Wales.

Shape-shifting ligands for supramolecular nanocages.
Andre Birve, The University of Adelaide.

Automated liquid nitrogen supply management system.
Archana Bulathsinghala, Macquarie University.

The structural characterisation of NLR and effector protein pairs using a novel *Escherichia coli* expression system.
Emma Crean, The Australian National University.

Companion PET imaging agents for Neutron Capture Enhanced Particle Therapy.
Valerio Falasca, The University of Western Australia.

Trophic ecology of the invasive freshwater crayfish, *Cherax destructor*, inferred by stable isotope analysis.
Rosie Gray, University of Wollongong.

Neuroinflammation induced by chemotherapy and radiation exposure.
Vivien Heng, The University of Adelaide.

Radiation-induced damage of C/C composite and graphite.
Guangyu Hu, The University of New South Wales.

Spin crossover kagome framework materials.
Lisa Hua, The University of New South Wales.

Experimental quantification of prompt gamma emission in carbon and helium ion therapy.
Marissa Kielly, University of Wollongong.

Functional consequences of radiation impact on glymphatic pathways within the brain.
Cassandra Leith, Macquarie University.

Performance of industrial hemp (*Cannabis sativa L.*) in mixed-wasteorganic-outputs (MWOO) as capping substrate for lead rich mine tailings.
Jack Livingstone, University of Canberra.

Unearthing Australia's climate history: Sampling and radiocarbon dating subfossil Tasmanian huon trees.
Priyadarshini Parsons O'Brien, The University of New South Wales.

The development of a representative sampling protocol for prehistoric middens on the windward coastline of Moloka'i Island, Hawai'i: Implications for understanding marine subsistence studies.
Rachel Phelan, The University of Queensland.

Tales of a changing climate from speleothem fabrics.
Nicole Pierce, The University of Newcastle.

Group II mediated benzene formylation.
Georgia Richardson, Victoria University of Wellington.

How the fires roared: Interpreting fire activities from the spectral analysis and micro-context of burnt bone in Pleistocene Australia.
Nikola Ristovski, The University of Western Australia.

Have fuel-loads increased in Australia in response to the British Invasion: a case study from Tasmania.
Ellie-Rose Rogers, The University of Melbourne.

One-pot incorporation of radioiodine and responsive drug linkers into porous silicon nanoparticles: Combining therapy and diagnostics.
Peije Russell, Monash University.

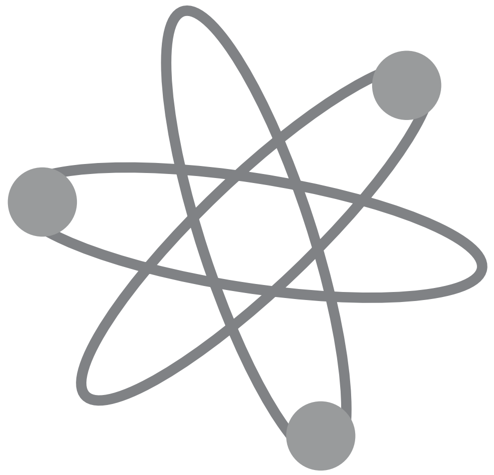
Enhancing radiosensitivity in tumours through inhibiting formation of the protective outer layer of cell surface carbohydrates.
Harrison Steele, University of Wollongong.

Mechanical behavior and fracture behavior of reinforced carbon-carbon (C/C) composite.
Joshua Townsend, The University of New South Wales.

Phytotoxic response of seagrass species, *Zostera capricorni*, to aluminium.
Holly Trim, The University of New South Wales.

Neutron tomography analysis for carbon dioxide thermal batteries in a fluidised bed reactor.
Liam Turner, Curtin University.

Development of hybrid inorganic-organic lithium adsorbent for lithium mining applications.
Riley Williams, The University of New South Wales.



Rebecca Duncan holding a typical ice core after extracting ice algae in Van Mijenfjorden, Svalbard. Rebecca's postgraduate research project is using FTIR microspectroscopy at ANSTO's Australian Synchrotron to investigate the impact of projected climate change effects and sea ice decline in the Artic on the nutrional content of dominant sea ice algal species.
Photo credit: Rebecca Duncan, AINSE PGRA scholar.

PGRA Scholarships

Postgraduate Research Award

PGRA students supported in 2020: **107**

New PGRA students in 2020: **42**

Students trained in nuclear science and related fields under an AINSE PGRA: **491**

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 (AGRTP or RTP) or equivalent scholarship. The PGRA may be held until the expiry of the primary scholarship.

In addition to providing a student with a stipend of A$7,500 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 one month's accommodation to Lucas Heights per annum is also awarded.

Forty-two new AINSE postgraduate research projects were supported by a PGRA in 2020. The total number of scholars supported in 2020 was one-hundred-and-seven. AINSE received notification of twenty-nine theses this year and, through its PGRA program, has now helped train four hundred and ninety-four 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 Council believes that one of the most valuable roles fulfilled by AINSE is the provision of these scholarships.

ANSTO's OPAL Multipurpose Reactor at Lucas Heights, Sydney. Photo credit: ANSTO.

PhD Theses of Postgraduate Scholars Notified during 2020:

Hydrologic and isotopic lake modelling for Palaeoclimate research.

Martin Ankor, School of Chemical and Physical Sciences, The University of Adelaide.
Commenced 01/07/2015.

Sedimentology and environmental history of Holocene lakes on Rottnest Island, Western Australia.

Karl Bischoff, School of Earth Sciences, The University of Western Australia.
Commenced 01/07/2017.

The effect of geometric constraints in multiferroic heterostructures.

Stuart Burns, School of Materials Science and Engineering, The University of New South Wales.
Commenced 01/07/2016.

Development of solid state microdosimetric tools for quality assurance in proton and heavy ion therapy.

Lachlan Chartier, Centre for Medical Radiation Physics, University of Wollongong.
Commenced 01/07/2016.

Low melting point salts as lubricants and lubricant additives.

Peter Cooper, School of Engineering, The University of Western Australia.
Commenced 01/07/2017.

Mechanistic studies of MLKL mediated cell death.

Katherine Davies, Department of Medical Biology, The University of Melbourne.
Commenced 01/07/2017.

Environmental change recorded in physical and geochemical proxies over the Last Glacial Cycle from two Northland, New Zealand dune lakes: Lake Kanono and Lake Kai Iwi.

Gianna Evans, School of Environment, The University of Auckland.
Commenced 01/07/2015.

The significance of dissolved organic carbon (DOC) to deep soil carbon storage.

Rubeca Fancy, School of Environmental & Rural Science, University of New Englan.
Commenced 01/07/2016.

Radiocarbon Dating of Kimberley Rock Art.

Damien Finch, School of Earth Sciences, The University of Melbourne.
Commenced 01/07/2016.

The gold standard; Enhancing antibiotic effectiveness through gold nanoparticles.

Melanie Fuller, School of Chemical and Physical Sciences, Flinders University.
Commenced 01/07/2016.

Late Quaternary Southern Hemisphere westerly wind variability in the mid-to high-latitude southwest Pacific.

Greer Gilmer, Geological Sciences, University of Otago.
Commenced 01/07/2015.

Biological effects of nickel on tropical marine biota to underpin the development of water quality guidelines for metals.

Francesca Gissi, School of Chemistry, University of Wollongong / CSIRO
Commenced 01/07/2016.

Neutron strain tomography.

Alexander Gregg, School of Engineering, The University of Newcastle
Commenced 01/07/2017.

Teaching old molecules new tricks: Repurposing investigational drugs as chemical probes.

James Hill, Institute for Molecular Bioscience, The University of Queensland.
Commenced 01/07/2018.

Investigation of spin and charge order in ferrite spinels by synchrotron x-ray and neutron diffraction.

Yousef Kareri, School of Physics, The University of New South Wales.
Commenced 01/07/2017.

Nanoplastics and protein corona - Investigating the corona structure and their biological impacts.

Shinji Kihara, School of Chemical Sciences, The University of Auckland.
Commenced 01/07/2018.

A novel radiofluorination method for the design of Rhenium(I) PET-Optical hybrid nuclear medicines.

Mitchell Klenner, School of Molecular and Life Sciences, Curtin University.
Commenced 01/07/2015.

Nanoparticles and liquid crystals: The effects of size, shape, shear, surface chemistry, temperature, and concentration on structure and rheology.

Joshua Marlow, School of Chemistry, Monash University.
Commenced 01/07/2018.

Nanoarchitectured point-of-care detection system for clinically relevant biomarkers.

Mostafa Kamal Masud, Institute for Superconducting & Electronic Materials, The University of Queensland.
Commenced 01/07/2018.

Precipitation mechanisms in an Al-Cu-Li alloy with Sc and Zr modification.

Anne Katrin Mester, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2017.

The effects of floods on estuarine fisheries and food webs.

Kaitlyn O'Mara, Australian Rivers Institute, Griffith University.
Commenced 01/07/2016.

Speleothem-based palaeo-climate research-methodology, applications, and insight from the Snowy Mountains, southeast Australia.

Leonie Peti, School of Earth and Environment, The University of Western Australia.
Commenced 01/07/2015.

Fire and environmental change in Northern Australian Savannas during the Holocene.

Emma Rehn, College of Science and Engineering, James Cook University.
Commenced 01/07/2017.

