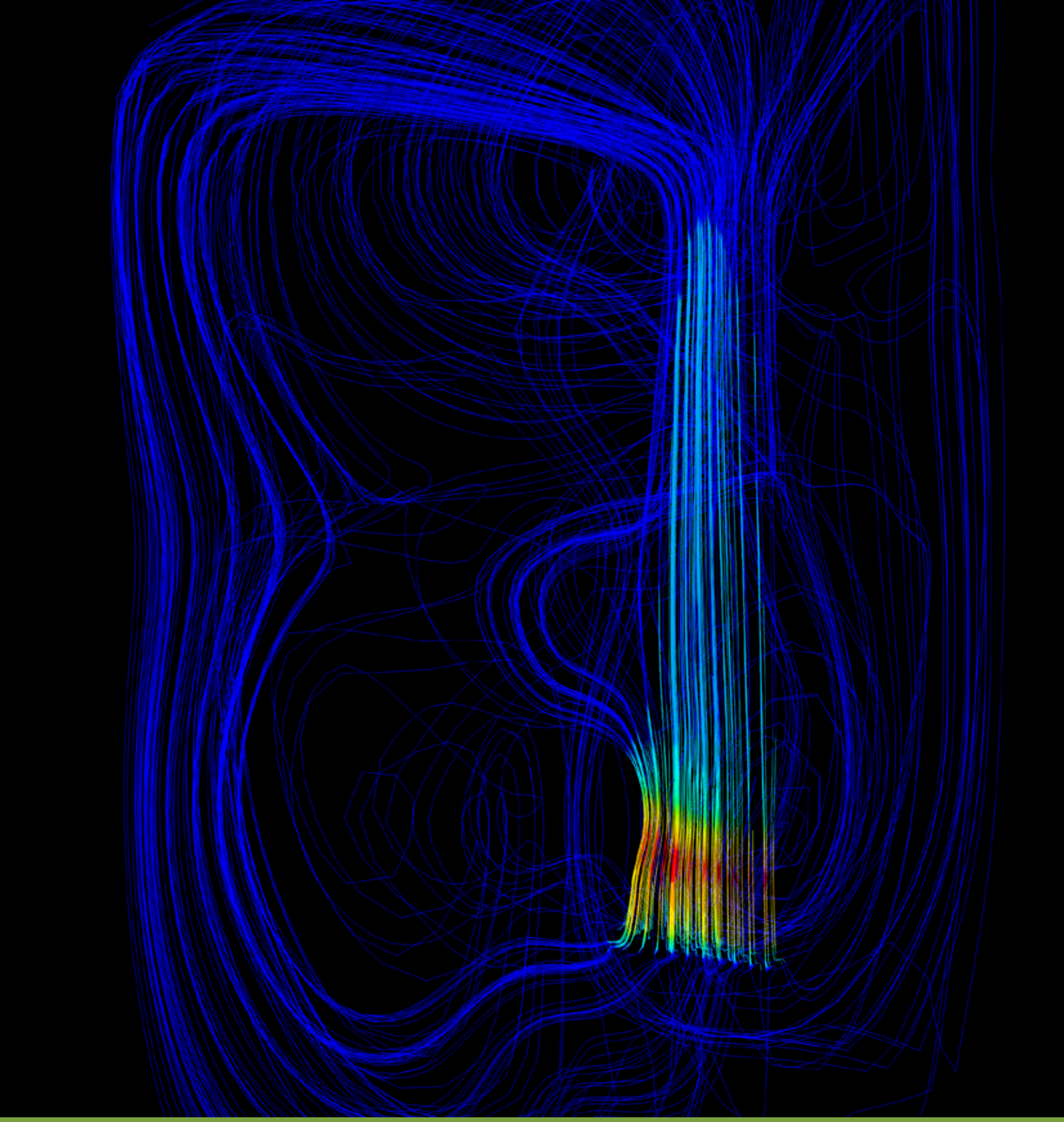

ANNUAL REPORT 2019

AINSE

THE AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

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

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

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

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

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

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

CONTENTS

AINSE 2019 Annual Report

From the President and the Managing Director

AINSE commenced 2019 with a new strategic plan to develop opportunities for the business through: facilitating research collaborations; creating a large pipeline of skilled researchers; providing new opportunities nationally and internationally; and being a visible, highly respected brand that is resourced to provide sustainable growth while remaining responsive in a changing environment.

In recent years AINSE has been adapting to significant changes in the ANSTO access model and therefore the membership benefits. In 2019, AINSE continued this journey by adding an early career funding opportunity to the programs developed in 2017. These programs provide a range of opportunities for members to enhance their capabilities in nuclear science and engineering and related fields.

One highlight for 2019 was the release of a new AINSE website, which has streamlined all aspects of the business into a modernised platform. This website, together with an expansion of social media channels, has allowed AINSE to highlight its collaborative potential and increase the value of the brand beyond nuclear scientists and engineers to a wider audience.

Another highlight 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 2019, Dr. Lydia Mackenzie from the University of Queensland was presented with an AINSE Gold Medal in front of an audience of assembled AINSE Councillors. At the General Meeting of AINSE in November 2019, members voted to award Dr. Cynthia Isley from Macquarie University and Dr. Gabriel Murphy from the University of Sydney each with an AINSE Gold Medal for outstanding PhD research. These will be presented in May 2020.

AINSE offered a variety of funding opportunities throughout 2019, including: Honours Scholarships; Postgraduate Research Awards (PGRA); Residential Student Scholarships (RSS); Scholarship AINSE ANSTO French Embassy (SAAFE); Early Career Researcher Grants (ECRG) and International Travel Scholarships. AINSE awarded 30 new Honours scholarships to support students from 13 members, 29 new PGRAs from 21 members, and four new RSS scholarships.

The most highly funded AINSE program, the Postgraduate Research Awards, supported 93 PhD students in 2019. During the year 24 theses were received and 13 students completed their higher degree research programs.

2019 saw an increase in successful applications for the Scholarship AINSE ANSTO French Embassy (SAAFE) program, with seven new scholars approved to undertake internship opportunities between Australia and France. The SAAFE program facilitates collaborations between Australia and France in nuclear science and engineering. In 2019 the scope was increased to allow the participation of postdoctoral researchers in addition to postgraduate students. This program has provided AINSE with valuable experience in reaching out to international facilities to expand collaborative opportunities.

AINSE staff alongside the new cohort of postgraduate scholars at the AINSE Postgraduate Orientation Week, October 2019.

In 2019, AINSE offered Early Career Researcher Grants (ECRG) for the first time to support postdoctoral researchers in the first five years of their post-PhD research career. This new grant attracted applications from 26 different members, 12 of which were approved for funding. The ECRG covers travel and accommodation, consumables, as well as carer requirements.

AINSE supported travel for nine conferences as well as 27 students to attend 25 international conferences. This enabled AINSE to enhance its international presence and build AINSE as a globally recognised brand. To further enhance international presence, Dr. Michael Rose, AINSE's Communications and STEM Manager, represented AINSE in Japan as the first delegate from Australia at the Research Reactor School on Reactor Physics, Neutron Applications and Reactor Operations for the Asia-Pacific Region. This helped to strengthen the possibility of collaborations between AINSE and Japanese facilities and universities.

The AINSE schools continued to play a major role in creating a pipeline of skilled students to further enhance capacity in nuclear science, engineering and related research fields. AINSE held three schools in 2019: the AINSE Winter School; Postgraduate Orientation Week; and the Women in STEM and Entrepreneurship (WISE) School.