Functional ecology of calcrete aquifers in arid zone Western Australia.

Mattia Saccò, School of Earth and Planetary Sciences, Curtin University.
Commenced 01/07/2017.

Causes and consequences of a massive mangrove dieback event in the Gulf of Carpentaria, Australia.

James Sippo, Centre for Coastal Biogeochemistry, Southern Cross University.
Commenced 01/07/2016.

New manufacturing methods for advanced lithium ion battery anode materials.

Xin Fu Tan, School of Mechanical and Mining Engineering, The University of Queensland.
Commenced 01/07/2019.

Tumour copper levels regulate PD-L1 driven immune evasion.

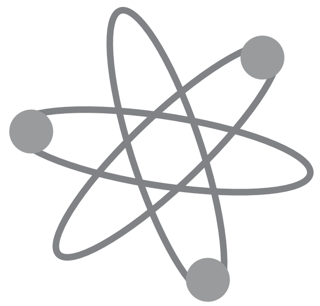
Florida Voli, School of Women's and Children's Health, The University of New South Wales.
Commenced 01/07/2018.

Iron isotope geochemistry and crystal chemistry ofjarosite in acidic, sulfate–rich environments.

Anne Whitworth, School of Earth, Atmosphere and Environment, Monash University.
Commenced 01/07/2018.

Electrostatic effects on chemical reactivity: Oriented double layer effects on chemical bonding kinetics and thermodynamics.

Long Zhang, Intelligent Polymer Research Institute, University of Wollongong.
Commenced 01/07/2016.



Research Highlights:

Katherine Davies - p.28

Understanding the mechanics of programmed cell death.

Alexander Gregg - p.39

Bragg-edge neutron strain tomography.

Shinji Kihara - p.46

Nanoplastic toxicology at the interface.

Joshua Marlow - p.52

Nanoparticles and liquid crystals: the effects of different variables on structure and rheology.

Mattia Saccò - p.21

Elucidating carbon sources and food web interactions in groundwater ecosystems

Postgraduate Scholars, and Their Projects, supported in 2020:

In vivo chemical characterisation of the beneficial vs toxic forms of selenium in the diet using synchrotron imaging technology.
Jake Andersen, School of Physical Sciences, The University of Adelaide.
Commenced 01/07/2020.

Unravelling foliar phosphate nanoparticle uptake in cereal crops using nuclear techniques.
Maja Arsic, Future Industries Institute, University of South Australia.
Commenced 01/07/2019.

Environmental and climatic change on the Great Barrier Reef over millennial to centennial time scales.
Ariella Arzey, School of Earth, Atmoshperic, and Life Sciences, University of Wollongong.
Commenced 01/07/2020.

Towards low-energy electronics: Ion beam implantation into the surface of topological insulators.
Abuduliken Bake, Australian Institute for Innovative Materials, University of Wollongong..
Commenced 01/07/2020.

Controlling digestion kinetics through food microstructure design.
Meltem Bayrak, School of Science, RMIT University.
Commenced 01/07/2019.

The impact of ionizing radiation on the central nervous system.
Calina Betlazar-Maseh, Faculty of Health Sciences, The University of Sydney.
Commenced 01/07/2017.

Topographic modulation of East Antarctic ice sheet mass loss measured using in-situ ^{10}Be and ^{14}C.
Marcello Blaxwell, Institute for Applied Ecology, University of Canberra.
Commenced 01/07/2019.

Recovery and enhancement of fingermarks and other physical evidence: Towards improved protocols for crime scene investigation.
Rhiannon Boseley, School of Molecular and Life Sciences, Curtin University.
Commenced 01/07/2020.

The use of BiNSAIDs as novel chemopreventive agents for colorectal cancer.
Tara Brown, School of Chemistry, University of Wollongong.
Commenced 01/07/2017.

Pre-treatment of biomass and dissolution of (bio)polymers using choline amino acid ionic liquids.
Manuel Brunner, School of Molecular Sciences, The University of Western Australia.
Commenced 01/07/2018.

Exploration of the relationship between the molecular architecture and solution state properties of surfactants for the development of tailor made colloidal systems.
Calum Butler, School of Chemistry, Monash University.
Commenced 01/07/2020.

Characterisation of pregnancy zone protein-cytokine interactions by autoradiography.
Jordan Carter, School of Biological Sciences, University of Wollongong.
Commenced 01/07/2017.

New insights into colloidal phase transitions using neutron scattering techniques.
Katherine Chea, School of Science, RMIT University.
Commenced 01/07/2020.

Characterizing insect odorant receptors on electropolymerized conducting polymer thin films for odorant sensing.
Jamal Cheema, School of Chemical Sciences, The University of Auckland .
Commenced 01/07/2018.

Diffusion in solid ionic conductors for sodium-ion battery applications: structure and dynamics.
Emily Cheung, School of Chemistry, The University of New South Wales.
Commenced 01/07/2017.

Blast survivability of a fatigued naval surface platform.
Daniel Clayton, Australian Maritime College, University of Tasmania.
Commenced 01/07/2018.

Sulphur: a new proxy for wildfire in speleothem records.
Katie Coleborn, Biological, Earth and Environmental Sciences, The University of New South Wales.
Commenced 01/07/2017.

Investigating the structure of TRAP transporters from pathogenic bacteria using small-angle X-ray scattering.
Michael Currie, School of Biological Sciences, University of Canterbury.
Commenced 01/07/2019.

Mechanistic studies of lipopeptide battacin analogues on fungal membranes using SAXS and SANS.
Nur Maizura Mohd Darbi, School of Chemical Sciences, The University of Auckland.
Commenced 01/07/2019.

Caught in a bacterial TRAP: X-ray crystallographic studies of an unusual transporter system.
James Davies, School of Biological Sciences, University of Canterbury.
Commenced 01/07/2019.

Examining the structure and function of mixed lineage kinase-domain like protein: the final executioner of necroptosis.
Katherine Davies, Department of Medical Biology, The University of Melbourne.
Commenced 01/07/2017.

Groundwater exchanges with main-channel pools in a tropical intermittent river and their ecological implications.
Thiaggo de Castro Tayer, School of Biological Sciences, The University of Western Australia.
Commenced 01/07/2020.

Paleo-environmental setting of the earliest life on land: An analysis of 3 new diamond drill cores through the 3.48-billion-year-old Dresser Formation, Pilbara, Western Australia.
Michaela Dobson, School of Environment, The University of Auckland.
Commenced 01/07/2020.

Seeking for an explanation of hot carrier effect in lead-halide perovskites through investigation of phonon dynamic by inelastic neutron scattering".
Milos Dubajic, School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales.
Commenced 01/07/2019.

Climate change induced shifts in the macromolecular content of sea ice algae: a single-cell study.
Rebecca Duncan, School of Life Sciences, University of Technology Sydney.
Commenced 01/07/2020.

Crystal field excitations and exchange coupling in lanthanoid complexes by inelastic neutron scattering.
Maja Dunstan, School of Chemistry, The University of Melbourne.
Commenced 01/07/2018.

Research Highlights:

Calina Betlazar-Maseh - p.25

Gamma radiation-induced responses of the mitochondrial translocator protein (TSPO).

Katherine Davies - p.28

Understanding the mechanics of programmed cell death.

Maja Dunstan - p.35

Probing the magnetic properties of lanthanoid molecular nanomagnets.

Investigation of hybrid solid-state nanopore membranes fabricated using ion track technology.
Shankur Dutt, Research School of Physics and Engineering, The Australian National University.
Commenced 01/07/2019.

Radiocarbon dating of modern portions of the Cook Island stalagmites and variability in speleothem dead carbon fraction as a rainfall proxy.
Mohammadali Faraji, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2019.

Quantifying the post-seismic sediment cascade and its impact on river dynamics.
Dina Fieman, School of Geography, Environment and Earth Sciences, Victoria University of Wellington.
Commenced 01/07/2020.

Towards linking long-term denudation and modern fluvial dynamics in the Pilbara, WA.
Alissa Flatley, School of Geography, The University of Melbourne.
Commenced 01/07/2019.

Incorporation of stimuli-responsive liquid crystals into polymeric networks.
Luke Giles, School of Chemistry, Monash University.
Commenced 01/07/2019.

Structures and properties of newly synthesised layered metal chalcogenides.
Conrad Gillard, School of Chemistry, The University of New South Wales.
Commenced 01/07/2018.

Catalytic site isolation in a MOF matrix.
Pol Gimeno I Fonquernie, Department of Chemistry, The University of Adelaide.
Commenced 01/07/2020.

Holocene hydroclimate variability in New South Wales and New Zealand interpreted from Synchrotron Radiation micro-Xray Fluorescence Microscopy (SR-uXRF) of stalagmite trace elements .
Matthew Goodwin, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2020.

In-situ small angle scattering analysis to investigate the alignment of graphene flakes under the magnetic field.
Premika Govindaraj, Department of Mechanical Engineering, Swinburne University of Technology..
Commenced 01/07/2020.

Interactions between meteoric, surface and ground water in fractured rock: Upper Murrumbidgee catchment.
Sharon Gray, Research School of Earth Sciences, The Australian National University.
Commenced 01/07/2016.

Experimental demonstration of Bragg-edge neutron strain tomography.
Alexander Gregg, School of Engineering, The University of Newcastle.
Commenced 01/07/2017.