The AINSE Winter School celebrated its 23rd year and was attended by 62 students from 39 Universities. The capacity of this school was increased in 2018 and this higher attendance rate was maintained in 2019, maximising the opportunities for students to participate in the ANSTO experimental sessions. This week-long event provided the opportunity for senior undergraduate participants to gain hands-on experience across a wide range of ANSTO's facilities. One highlight of this experience identified by attendees was the opportunity to attend the Research Roundup networking dinner, where students were able to network with ANSTO researchers and senior staff. This event led to collaborations that developed into further research projects proposed for 2020.

The next school in the 2019 AINSE calendar was the Postgraduate Orientation Week, where new PhD scholars were invited to attend the ANSTO Lucas Heights campus in order to network with their fellow AINSE scholars from the Postgraduate Research Award Program (PGRA) and the Residential Student Scholarship (RSS) programs, gain an overview of ANSTO research programs 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, a global event celebrating the benefits of nuclear science.

The final school of the year was the WISE School, in which 62 students from 35 Universities participated. The WISE School commenced with a visit to the ANSTO Lucas Heights campus where first-year female undergraduate students had the opportunity to meet high-profile researchers and learn about ANSTO. At this time, students were also introduced to their new mentors, drawn from a group of ANSTO researchers who commit to engaging with the students for a minimum of 12 months following the initial school.

We would like to thank the AINSE team for their tireless efforts in 2019. As usual, this small team continued to provide opportunities to hundreds of researchers with seemingly endless enthusiasm. In 2019 we welcomed a new staff member, Cara Smith, into a new Membership Officer position. Business Manager Paul Graydon left the team, replaced by Kim Shields, and Michael Rose took up a new position as the Communications and STEM Manager. We congratulate Nerissa Phillips for her 25 years of service to AINSE. We are fortunate that we are able to draw upon Nerissa's valuable insights and corporate knowledge gained over her longstanding service to the business. Joshua Keegan worked as a casual Administration Assistant and Lillian Caruana joined AINSE at the end of the year in a similar role.

AINSE finished 2019 with a deficit of $12,826, which was lower than the expected deficit of $62,400. This leaves the company in a strong financial position for 2020. This strong position is also attributable to the ongoing collaborative support of our AINSE Member Representatives, AINSE Member Researchers, and ANSTO staff. We thank Dr. Adi Paterson, Chief Executive Officer of ANSTO, for allowing us to utilise the ANSTO facilities and collaborate with the ANSTO staff to maximise benefits for our members.

We express thanks to the AINSE Board for their strong governance and guidance through 2019. The Board has implemented the new strategic plan and looks forward to working with this framework for the next four years. This new plan sets AINSE up for success in the future by enhancing reputation, membership base, and global connections.

We finish by thanking Professor Claire Lenehan for her leadership as President of AINSE through the first half of the year and for the years prior. Claire commenced the President role in 2016 and has been so thoughtful with her careful and considered approach to the changing model of AINSE and how to enhance benefits to all members.

We look forward to continuing our new programs in 2020 and utilising the diversity of the AINSE Secretariat and AINSE Board in working towards our strategic goals.

Prof. Ian Gentle
AINSE President

Ms. Michelle Durant
AINSE Managing Director

AINSE Board 2019

Prof. Ian Gentle
President
University Representative

Ms. Michelle Durant
Managing Director

Dr. Peter Coldrey
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

Former Board Member during 2019:

Prof. Claire Lenehan
President
University Representative
Concluded 22nd August 2019

The AINSE staff. Top left: Joshua Keegan. Top right: Mitchell Klenner. Above, from L to R: Michelle Durant, Kim Shields, Lillian Caruana, Nerissa Phillips, Cara Smith, and Michael Rose

AINSE Staff:

Managing Director:

Michelle Durant
BSc, BFinAdmin, GradDipAppCorpGov, FGIA, FCIS

Secretariat:

Business Manager:
Kim Shields (commenced Oct 2019)
GradCertMgt, AIPA AFA

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

Membership Officer:
Cara Smith (commenced May 2019)
BA

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

Administration Assistant:
Joshua Keegan (casual)

Administration Assistant:
Lillian Caruana (casual, commenced Oct 2019)
BLS

Scientific Officer:
Mitchell Klenner (short-term casual position, 3 months duration)
BSc(Hons)

Business Manager:
Paul Graydon (concluded May 2019)
BEc, CPA

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.

RSS student Patrick Adams sampling for in-situ Beryllium-10 in Arthur's Pass, New Zealand, in order to reconstruct the deglacial sequence in the valley and examine how the climate has changed over the past 30,000 years.

Research Highlights

Using isotopic and elemental fingerprints to determine the provenance of tiger prawns

Karthik Gopi[1], Debashish Mazumder[1,2,3], Jesmond Sammut[1,2], Neil Saintilan[3], Jagoda Crawford[2], Patricia Gadd[2]

[1] Centre for Ecosystem Science, School of Biological, Earth and Environmental Sciences, The University of New South Wales, Sydney, NSW, Australia.

[2] Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Lucas Heights, NSW, Australia.

[3] Department of Environmental Sciences, Macquarie University, Sydney, NSW, Australia.

As the population of the world increases, the demand for seafood will increase accordingly. The increased demand will likely lead to a higher number of reported instances of seafood fraud. To date, there is no single method which can be utilised to combat this issue.

However, a combination of the isotopic and elemental fingerprints of seafood can be utilised to determine provenance with high accuracy. This enables consumers to purchase seafood with confidence of its origin. Additionally, the fingerprinting helps seafood industries to comply with regulations.

The global population is predicted to reach 10 billion by the year 2050 (United Nations 2015), which will subsequently increase the demand for food. The seafood industry is one of the fastest-growing food sectors (FAO 2018), generating an estimated $151 billion USD per annum (OECD 2017).

The seafood trade is expected to increase in value to meet growing demand. However, this is also likely to increase instances of *food fraud*; that is, practices in which seafood is deliberately substituted, tampered with or misrepresented in order to increase profitability (Spink & Moyer 2011). The global food industry loses around $52 billion USD per annum to food fraud (PricewaterhouseCoopers 2016).

In recent times, there has been a growing number of cases where seafood fraud has been detected in various countries (Huang et al. 2014, Rehbein 2008, Hsieh et al. 2010). This type of mislabelling can negatively affect the health of consumers if the seafood products contain banned substances or pathogens. It can also reduce consumer confidence in seafood products (Henson et al. 2005, Gale & Buzby 2009). Therefore, methods of determining seafood provenance are necessary to ensure consumer confidence and to allow seafood industries to meet certification requirements.

The global food industry loses around $52 billion USD per annum to food fraud.

There are several methods currently available to determine the provenance of seafood, all with their own set of advantages and drawbacks (Primrose et al. 2010). To our knowledge, there is no single method that can fully resolve the chances of determining the provenance of seafood (Gopi et al. 2019). In order to improve provenance determination, the Australian Nuclear Science and Technology Organisation (ANSTO) partnered with the University of New South Wales (UNSW) and Macquarie University for proof-of-concept research that uses cutting edge methods, as

...this research will allow the seafood industry to meet regulatory requirements while providing consumers with confidence when purchasing their seafood.

well as statistical analyses, to determine the provenance of seafood.

Stable isotope analysis (SIA) is typically utilised in environmental studies to determine the stable carbon and nitrogen isotopes for food web analysis (Peterson and Fry 1987, Fry 1991, Post 2002). These isotopic values are unique to each organism, based on diet composition, use of formulated feeds and varying environmental conditions (Kling et al. 1992, Fry 2006, Mazumder et al. 2017). Similarly, the elemental profile of an organism can be influenced by water, diet, climate and also management practices in the case of aquaculture (Alasalvar et al. 2002, Roy & Lall 2006, Yamashita et al. 2006). Therefore it is postulated that, based on geographic locations and production methods, the isotopic and elemental fingerprints of tiger prawns (*Penaeus monodon*) will be significantly different.