Toward smarter surfaces: exploring the selectivity and stimuli-response available through polymer brushes.
Isaac Gresham, School of Chemistry, The University of New South Wales.
Commenced 01/07/2017.

Unravelling the early diagenesis of vanadium in anoxic marine sediments using Synchrotron-based X-ray spectroscopy.
Felicia Haase, School of Environment and Science, Griffith University.
Commenced 01/07/2020.

Structural and functional characterisations of the CCC protein family.
Michael Healy, Institute for Molecular Bioscience, The University of Queensland.
Commenced 01/07/2018.

Developing sub-cellular Synchrotron imaging techniques to associate altered brain biochemistry with zinc deficiency during dementia.
Ashley Hollings, School of Molecular and Life Sciences, Curtin University.
Commenced 01/07/2019.

Interdecadal ENSO variability in the past millennium: the role of coupled air-sea interactions in the central Pacific.
Jasmine Hunter, School of Earth Sciences & Environmental Sciences, University of Wollongong.
Commenced 01/07/2017.

Interface design of Li-rich cathode materials for Li-ion batteries.
Tristram Jenkins, Institute for Future Environments, Queensland University of Technology.
Commenced 01/07/2020.

Antarctic ice-shelf stability and collapse: a geochemical history of Antarctic Peninsula ice-shelves.
Matthew Jeromson, Institute for Applied Ecology, University of Canberra.
Commenced 01/07/2018.

Synthesis and characterisation of multi-stimuli responsive polymer brushes.
Edwin Johnson, Chemistry, The University of Newcastle.
Commenced 01/07/2017.

Understanding the creation and evolution of mineral porosity during mineral-fluid reactions.
Muhammet Kartal, Department of Chemical and Metallurgical Engineering and Chemistry, Murdoch University.
Commenced 01/07/2019.

Development of nanosensors for Reactive Oxygen Species (ROS) detection in impact of radiation and radiotherapy.
Jagjit Kaur, Biomedical Engineering, The University of New South Wales.
Commenced 01/07/2018.

Metallurgical changes, residual stress and mechanical properties of laser clad rail components.
Olivia Kendall, Department of Mechanical and Aerospace Engineering, Monash University.
Commenced 01/07/2020.

Metallation of disulfide-rich peptides for radiopharmaceutical applications.
Adam Kennedy, School of Chemistry, Monash University.
Commenced 01/07/2019.

Nanoplastic waste: exploring the damage nanoplastics cause to biological systems at nanoscale using neutron scattering.
Shinji Kihara, School of Chemical Sciences, The University of Auckland .
Commenced 01/07/2018.

Relating microstructure to rheology for complex fluids.
Joshua King, School of Chemistry, Monash University.
Commenced 01/07/2019.

Explosive or effusive? Mapping Fe oxidation state in pink pumice to test eruption models for the 2012 Havre submarine volcanic eruption.
Joseph Knafelc, School of Earth Environmental and Biological Sciences, Queensland University of Technology.
Commenced 01/07/2019.

A 10-million year time profile of interstellar influx to Earth mapped through long-lived Fe-60 and Pu-244.
Dominik Koll, Department of Nuclear Physics, The Australian National University.
Commenced 01/07/2019.

Research Highlights:

Stephanie Anna Florin - p.13

A novel climatic proxy from ancient pandanus nutshell: Madjedbebe, northern Australia.
(PGRA scholarship concluded in 2019)

Alexander Gregg - p.39

Bragg-edge neutron strain tomography.

Isaac Gresham - p.43

Imaging the invisible: observing polymer brushes using neutron reflectometry.

Shinji Kihara - p.46

Nanoplastic toxicology at the interface.

Reconstruction of 250,000 years of high-resolution records of paleo environmental and paleoclimate evolution established from Auckland Maar Lake records.
Benjamin Laeuchli, Chemistry, School of Environment, The University of Auckland.
Commenced 01/07/2019.

Advanced materials for radiation protection in space.
Matthew Large, School of Physics, University of Wollongong.
Commenced 01/07/2020.

Isotopic dietary reconstruction of pastoralists from the Kadruka cemeteries, Middle Nile Valley.
Charles Le Moyne, School of Social Science, The University of Queensland.
Commenced 01/07/2020.

Realizing new intrinsic magnetic topological insulators and heterostructures.
Qile Li, Department of Materials Science and Engineering, Monash University.
Commenced 01/07/2020.

Interplay between doping and mechanistic behavior of a high-voltage spinel positive electrode for lithium-ion batteries.
Gemeng Liang, Institute for Superconducting & Electronic Materials, University of Wollongong.
Commenced 01/07/2018.

A combined *in situ* electron microscopy and neutron scattering study of "honeycomb" layered oxides as sodium ion battery electrodes.
Jiatu Liu, School of Chemistry, The University of Sydney.
Commenced 01/07/2018.

In-situ and *ex-situ* monitoring of electrochemical processes of non-flammable electrolytes on electrode surface using synchrotron infrared micro-spectroscopy.
Sailin Liu, Institute for Superconducting & Electronic Materials, University of Wollongong.
Commenced 01/07/2020.

Mg/Ca and Sr/Ca ratios of southern Australian speleothems as a proxy for palaeohydrological changes during the abrupt climate change events of the Last Glacial Period.
Claire Macgregor, School of Earth Sciences, The University of Melbourne.
Commenced 01/07/2020.

Probing the relationship between the structural and rheological properties of liquid crystals using scattering and fluorescence techniques.
Joshua Marlow, School of Chemistry, Monash University.
Commenced 01/07/2018.

Southeast Australian palaeofloras of the past 100,000 years, and their implications for palaeoclimate reconstructions.
Kia Matley, School of Biosciences, The University of Melbourne.
Commenced 01/07/2018.

Investigating the function of fungal Nudix hydrolases and plant wall-associated kinases in plant-pathogen interactions.
Carl Mccombe, Research School of Biology, The Australian National University..
Commenced 01/07/2020.

Metal pollution during pulse storm events: accumulation kinetics and effects in a freshwater decapod crustacean.
Sarah McDonald, School of Biosciences, The University of Melbourne.
Commenced 01/07/2018.

Timescales and processes of marine terrace formation and preservation.
Aidan McLean, School of Environment, The University of Auckland.
Commenced 01/07/2019.

Evolution and sedimentary architecture of *Halimeda* bioherms in the Great Barrier Reef: understanding origin, development, morphology, and palaeo-environment.
Mardi McNeil, School of Earth, Environmental and Biological Science, Queensland University of Technology.
Commenced 01/07/2017.

Understanding the activation mechanism of pseudokinase MLKL involved in the necroptosis pathway.
Yanxiang Meng, Walter and Eliza Hall Institute of Medical Research, The University of Melbourne.
Commenced 01/07/2020.

Understanding the co-precipitation mechanisms of $Al_3(Sc,Zr)$ with Li-containing phases in Al-Cu-Li model alloys.
Anne Mester, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2017.

Structure property relationship of Nanostructured Ionic-Molecular Hybrid Solvents (NIMHS).
Shurui Miao, School of Chemistry, The University of Sydney.
Commenced 01/07/2019.

Nanostructured protein-lipid materials and their application for enhancing cell membrane fusion.
Izabela Milogrodzka, Department of Chemical Engineering, Monash University..
Commenced 01/07/2020.

Radiobiological effectiveness of charged particle therapeutic beams: experimental derivation and application for treatment optimization.
Vladimir Pan, School of Physics, University of Wollongong.
Commenced 01/07/2019.

Examination of radionuclide uptake by flora in the arid environment surrounding the Olympic Dam Cu-U-Au-Ag mine in South Australia.
Samantha Pandelus, College of Science and Engineering, Flinders University.
Commenced 01/07/2018.

Interfacial magnetism effects and multiferroic thin films for device applications.
Oliver Paull, Institute of Superconduction & Electronic Materials, The University of New South Wales.
Commenced 01/07/2017.

Characterisation of organic electronic components for dosimetry in radiotherapy.
Jessie Posar, School of Physics, University of Wollongong.
Commenced 01/07/2018.

Is there a microbical soil CO_2 sink? Determining the impact of soil carbon dynamics on silicate weathering.
Eron Raines, School of Geography, Environment and Earth Sciences, Victoria University of Wellington.
Commenced 01/07/2019.

Radiocarbon and cryptotephra in the Australian tropical savannas: a case study from Sanemere Lagoon, northeast Australia.
Maria Jose Rivera Araya, College of Science and Engineering, James Cook University.
Commenced 01/07/2018.

Characterising a biologically relevant protein-G4 interaction: HP1alpha and TERRA.
Ruby Roach, School of Fundamental Sciences, Massey University.
Commenced 01/07/2019.

Research Highlights:

Gemeng Liang - p.49

Stabilizing spinel structured lithium-ion battery electrode materials.

Joshua Marlow - p.52

Nanoparticles and liquid crystals: the effects of different variables on structure and rheology.

Kia Matley - p.17

Australian palaeofloras of the late Pleistocene and implications for palaeoclimate reconstructions.

Jessie Posar - p.31

Characterisation of organic semiconductors for dosimetry in radiation therapy

Unravelling the dominant drivers behind ion specificity.

Hayden Robertson, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2020.

Investigating sustainable management of marine resources over five centuries on Molokai, Hawaiian Islands.