SIA, along with X-ray fluorescence (XRF) measurements from Itrax at ANSTO, were used to determine the isotopic and elemental fingerprints of farmed and wild-caught *P. monodon* from a range of Asia-Pacific locations. The use of XRF through Itrax is unique as it is typically used to scan sediment core samples. However, Gadd et al. (2018) modified and adapted this technique to scan soft biological tissues. Multiple statistical analyses on the isotopic and elemental fingerprints were used to create models which determined whether the fingerprints were significantly different between production methods and geographic locations.

The models found that determining the provenance of *P. monodon* is possible with an accuracy of 95% when using the isotopic fingerprint and 100% when using the elemental fingerprint. However, in both cases there were a number of incorrect predictions of

Figure 1: New Zealand snapper and rainbow trout being sold at a fish market. Authentic samples are a necessary part of this research and were collected with the help of Sydney Fish Market.

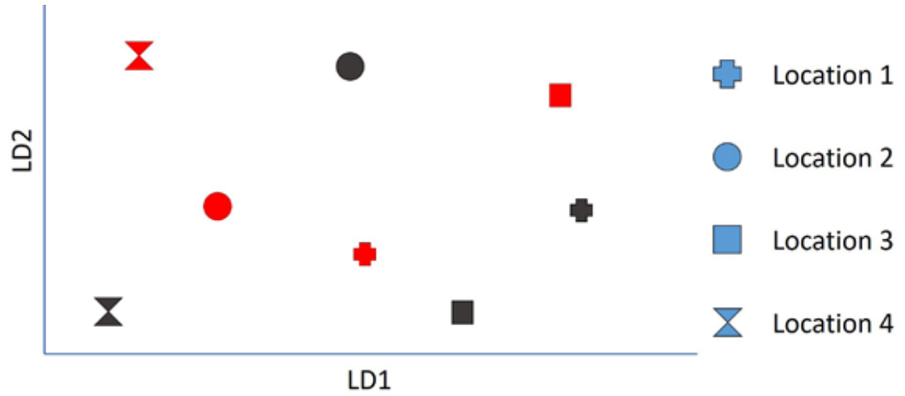

Figure 2: Conceptual diagram using both stable isotope analysis (SIA) and X-ray fluorescence (XRF) measurements from Itrax to distinguish the provenance of Penaeus monodon *with no incorrect predictions. Black indicates farmed, red indicates wild-caught).*

provenance when the models were tested. To overcome this issue the isotopic and elemental fingerprints were combined into a single dataset, which returned an accuracy of 97% with no incorrect predictions of provenance. The overall accuracy of the combined dataset suggests that a combination of methodologies is ideally suited for determining the provenance of seafood.

The proof of concept has demonstrated the efficacy of isotopic and elemental analyses in determining seafood provenance. Subsequently, a seafood consortium has been established with ANSTO, UNSW, Macquarie University, the National Measurement Institute (NMI) and Sydney Fish Market (SFM) to pursue a larger scale study to further test and refine the methodologies using *P. monodon* and Australasian snapper (*Pagrus auratus*). It is expected that this research will allow the seafood industry to meet regulatory requirements while providing consumers with confidence when purchasing their seafood.

The authors want to thank all our consortium partners including ANSTO, UNSW, Macquarie University, NMI, and SFM for providing funding and in-kind support for sample analyses. The authors also extend their thanks to Prof. Peter Holden and Prof. Henk Heijnis (ANSTO) for continued support of this research. The Australian Institute of Nuclear Science and Engineering (AINSE) has provided support for this project in the form of a Residential Student Scholarship.