Ashleigh Rogers, School of Social Science, The University of Queensland.
Commenced 01/07/2018.

Elucidating carbon sources in groundwater ecosystems via radiocarbon and stable isotope analysis.

Mattia Saccò, School of Earth and Planetary Sciences, Curtin University.
Commenced 01/07/2017.

Investigation of multiferroic skyrmion materials using Small-Angle Neutron Scattering.

Jorge Arturo Sauceda Flores, School of Physics, The University of New South Wales.
Commenced 01/07/2020.

Leaky tropics: elucidating the origin and age of carbon exported to wetlands and rivers in northern Australia.

Vanessa Solano, Research Institute for the Environment and Livelihoods, Charles Darwin University.
Commenced 01/07/2019.

Amelioration of tailings into a blended waste cap for improvement of tailings dam closure.

Golam Taki, School of Agriculture and Environment, The University of Western Australia.
Commenced 01/07/2020.

New manufacturing methods for advanced lithium ion battery anode materials.

Xin Fu Tan, School of Mechanical and Mining Engineering, The University of Queensland.
Commenced 01/07/2019.

Precision spectroscopy of low-energy electrons from medical isotopes.

Bryan Tee Pi-Ern, Department of Nuclear Physics, The Australian National University.
Commenced 01/07/2019.

Atomic-scale resolution of the mechanism of bending in elastically flexible crystals by automatic analysis.

Amy Thompson, School of Chemistry and Moelcular Biosciences, The University of Queensland.
Commenced 01/07/2020.

Processes leading to exceptional soft-tissue preservation in Mazon Creek (Carboniferous) concretions: A combined palaeontological, organic and inorganic geochemical approach.

Madison Tripp, School of Earth and Planetary Sciences, Curtin University.
Commenced 01/07/2020.

Formation of a stable long range magnetic skyrmion lattice in thin films of the room temperature chiral material $Co_8Zn_8Mn_4$.

Gaurav Vats, School of Materials Science and Engineering, The University of New South Wales.
Commenced 01/07/2018.

Neutron scattering techniques as probes to study phase change colloidal systems.

Mark Louis Vidallon, School of Chemistry, Monash University.
Commenced 01/07/2020.

Nanoparticle enhanced Image-Guided Microbeam Radiation Therapy: from *in vitro* to *in vivo*.

Sarah Vogel, School of Physics, University of Wollongong.
Commenced 01/07/2020.

Towards personalised therapy: [^{64}Cu]$CuCl_2$ PET/CT imaging to determine acquired platinum drug resistance, and to monitor the treatment response in neuroblastoma.

Florida Voli, School of Women's and Children's Health, The University of New South Wales.
Commenced 01/07/2018.

Effect of the feeding with a highly bioavailable curcumin in a mouse model of chronic neuroinflammation: Validation of TSPO [^{18}F]PBR111 PET imaging as an *in vivo* neuroinflammatory marker.

Ingrid Wagnon, School of Medicine, Western Sydney University.
Commenced 01/07/2020.

Investigating the homogeneity, thickness and fouling resistance of the plasma-synthesized polymer blend thin films for low-cost desalination.

Jingshi Wang, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2018.

Impact of large volcanic eruptions on Pacific hydroclimate assessed using speleothem radiocarbon measurements.

Brittany Ward, School of Science, University of Waikato.
Commenced 01/07/2019.

Exploring the application of dynamic stress upon the micro-structure of WAAM constructed materials.

Robert Wells, School of Mechanical and Mining Engineering, The University of Queensland.
Commenced 01/07/2020.

Iron isotope geochemistry of jarosite and implications for iron cycling in sediments on Earth and Mars.

Anne Whitworth, School of Earth, Atmosphere and Environment, Monash University.
Commenced 01/07/2018.

Tracing coseismically-triggered landslide material in river catchments using ^{10}Be.

Clare Wilkinson, Department of Geological Sciences, University of Canterbury.
Commenced 01/07/2019.

Synergism and Antagonism in binary surfactant self-assemblies.

Ashley Williams, School of Chemistry, Monash University.
Commenced 01/07/2020.

Formation and investigation of polymeric nanocapsules with high aspect ratio via vesicle templation with RAFT polymerisation and their interactions with cells.

Yunxin Xiao, Monash Institute of Pharmaceutical Sciences, Monash University.
Commenced 01/07/2018.

Study on the interactions between milk protein and digestive enzymes (pepsin).

Mengxiao Yang, Riddet Institute, Massey University.
Commenced 01/07/2020.

Structural investigation of the interaction between SIX effectors and resistance proteins.

Daniel Yu, Research School of Biology, The Australian National University.
Commenced 01/07/2020.

Detailed investigation of factors affecting the formation of intermediate phase during dehydroxylation of serpentine minerals.

Sana Zahid, School of Engineering, Murdoch University.
Commenced 01/07/2017.

Optimisation of ionic liquid/polymer/pil mixtures for lubrication.

Yunxia Zhang, School of Molecular Science, The University of Western Australia.
Commenced 01/07/2019.

Research Highlights:

Mattia Saccò - p.21

Elucidating carbon sources and food web interactions in groundwater ecosystems.

Nanostructures and their application for enhancing photocatalytic activity of CO_2.
Jiajia Zhao, School of Engineering, RMIT University.
Commenced 01/07/2019.

Magnons in the ferromagnetic semimetal $NdCrSb_3$.
Weiyao Zhao, Institute for Superconducting & Electronic Materials, University of Wollongong..
Commenced 01/07/2020.

RSS scholar Patrick Adams sampling for cosmogenic radionuclides in Arthur's Pass, New Zealand, in order to reconstruct the deglacial sequence in the valley and examing how the climate has changed over the past 30,000 years. Photo credit: Prof. Jamie Shulmeister.

Residential Student Scholarships

In 2020 AINSE continued to offer the Residential Student Scholarship (RSS), which is a ‘top-up’ residential postgraduate scholarship to high-quality students who are enrolled in a PhD 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, Camperdown 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, Human Health, Nuclear Fuel Cycle, Defence Industry, and Fusion.

AINSE wishes to congratulate the six successful RSS applicants for 2020 (listed below), who have secured an A$7,500 (pro rata where applicable) stipend per annum with up to A$5,000 travel and accommodation allowance per annum.

Residential Scholars, and Their Projects, awarded in 2020:

Impact of radiation and microgravity on Heart-on-a-Chip.
Carin Basirun, University of Technology, Sydney.

Characterising shell development of the Pacific oyster using the novel application of nuclear technologies.
Ernest Chuku, University of Tasmania.

Impacts of industrial activities on aquatic organisms: investigating contaminant toxicokinetics and the effects of metamorphosis.
Danielle Hill, Griffith University.

Development of a validated Monte Carlo model of the ACNS DINGO beamline for radiobiological applications.
Klaudiusz Jakubowski, University of Wollongong.

How does dust contribute to ecosystem fertilisation in the Southern Ocean?
Andrea Johansen, University of Wollongong.

Synthesis, radiolabelling and *in vitro* evaluation of B10-enriched, fluorine-18 radiolabelled BODIPY analogues for neutron capture enhanced particle therapy (NCEPT) of glioblastoma multiforme (GBM).
Bradley Schwehr, Curtin University.

Research Highlights:

Patrick Adams - p.9

The 20,000-year environmental history of Arthur’s Pass Valley, South Island, New Zealand
(continuing AINSE RSS scholar)

Postgraduate Orientation Week

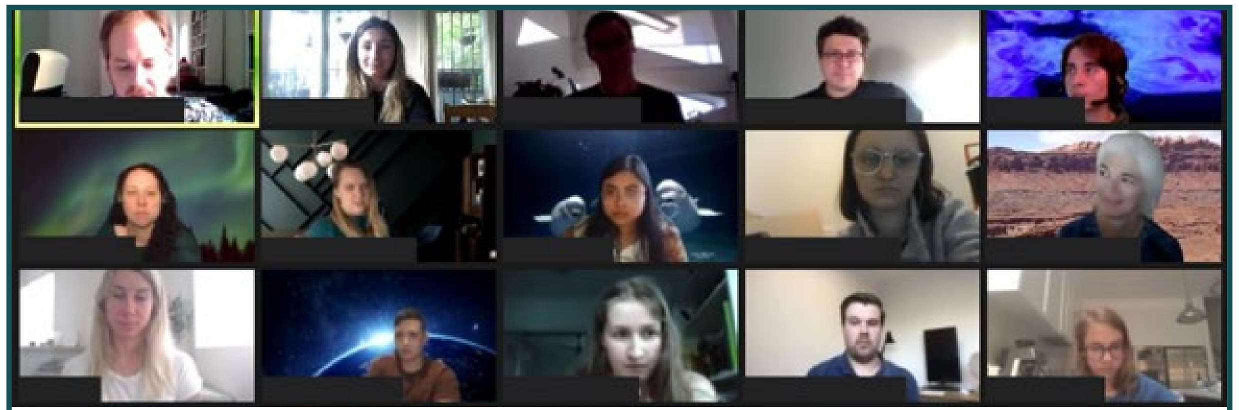
The AINSE Postgraduate Orientation Week aims to provide students with additional support in their goal of achieving a postgraduate qualification at ANSTO. The event also assists students in building their professional networks through meetings with ANSTO researchers and other AINSE-supported postgraduate students.

From October 19–21, AINSE welcomed thirty-three new postgraduate scholars to the annual Orientation Week. Due to the COVID-19 pandemic, the Orientation Week was hosted entirely online, via Zoom videoconferencing, for the first time in the event's history.

Over the course of the program, students attended a series of virtual panel discussions with ANSTO researchers and research leaders who provided a detailed overview of ANSTO's landmark research infrastructure and ongoing research projects in the areas of Environment, Human Health, and the Nuclear Fuel Cycle. Students were also able to attend an online science communication workshop to assist them in promoting their ongoing work through AINSE. Past and present AINSE scholars Meltem Bayrak and Patrick Adams also met with the new cohort to discuss their own experiences with the AINSE PGRA and RSS programs.

Attendees also had the opportunity to undertake a virtual tour of a selection of ANSTO's landmark research infrastructure at Lucas Heights, including the Centre for Accelerator Science and the Australian Centre for Neutron Scattering. On the final day of the program, students connected with their ANSTO co-supervisors online to discuss their projects and undertake introductions to their individual research areas.

Students undertaking a virtual tour of the OPAL multipurpose reactor, courtesy of the ANSTO Discovery Centre.



The new AINSE PGRA and RSS cohort attending an online science trivia night as part of the Nuclear Science Week celebrations.

The Postgraduate Orientation Week coincided with Nuclear Science Week, an international celebration of nuclear science. AINSE once again coordinated with the National Museum of Nuclear Science and History in Albuquerque to deliver a series of social events in celebration of Nuclear Science Week. These social activities included an online science trivia night and, new to the 2020 program, a fun "2 Minute Thesis"-style competition that challenged students to present an overview of the research in under 2 minutes by sharing their screen and using only simple graphical tools such as MS Paint. This event was attended by AINSE and ANSTO staff, with AINSE President Prof. Ian Gentle judging the best presentation on the day. It is hoped that such social events can assist AINSE scholars in building support networks that can aid them in their postgraduate studies and continue to be an asset to them in their future research careers.

Students also heard from representatives of Australian nuclear organisations, including Women in Nuclear (WiN) Australian Chapter and Australian Young Generation in Nuclear (AusYGN).

AINSE would like to thank ANSTO, AusYGN, WiN and all our guest speakers for contributing to a successful virtual O'Week. We wish our new AINSE scholars all the best for their research endeavours in 2021 and beyond.

2020 AINSE Postgraduate Orientation Week Attendees

Ariella Arzey	WOL	Olivia Kendall	MON
Carin Basirun	UTS	Karina Khambatta	CUR
Rhiannon Boseley	CUR	Claire MacGregor	MEL
Calum Butler	MON	Carl McCombe	ANU
Katherine Chea	RMI	Izabela Milogrodzka	MON
Ernest Obeng Chuku	TAS	Hayden Robertson	NCT
Michaela Dobson	AKL	Bradley Schwehr	CUR
Rebecca Duncan	UTS	Golam Taki	UWA
Jorge Arturo Sauceda Flores	NSW	Amy Thompson	QLD
Matthew Goodwin	NCT	Madison Tripp	CUR
Premika Govindaraj	SWI	Mark Louis Vidallon	MON
Felicia Haase	GRI	Sarah Vogel	WOL
Danielle Hill	GRI	Ingrid Wagnon	UWS
Ashley Hollings	CUR	Ashley Williams	MON
Klaudiusz Jakubowski	WOL	Mengxiao Yang	MAS
Tristram Jenkins	QUT	Daniel Yu	ANU
Andrea Johansen	WOL		

Early Career Researcher Grant (ECRG)

An AINSE Early Career Researcher Grant (ECRG) is a grant of 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 2020, AINSE continued the ECRG into its second consecutive year. AINSE wishes to congratulate the seventeen successful applicants for the 2020 round of the ECRG, who are listed below.

Early Career Research Grants Awarded in 2020:

Understanding order and correlation in liquid crystals by fluctuation scattering.
Jack Binns, RMIT University.

An investigation of the functional and structural features of the T cell response in Human Immunodeficiency Virus (HIV) controllers.
Dimitra Chatzileontiadou, Monash University.

Elemental analysis of pancreatic islets to study metal homeostasis during diabetes.
Gaewyn Colleen Ellison, Curtin University.

Terminal anionic magnesium and calcium hydride complexes: Turning environmental pollutants into fine chemicals.
Jamie Hicks, The Australian National University.

Synthesis of ^{19}F-^{13}C labelled aromatic amino acid TROSY probes for the investigation of protein structure and dynamics by NMR spectroscopy..
Anitha Kopinathan, Monash University.

Tuning the negative thermal expansion properties in MOF materials.
Lauren Macreadie, The University of Sydney.

Development of real time fatigue testing of carbon fibre-based composite materials.
Pablo Ernesto Mota Santiago,
Deakin University / ANSTO.

Dissecting regulatory processes associated with nutritional immunity in plants to limit the spread of fungal pathogens.
Fatima Naim, Curtin University.

Samarium-145 - Paving the way to study the history of the Early Solar System.
Stefan Pavetich, The Australian National University.

Effects of radiation-induced defects to damage resistance in high-temperature resistant composites.
Johannes Reiner, Deakin University.

Groundwater dynamics of the Salar de Atacama (Chile).
Mattia Saccò, Curtin University.

Interaction of membrane proteins with confined water and lipids in biomimetic lipidic cubic phases.
Livia Salvati Manni, The University of Sydney.

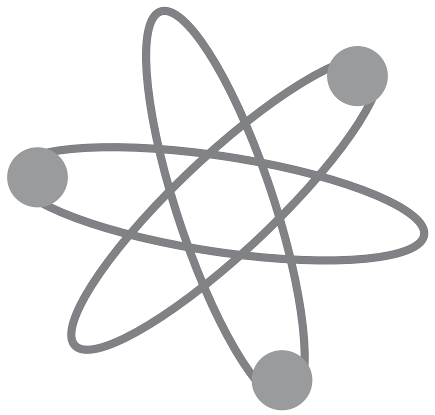
Surface exposure dating tools to reconstruct Past Anstarctic Ice Sheet.
Jamey Stutz, Victoria University of Wellington.

Characterisation of SARS-CoV-2 peptides presented by Human Leukocyte Antigen molecules.
Christopher Szeto, Monash University.

A mesoporous-gold platform towards point-of-care diagnostic device for COVID-19 detection.
Jing Tang, The University of Queensland.

Hybrid protein–lipid nanomaterials for advancing food and pharmaceutical sciences.
Leonie van 't Hag, Monash University.

(Ultra) Small-angle neutron scattering study of structure and in vitro digestion of vegetable protein gels and solutions.
Zhi Yang, Massey University.



Scholarship AINSE/ANSTO/French Embassy (SAAFE)

As a result of the MOU signed between AINSE, ANSTO and the Embassy of France in Australia in 2017, two PhD students were approved to travel either from Australia to France or from France to Australia as part of the fourth round of the Scholarship AINSE ANSTO French Embassy (SAAFE) research internship program in 2020. In response to the impact of the COVID-19 pandemic on international travel, all participants of the SAAFE program received a no-cost extension to their scholarship.

The SAAFE Program facilitates the conduct of research and fosters research collaborations between France and Australia in nuclear science and engineering. The program supports early careers researchers at the PhD level to expand research and innovation activities within the research areas of Human Health, the Environment and the Nuclear Fuel Cycle, and to initiate sustainable research networks and linkages to support Australia and France in research and innovation.

AINSE is thankful for the support offered by the Embassy of France in Australia and ANSTO to enable this wonderful overseas internship opportunity.

SAAFE Scholars awarded in 2020:

STUDENT	UNIVERSITY OF ENROLMENT	HOST INSTITUTION(S)
Meltem Bayrak	RMIT University (AUS)	CEA-LIST (FRA)
Sachini Pathirannahalage	RMIT University (AUS)	ANSTO (AUS)

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 2020, AINSE supported the following conferences and events through the provision of sponsorship funding and travel & accommodation assistance 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.