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A new late-Holocene dust record tracking environmental response in Argentina's Puna-Altiplano

James Hooper[1], Samuel K. Marx[1], Jan-Hendrik May[1,2], Liliana C. Lupo[3], Julio J. Kulemeyer[4], Elizabeth d. l. Á. Pereira[3], Osamu Seki[5], Henk Heijnis[6], David Child[6], Patricia Gadd[6], Atun Zawadzki[6]

[1] GeoQuEST Research Centre, School of Earth and Environmental Sciences, The University of Wollongong, NSW, Australia.

[2] School of Geography, The University of Melbourne, VIC, Australia.

[3] Laboratorio de Palinología Facultad de Ciencias Agrarias, UNJu, Instituto de Ecorregiones Andinas (INECOA) UNJu-CONICET.

[4] Instituto de Datación y Arqueometría (InDyA) CONICET-UNJu-UNT-Gobierno de Jujuy.

[5] Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo 060-0819, Japan.

[6] Institute for Environmental Research, Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Lucas Heights, NSW, Australia.

The southern Puna-Altiplano plateau sits at the nexus of some of the world's most distinct and extreme bio-regions.

The high-altitude Andean spine acts as a barrier to tropospheric circulation (Garreaud et al. 2009), resulting in a dramatic moisture contrast between the hyper-arid Atacama desert to the south-west and the humid Amazon basin to the north-east. The Puna-Altiplano therefore forms the meeting point between cool mid-latitude westerlies and warm, moist airmasses from the Atlantic Ocean and Amazon Basin.

Constructing palaeo records from this transition zone is critical for understanding the interplay between the tropical and sub-polar synoptic systems that dominate the South American climate, including the strength of the South American Summer Monsoon (SASM) and northern influence of the mid-latitude Westerlies.

A 58.5 cm core, termed the SVC (Santa Victoria Core), was collected from the centre of a minerotrophic peat bog situated in a small east-facing cirque at ~4300 m above sea level in Santa Victoria province, Argentina (22.224° S, 65.097° W) (Figure 1). Peat bogs, particularly ombrotrophic (rain-fed) peat bogs, have previously been shown to be good sites for developing dust flux records (see for example Marx et al. 2018).

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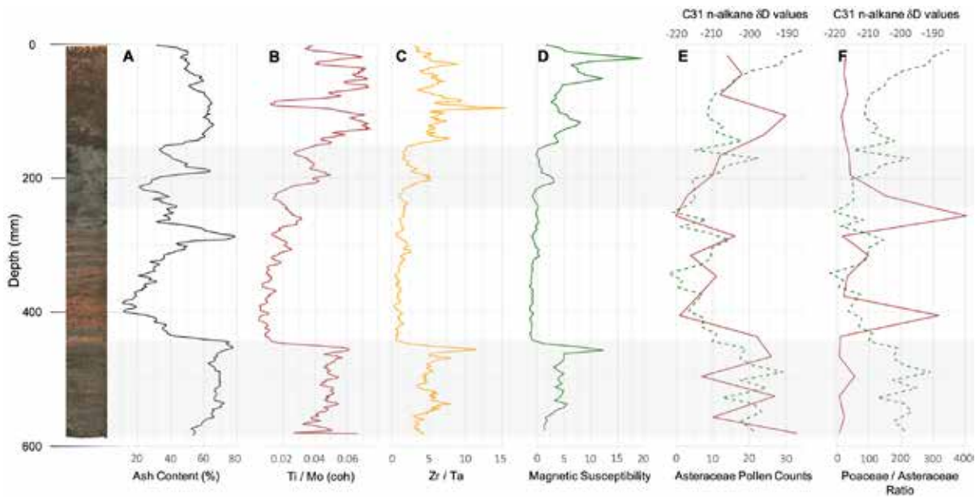