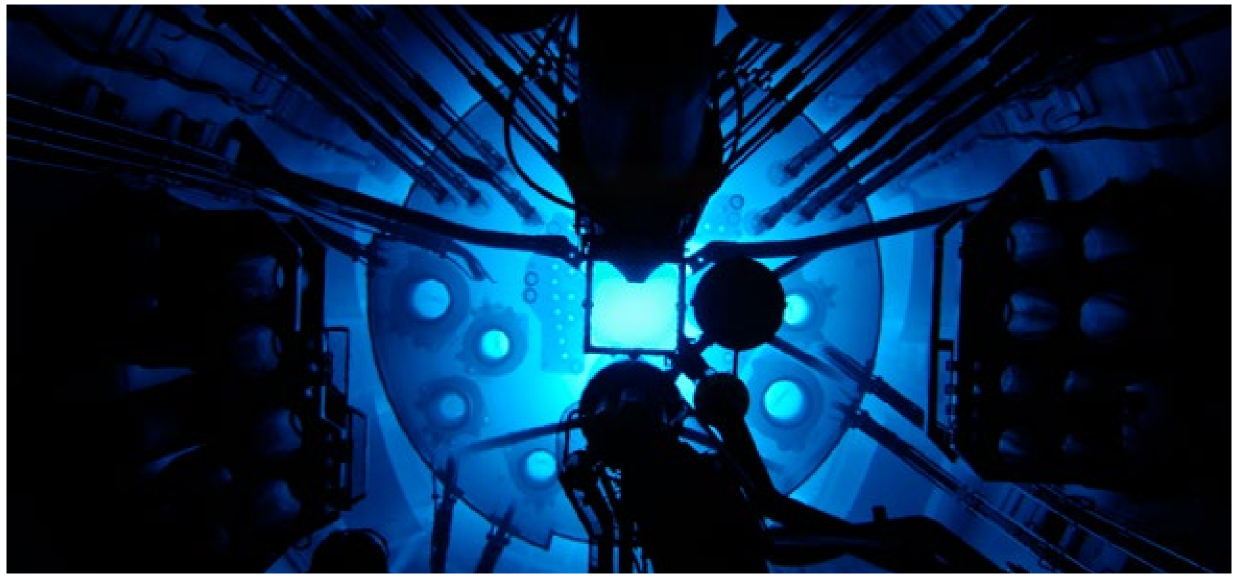
NAME OF EVENT	TYPE OF EVENT	DATE	VENUE	STUDENT UNIVERSITIES / ORGANISATIONS
Universities Australia Conference 2020	Conference	26–27 February	National Convention Centre, Canberra, ACT	(Event Sponsorship)
International Youth Nuclear Congress (IYNC) 2020	Conference	8–13 March	International Convention Centre, Sydney, NSW	Curtin University Monash University RMIT University
Australian X-ray Analytical Association (AXAA) 2020	Conference	29 April–1 May	Bond University, Gold Coast, QLD	Event cancelled due to COVID-19 impacts
Australasian Environmental Isotope Conference	Conference	28 Jun–1 July	Riverside Function Centre, Ballina NSW	Event postponed due to COVID-19 impacts
Australian and New Zealand Society of Nuclear Medicine (ANZSNM) 2020	Virtual Conference	28 May–17 September	Online	Charles Sturt University
BLiSS*Adelaide 2020 Virtual Conference	Virtual Conference	20–23 October	Online	(Event Sponsorship)
AINSE-ANBUG Neutron Scattering Symposium (AANSS) 2020	Virtual Conference	11–13 November	Online	(Event Sponsorship)

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. The following AINSE members received support to attend ANSTO's NSW campuses in 2020.

ANSTO-Funded Travel and Accommodation Support in 2020:

ADE	The University of Adelaide
AKL	The University of Auckland
ANU	The Australian National University
CSI	CSIRO
DEA	Deakin University
FLI	Flinders University
GRI	Griffith University
MEL	The University of Melbourne
MON	Monash 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
TAS	University of Tasmania
UNE	The University of New England
USC	University of the Sunshine Coast
UWA	The University of Western Australia
VUW	Victoria University of Wellington
WOL	University of Wollongong



The interior of ANSTO's OPAL Multipurpose Reactor, illuminated by Cherenkov radiation. Photo credit: ANSTO.

Supported Publications

The University of Adelaide

Mohammed Alsharifi

Singleton, E V, David, S C, Davies, J B, Hirst, T R, Paton, J C, Beard, M R, Hemmatzadeh, F & Alsharifi, M 2020, 'Sterility of gamma-irradiated pathogens: a new mathematical formula to calculate sterilizing doses', *Journal of Radiation Research*, vol. 61 (6), pp. 886–894.
Available from: doi:10.1093/jrr/rraa076.

Martin Ankor

Ankor, M J, Tyler, J T & Hughes, C E 2019, 'Development of an autonomous, monthly and daily, rainfall sampler for isotope research', *Hydrology*, vol. 575, pp. 31–41.
Available from: doi:10.1016/j.jhydrol.2019.04.074.

Ankor, M 2020, 'Hydrologic and isotopic lake modelling for Palaeoclimate research', Ph.D. thesis, The University of Adelaide.

Andre Birve

Birve, A 2020, 'Applications and synthesis of bullvalenes', Honours thesis, The University of Adelaide.

Vivien Heng

Heng, V, Bowen, J, Liu, G-J & Middleton, R 2020, 'Cancer therapy changes microglia - the CANARY in the mine for neuroinflammation in the brain', Poster presented at The University of Adelaide Undergraduate Conference: Honours Poster Presentation, Adelaide, Australia, October 2020.

Heng, V 2020, 'The respective impacts of chemo- and radiotherapy on microglia in the brain', Honours thesis, The University of Adelaide.

Christopher Kemp

Kemp, C W 2020, 'A 210,000-year reconstruction of subtropical climates from Fern Gully Lagoon, North Stradbroke Island (Minjerribah), Australia', Ph.D. thesis, The University of Adelaide.

The University of Auckland

Wan-Ting Chen

Chen, W-T, Dong, Y, Yadav, P, Aughterson, R D, Sun-Waterhouse, D & Waterhouse, G I N 2020, 'Effect of alcohol sacrificial agent on the performance of Cu/TiO_2 photocatalysts for UV-driven hydrogen production', *Applied Catalysis A: General*, vol. 602, p. 117703.
Available from: doi:10.1016/j.apcata.2020.117703.

Gianna Evans

Evans, G, Augustinus, P, Gadd, P, Zawadzki, A, Ditchfield, A & Hopkins, J 2020, 'A multi-proxy paleoenvironmental interpretation spanning the last glacial cycle (ca. 117±8.5 ka BP) from a lake sediment stratigraphy from Lake Kai Iwi, Northland, New Zealand', *Journal of Paleolimnology*, vol. 65, pp. 101–122.
Available from: doi:10.1007/s10933-020-00151-z.

Evans, G 2019, 'Environmental change recorded in physical and geochemical proxies over the Last Glacial Cycle from two Northland, New Zealand dune lakes: Lake Kanono and Lake Kai Iwi', Ph.D. thesis, The University of Auckland.

Murray Ford

Ford, M R, Kench, P S, Owen, S D & Hua, Q 2020, 'Active sediment generation on coral reef flats contributes to recent reef island expansion', *Geophysical Research Letters*, vol. 47 (23), p. e2020GL088752.
Available from: doi:10.1029/2020GL088752.

Shinji Kihara

Kihara, S, Ghosh, S, McDougall, D, Whitten, A, Mata, J, Koeper, I & McGillivray, D 2020, 'Structure of soft and hard protein corona around polystyrene nanoplastics - Particle size and protein types', *Biointerphases*, vol. 15 (5), p. 051002.
Available from: doi:10.1116/6.0000404.

Kihara, S, Köper, I, Mata, J P & McGillivray, D J 2020, 'Nanoplastic waste: exploring the damage nanoplastics cause to biological systems using neutron scattering', Oral presentation delivered at the AINSE New Zealand Symposium, Online, June 2020.

Kihara, S, Köper, I, Mata, J P & McGillivray, D J 2019, 'Exploring the biological identity of nanoplastics', Oral presentation delivered at Okinawa Colloids 2019, Nago, Okinawa, Japan, November 2019.

Kihara, S 2020, 'Nanoplastics and protein corona - Investigating the corona structure and their biological impacts', Ph.D. thesis, The University of Auckland.

Geoffrey Lerner

Lerner, G A, Cronin, S J & Turner, G M 2019, 'Evaluating emplacement temperature of a 1000-year sequence of mass flows using paleomagnetism of their deposits at Mt. Taranaki, New Zealand', *Volcanica*, vol. 2 (1), pp. 11–24.
Available from: doi:10.30909/vol.02.01.1124.

Lerner, G A, Cronin, S J, Turner, G M & Rowe, M C 2019, 'Paleomagnetic determination of the age and properties of the 1780-1800 AD dome effusion/collapse episode of Mt. Taranaki, New Zealand', *Bulletin of Volcanology*, vol. 81, p. 15.
Available from: doi:10.1007/s00445-019-1275-z.

Lerner, G A, Cronin, S J, Bebbington, M S & Platz, T 2019, 'The characteristics of a multi-episode volcanic regime: the post-AD 960 Maero Eruptive Period of Mt. Taranaki (New Zealand)', *Bulletin of Volcanology*, vol. 81, p. 61.
Available from: doi:10.1007/s00445-019-1327-4.

Leonie Peti

Peti, L, Fitzsimmons, K E, Hopkins, J L, Nilsson, A, Fujioka, T, Fink, D, Mifsud, C, Christl, M, Muscheler, R & Augustinus, P C 2020, 'Development of a multi-method chronology spanning the Last Glacial Interval from Orakei maar lake, Auckland, New Zealand', *Geochronology*, vol. 2, pp. 367–410.
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Available from: doi:10.1002/jqs.3133.

Peti, L 2020, 'High-resolution composite stratigraphy and multi-method dating of Auckland maar sediment records spanning the Last Glacial Interval', Ph.D. thesis, The University of Auckland.

The Australian National University

Emma Crean

Crean, E 2020, 'Establishing an escherchia coli expression system for the production of intracellular plant immunity receptors', Honours thesis, The Australian National University.

University of Canterbury

Timothy Davies

Williams, S, Titimaea, A, Bosserelle C, Simanu, L & Prasetya, G 2020, 'Reassessment of long-term tsunami hazards in Samoa based on sedimentary signatures', *Geosciences*, vol. 10, p. 481.
Available from: doi:10.3390/geosciences10120481.

University of Canberra

Corey Goodwin

Goodwin, C, Wotherspoon, A, Gahan, M E, & McNevin, D 2020, 'Degradation of nuclear and mitochondrial DNA after γ-irradiation and effect on forensic genotyping', *Forensic Science, Medicine and Pathology*, vol. 16 (3), pp. 395–405.
Available from: doi:10.1007/s12024-020-00251-2.

CSIRO

Meltem Bayrak

Bayrak, M, Mata, J, Raynes, J, Conn, C E, Floury, J & Logan, A 2019, 'The effect of differences in protein structure on digestibility', Poster presented at the International Congress on Engineering and Food (ICEF13), Melbourne, Australia, September 2019.

Bayrak, M, Mata, J, Raynes, J, Conn, C E, Floury, J & Logan, A 2020, 'The effect of microstructure on digestibility of micellar casein gels', Oral presentation delivered at the 32nd Australian Colloid and Surface Science Conference, Melbourne, Australia, January 2020.

Bayrak, M, Mata, J, Raynes, J, Conn, C E, Floury, J & Logan, A 2020, 'Understanding in vitro gastric digestion of casein gels by ultra-small and small-angle scattering', Poster presented at the 15th International Food Hydrocolloid Conference, Melbourne, Australia, March 2020.

Bayrak, M, Mata, J, Raynes, J, Conn, C E, Floury, J & Logan, A 2020, 'Neutron scattering for the study of casein gel microstructure during digestion', Oral presentation delivered at the ANBUG AINSE Neutron Scattering Symposium (AANSS) 2020, Online, November 2020.

Francesca Gissi

Gissi, F 2019, 'Biological effects of nickel on tropical marine biota to underpin the development of water quality guidelines for metals', Ph.D. thesis, University of Wollongong / CSIRO.

Curtin University

Mitchell Klenner

Klenner, M A, Zhang, B, Ciancaleoni, G, Howard, J K, Maynard-Casely, H E, Clegg, J K, Massi, M, Fraser, B H & Pascali, G 2020, 'Rhenium(I) complexation–dissociation strategy for synthesising fluorine-18 labelled pyridine bidentate radiotracers', *Royal Society of Chemistry*, vol. 10, pp. 8853–8865.
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Klenner, M 2019, 'A novel radiofluorination method for the design of Rhenium(I) PET-Optical hybrid nuclear medicines', Ph.D. thesis, Curtin University.

Mattia Saccò

Saccò, M, Blyth, A J, Humphreys, W F, Cooper, S J B, Austin, A D, Hyde, J, Mazumder, D, Hua, Q, White, N E & Grice, K 2020, 'Refining trophic dynamics through multi-factor Bayesian mixing models: A case study of subterranean beetles', *Ecology and Evolution*, vol. 10 (16), pp. 8815–8826.
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Saccò, M, Blyth, A J, Humphreys, W F, Karasiewicz, S, Meredith, K T, Laini, A, Cooper, S J B, Bateman, P W & Grice, K 2020, 'Stygofaunal community trends along varied rainfall conditions: Deciphering ecological niche dynamics of a shallow calcrete in Western Australia', *Ecohydrology*, vol. 13, p. e2150.
Available from: doi:10.1002/eco.2150.

Saccò, M, Blyth, A, Humphreys, W, Middleton, J, White, N, Campbell, M, Mousavi-Derazmahalleh, M, Laini, A, Hua, Q, Meredith, K, Cooper, S, Griebler, C, Allard, S, Grierson, P & Grice, K 2020, 'Tracking down carbon inputs underground from an arid zone Australian calcrete', *PLoS ONE*, vol. 15 (8), p. e0237730.
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Deakin University

James Maina

Maina, J W, Pozo-Gonzalo, C, Schütz, J A, Wang, J & Dumée, L F 2019, 'Tuning CO_2 conversion product selectivity of metal organic frameworks derived hybrid carbon photoelectrocatalytic reactors', *Carbon*, vol. 148, pp. 80-90.
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Anne Katrin Mester

Mester, K A 2020, 'Precipitation mechanisms in an Al-Cu-Li alloy with Sc and Zr modification', Ph.D. thesis, Deakin University.

Jingshi Wang

Wang, J, Vongsvivut, J, Tobin, M J, Dumée, L F & Kong L 2020, 'Tight ultrafiltration membranes developed for perfluoroalkyl (PFAS) compounds rejection', Oral presentation delivered at the International Membrane Science & Technology Conference (IMSTEC) 2020, Sydney, Australia, February 2020.

Federation University

Giri Kattel

Kattel, G R, Eyre, B D & Gell, P A 2020, 'Integration of palaeo-and-modern food webs reveal slow changes in a river floodplain wetland ecosystem', *Scientific Reports*, vol. 10, p. 12955.
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Flinders University

Solheim, T E, Salvemini, F, Dalziel, S B & Raston, C L 2019, 'Neutron imaging and modelling inclined vortex driven thin films', *Scientific Reports*, vol. 9, p. 2817.
Available from: doi:10.1038/s41598-019-39307-x.

Melanie Fuller

Fuller, M, Whiley, H & Köper, I 2020, 'Antibiotic delivery using gold nanoparticles', *SN Applied Sciences*, vol. 2, p. 1022.
Available from: doi:10.1007/s42452-020-2835-8.

Fuller, M, Carey, A, Whiley, H, Kurimoto, R, Ebara, M & Köper, I 2019, 'Antibiotic delivery using gold nanoparticles', *RSC Advances*, vol. 9 (52), pp. 30064–30070.
Available from: doi:10.1039/C9RA06398F.

Fuller, M 2019, 'The gold standard; Enhancing antibiotic effectiveness through gold nanoparticles', Ph.D. thesis, Flinders University.

Griffith University

Mostafa Masud

Masud, M, Mahmudunnabi, R, Aziz, N, Stevens, C, Do-Ha, D, Yang, S, Blair, I, Hossain, M, Shim, Y-B, Ooi, L, Yamauchi, Y & Shiddiky, M 2020, 'Sensitive detection of motor neuron disease (MND) derived exosomal miRNA using electrocatalytic activity of gold-loaded superparamagnetic ferric oxide', *ChemElectroChem*, vol. 7, pp. 3459–3467.
Available from: doi:10.1002/celc.202000828.

Kaitlyn O'Mara

O'Mara, K, Fry, B, & Burford, M 2020, 'Changes in benthic microalgae biomass and brown tiger prawn penaeus esculentus body condition following a large cyclone-driven flood in Moreton Bay', *Estuaries and Coasts*, vol. 67, pp. 1–12.
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O'Mara, K, Adams, M, Burford , M A, Fry, B & Cresswell, T 2019, 'Uptake and accumulation of cadmium, manganese and zinc by fisheries species: Trophic differences in sensitivity to environmental metal accumulation', *Science of The Total Environment*, vol. 690, pp. 867–877.
Available from: doi:10.1016/j.scitotenv.2019.07.016.

O'Mara, K 2019, 'The effects of floods on estuarine fisheries and food webs', Ph.D. thesis, Griffith University.

James Cook University

Emma Rehn

Rehn, E 2020, 'Fire and environmental change in Northern Australian Savannas during the Holocene', Ph.D. thesis, James Cook University.

Sean Ulm

Hua, Q, Ulm, S, Yu, K, Clarke, T R, Nothdurft, L D, Leonard, N D, Pandolfi, J M, Jacobsen, G E & Zhao, J-X 2020, 'Temporal variability in the Holocene marine radiocarbon reservoir effect for the Tropical and South Pacific', *Quaternary Science Reviews*, vol. 249, p. 106613.
Available from: doi:10.1016/j.quascirev.2020.106613.

Macquarie University

Karen Lamont

Lamont, K, Saintilan, N, Kelleway, J, Mazumder, D & Zawadzki, A 2020, 'Thirty-year repeat measures of mangrove above- and below-ground biomass reveals unexpectedly high carbon sequestration', *Ecosystems*, vol. 23, pp. 370–382.
Available from: doi:10.1007/s10021-019-00408-3.

Cassandra Leith

Leith, C 2020, 'The effect of binge and chronic methamphetamine use on rodent social interactions and ultrasonic vocalisations', Honours thesis, Macquarie University.

Neil Saintilan

Rogers, K, Kelleway, J, Saintilan, N, Megonigal, J, Adams, J, Holmquist, J, Lu, M, Schile-Beers, L, Zawadzki, A, Mazumder, D, & Woodroffe, C 2019, 'Wetland carbon storage controlled by millennialscale variation in relative sea-level rise', *Nature*, vol. 567, pp. 91–95.
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Saintilan, N, Khan, N S, Ashe, E, Kelleway, J J, Rogers, K, Woodroffe, C D & Horton, B P 2020, 'Thresholds of mangrove survival under rapid sea level rise', *Science*, vol. 368, pp. 1118–1121.
Available from: doi:10.1126/science.aba2656.

Rory Williams

Williams, R T, Fryirs, K A & Hose, G C 2020, 'The hydrological function of a large chain-of-ponds: a wetland system with intermittent surface flows', *Aquatic Sciences*, vol. 82, p. 61.
Available from: doi:10.1007/s00027-020-00735-x.