Figure 1: ITRAX image of the studied core shown alongside (a) the ash content determined from Loss on Ignition, (b) Ti/Mo (coh) and (c) the Zr/Ta determined by ITRAX μXRF; (d) Magnetic susceptibility κ, (e) Asteraceae *shrub pollen counts (lower axis, brown line) and* C_{31} n*-alkanes (upper axis, green line), and (f) the* Poaceae *grass/*Asteraceae *shrub pollen ratio (lower axis, brown line) and* C_{31} n*-alkanes (upper axis, green line). The shaded bands denote the four time period zones of the core.*

The results of the core analyses show that from the beginning of the record at ~4200 calendar years before present (BP), and prior to 2600 calendar years BP, relatively arid conditions predominated in the Eastern Cordillera. During this period it is likely that a more northerly position of the Inter Tropical Convergence Zone (ITCZ) resulted in a weaker SASM and less moisture being delivered to the core site and the high-altitude endorheic basins on the Puna-Altiplano.

A major change in climate is recorded after ~2600 calendar years BP. This is evidenced by reduced dust deposition, more negative *n*-alkane δD and increased pollen concentrations, collectively indicating more moist conditions. This change has been concomitantly recognised in other regional records and is likely the result of an increasingly southerly positioning of the ITCZ and a strengthening SASM bringing more frequent and intense precipitation to the core site region.

The wettest period, denoted by low and stable *n*-alkane δD values and a spike in the Poaceae/Asteraceae pollen ratio, occurred between ~1700–1000 calendar years BP. During this period we hypothesise that greater moisture arriving at the core site, in combination with cooler temperatures and more cloud cover, may have resulted in greater and more enduring snow cover at the core site, inhibiting organic peat growth.

After 400 calendar years BP the SASM began to reduce in strength again and the climate and environment around the SVC site dried. This resulted in an increasingly arid environment in the Puna-Altiplano, shown by increasing *n*-alkane δD values, and greatly elevated dust deposition at the core site, likely as a result of drying within the large endorheic basins which would have been recharged with sediment during wetter conditions over the preceding ~2000 years. At the same time, the landscape of the Puna-Altiplano began to experience increasing intensification of human activity which would be expected to increase dust entrainment.

This study demonstrates that the climate and landscape of the Central Andes is highly sensitive to paleoclimate/ environmental change.

This study demonstrates that the climate and landscape of the Central Andes is highly sensitive to paleoclimate/environmental change. In this region, relatively minor forcing factors appear to result in shifts in the position and/or intensity of SASM, which provides the main source of moisture to this landscape. As a result, the SVC records marked paleoenvironmental change over the past ~4000 years. These changes are concurrent with climatic changes recorded in existing studies across the southern hemisphere tropical South American Andes and Altiplano.

The results of this study also re-confirm that paleo-dust emissions are a sensitive tracer of broad-scale landscape change. In this case, dust flux matches both other core proxies and existing regional paleoclimate records, and implies changes in moisture availability have driven changes in dust emissions over the late Holocene in this environment. Specifically, the SVC record shows the shutting off of regional dust emissions associated with the return of moisture and enhanced snow cover in the Puna.

After 400 calendar years BP, a major increase in dust flux is recorded at the SVC site. Although this coincides with a reduction in SASM strength corresponding with regional drying, the predominant cause appears to be related to changing land use following Spanish colonisation. That is, although the period after 400 calendar years BP is associated with enhanced climate variability, which in other settings has been linked to enhanced dust flux, the magnitude of the change is unprecedented by comparison to the previous 3500 years recorded by the SVC core.

The increasing impact of human activity on the Puna-Altiplano at this time is also apparent in the core by increases in Pb flux and a change in the relationship between moisture/temperature and precipitation, as evidenced by *n*-alkane δD values and pollen data. This result confirms the very significant impact that historical land use change (i.e the industrialisation of agriculture and resource extraction) has on dust emissions, as also observed in previous studies (see Hooper & Marx, 2018). That is, even within natural dust producig landscapes, and within landscapes with a long history of human land use (2600 years in this case), intensified human land use can increase dust emissions significantly, i.e. by a factor of 2-5 in this case.