The University of Melbourne

Katherine Davies

Davies, K A, Fitzgibbon, C, Young, S N, Garnish, S E, Yeung, W, Coursier, D, Birkinshaw, R W, Sandow, J J, Lehmann, W I L, Liang, L-Y, Lucet, I S, Chalmers, J D, Patrick, W M, Kannan, N, Petrie, E J, Czabotar, P E & Murphy, J M 2020, 'Distinct pseudokinase domain conformations underlie divergent activation mechanisms among vertebrate MLKL orthologs', *Nature Communications*, vol. 11(1), p. 3060.
Available from: doi:10.1038/s41467-020-16823-3.

Samson, A L, Zhang, Y, Geoghegan, N D, Gavin, X J, Davies, K A, Mlodzianoski, M J, Whitehead, L W, Frank, D, Garnish, S E, Fitzgibbon, C, Hempel, A, Young, S N, Jacobsen, A V, Cawthorne, W, Petrie, E J, Faux, M C, Shield-Artin, K, Lalaoui, N, Hildebrand, J M, Silke, J, Rogers, K L, Lessene, G, Hawkins, E D & Murphy, J M 2020, 'MLKL trafficking and accumulation at the plasma membrane control the kinetics and threshold for necroptosis', *Nature Communications*, vol. 11, p. 3151.
Available from: doi:10.1038/s41467-020-16887-1.

Davies, K 2020, 'Mechanistic studies of MLKL mediated cell death', Ph.D. thesis, The University of Melbourne.

Damien Finch

Finch, D, Gleadow, A, Hergt, J, Levchenko, V A & Fink, D 2019, 'New developments in the radiocarbon dating of mud wasp nests', *Quaternary Geochronology*, vol. 51, pp. 140–154.
Available from: doi:10.1016/j.quageo.2019.02.007.

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Giri Kattel

Kattel, G R, Eyre, B D & Gell, P A 2020, 'Integration of palaeo-and-modern food webs reveal slow changes in a river floodplain wetland ecosystem', *Scientific Reports*, vol. 10, p. 12955.
Available from: doi:10.1038/s41598-020-69829-8.

Sarah McDonald

McDonald, S, Cresswell, T & Hassell K 2020, 'Bioaccumulation kinetics of cadmium and zinc in the freshwater decapod crustacean Paratya australiensis following multiple pulse exposures', *Science of The Total Environment*, vol. 720, p. 137609.
Available from: doi:10.1016/j.scitotenv.2020.137609.

Michaela Mariani

Beck, K K, Mariani, M, Fletcher, M-S, Schneider, L, Aquino-López, A, Gadd, P S, Heijnis, H, Saunders, K M & Zawadzki, A 2020, 'The impacts of intensive mining on terrestrial and aquatic ecosystems: A case of sediment pollution and calcium decline in cool temperate Tasmania, Australia', *Environmental Pollution*, vol. 265 (Part A), p. 114695.
Available from: doi:10.1016/j.envpol.2020.114695.

Yanxiang Meng

Meng, Y, Sheen, C R, Magon, N J, Hampton, M B & Dobson, R C J 2020, 'Structure-function analyses of alkylhydroperoxidase D from Streptococcus pneumoniae reveal an unusual three-cysteine active site architecture', *Journal of Biological Chemistry*, vol. 295 (10), pp. 2984–2999.
Available from: doi:10.1074/jbc.RA119.012226.

Ellie-Rose Rogers

Rogers, E-R 2020, 'Cultural landscapes: a case study from Northwest Tasmania', Honours thesis, The University of Melbourne.

Monash University

Luke Giles

Giles, L W, Marlow, J B, Butler, C S G, Turpin, G A, de Campo, L D, Mudie, S T, Faul, C F J & Tabor, R F 2020, 'Structural relationships for the design of responsive azobenzene-based lyotropic liquid crystals', *Physical Chemistry Chemical Physics*, vol. 22, pp. 4086–4095. Available from: doi:10.1039/C9CP05463D.

Giles, L W, Meaney, S P, Prathapan, R, Pottage, M J, Knowles, G P, Chaffee, A L, Batten, S R Tabor, R F 2020, 'Surfactant-controlled crystal growth of metal–organic frameworks and their nanoporous pyrolysis products', *Materialia*, vol. 13, p. 100849. Available from: doi:10.1016/j.mtla.2020.100849.

Adam Kennedy

Kennedy, A, Belgi, A, Husselbee, B, Spanswick, D, Norton, R & Robinson, A 2020, 'α-conotoxin peptidomimetics: Probing the minimal binding motif for effective analgesia', *Toxins*, vol. 12 (8), pp. 505–530. Available from: doi:10.3390/toxins12080505.

Joshua Marlow

Marlow, J 2020, 'Nanoparticles and liquid crystals: The effects of size, shape, shear, surface chemistry, temperature, and concentration on structure and rheology', Ph.D. thesis, Monash University.

Thomas McCoy

McCoy, T M, Marlow, J B, Armstrong, A J, Clulow, A J, Garvey, C J, Manohar, M, Darwish, T A, Boyd, B J, Routh, A F & Tabor, R F 2020, 'Spontaneous self-assembly of thermoresponsive vesicles using a zwitterionic and an anionic surfactant', *Biomacromolecules*, vol. 21 (11), pp. 4569–4576. Available from: doi:10.1021/acs.biomac.0c00672.

Peije Russell

Russell, P, Esser, L, Peng, B, Xue, Y, Lengkeek, N & Voelcker, N 2020, 'One pot synthesis of a personalised medicine for diagnosis and treatment of inoperable brain tumours', Poster presented at the International Conference of Undergraduate Research (ICUR) 2020, Online, September 2020.

Russell, P 2020, 'One pot synthesis of a tumour responsive theranostic agent for treatment and diagnosis of inoperable cancer', Oral presentation delivered at the Australian Society for Medical Research (ASMR) Student Symposium, Online, November 2020.

Russell, P 2020, 'One pot synthesis of a tumour responsive nanotheranostic agent for the treatment and diagnosis of inoperable cancers', Honours thesis, Monash University.

Anne Whitworth

Whitworth, A J, Brand, H E A & Frierdich, A J 2020, 'Iron isotope exchange and fractionation between jarosite and aqueous Fe(II) in acid-sulfate systems', *Chemical Geology*, vol. 554, p. 119802. Available from: doi:10.1016/j.chemgeo.2020.119802.

Whitworth, A J, Brand, H E A, Wilson, S A & Frierdich, A J 2020, 'Iron isotope geochemistry and mineralogy of jarosite in sulfur-rich sediments', *Geochimica et Cosmochimica Acta*, vol. 270, pp. 282-295. Available from: doi:10.1016/j.gca.2019.11.029.

Whitworth, A 2020, 'Iron isotope geochemistry and crystal chemistry of jarosite in acidic, sulfate–rich environments', Ph.D. thesis, Monash University.

Ashley Williams

Williams, A P, King, J P, Sokolova A V, de Campo, L & Tabor, R F 2020, 'In situ nanostructural analysis of concentrated wormlike micellar fluids comprising sodium laureth sulfate and cocamidopropyl betaine using small-angle neutron scattering', *Langmuir*, vol. 36 (47), pp. 14296–14305. Available from: doi:10.1021/acs.langmuir.0c02530.

The University of Newcastle

Matthew Goodwin

Goodwin, M, Verdoo-Kidd, D, Allen, K, Hua, Q, English, N B & Haines, H 2020, 'Grey mangrove wood anatomy and stable isotopic composition: Novel proxies for East Australain hydroclimate', Oral presentation delivered at the Australian Meterological and Oceanographic Society Conference, Fremantle, Australia, February 2020.

Alexander Gregg

Gregg, A W T, Hendriks, J N, Wensrich, C M & O'Dell, N 2020, 'Radial basis functions and improved hyperparameter optimisation for gaussian process strain estimation', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, vol. 480, pp. 67-77. Available from: doi:10.1016/j.nimb.2020.08.003.

Gregg, A 2020, 'Neutron strain tomography', Ph.D. thesis, The University of Newcastle.

Ben Humphreys

Willott, J D, Humphreys, B A, Webber, G B, Wanless, E J & de Vos, W M 2019, 'Combined experimental and theoretical study of weak polyelectrolyte brushes in salt mixtures', *Langmuir*, vol. 35 (7), pp. 2709–2718. Available from: doi:10.1021/acs.langmuir.8b03838.

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International SAAFE Scholars

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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
FED	Federation University
FLI	Flinders University
GRI	Griffith University
JAM	James Cook University
LAT	La Trobe University
MAC	Macquarie University
MAS	Massey 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
UWS	Western Sydney University
VIC	Victoria University
VUW	Victoria University of Wellington
WAI	The University of Waikato
WOL	University of Wollongong

Industry Member

VAC	Vacuum Society of Australia

Specialist Areas

AGES	Archaeology, Geosciences and Environmental Sciences
BBS	Biomedical Science and Biotechnology
MSE	Materials Science and Engineering

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Cover Image: Researchers prepare to take ice algae samples in Van Mijenfjorden, Svalbard. AINSE PGRA scholar Rebecca Duncan, a PhD student from the University of Technology Sydney, is using FTIR microspectroscopy at ANSTO's Australian Synchrotron to investigate the impact of projected climate change effects and sea ice decline in the Arctic on the nutritional content of dominant sea ice algal species.

Image credit: Rebecca Duncan, AINSE PGRA scholar.