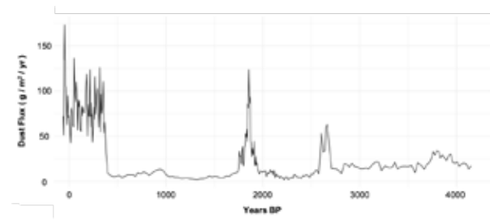

Figure 2: Dust flux (g/m²/yr) through the core.

This study demonstrates that the climate and landscape of the Central Andes is highly sensitive to paleoclimate/environmental change. In this region, relatively minor forcing factors appear to result in shifts in the position and/or intensity of SASM, which provides the main source of moisture to this landscape.

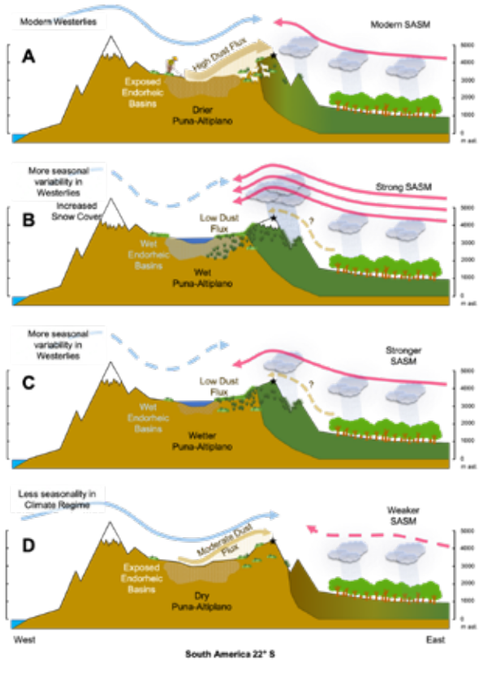

Figure 3: Schematic representing possible prevailing climatic and environmental conditions for each zone of the core. (a) Zone 1 (Present – 400 cal. years BP), (b) Zone 2 (400 – 1,700 cal. years BP), (c) Zone 3 (1,700 – 2,600 cal. years BP), and (d) Zone 4 (2,600 – 4,200 cal. years BP)

As a result, the SVC records marked paleoenvironmental change over the past ~4000 years. These changes are concurrent with climatic changes recorded in existing studies across the southern hemisphere tropical South American Andes and Altiplano.

The results of this study also re-confirm paleo-dust emissions are a sensitive tracer of broad-scale landscape change. In this case, dust flux matches both other core proxies and existing regional paleoclimate records and implies changes in moisture availability have driven changes in dust emissions over the late Holocene in this environment. Specifically, the SVC record shows the shutting off of regional dust emissions associated with the return of moisture and enhanced snow cover in the Puna- Altiplano.

We would like to thank AINSE for providing support for this project through a Postgraduate Research Award. The assistance of the team at the ANSTO Institute of Environmental Research, especially Atun Zawadzki, Prof. Henk Heijnis, Patricia Gadd and Dr. Krystyna Saunders for their help with ^{210}Pb dating, ITRAX core scanning and project guidance, has been hugely appreciated. We would also like to thank Dr. Geraldine Jacobsen and Alan Williams for their assistance with ^{14}C radiocarbon AMS dating, David Child and Dr. Michael Hotchkins for Pu and U isotope analyses, and Dr. Matthew Fischer for support with statistical analyses.

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Urban stormwater runoff: accumulation and effects in aquatic organisms

Sarah McDonald[1], Kathryn Hassell[2], Tom Cresswell[3]

[1] School of BioSciences, The University of Melbourne, Parkville, VIC, Australia.
[2] Aquatic Environmental Stress (AQUEST) group, RMIT University, Bundoora, VIC, Australia.
[3] Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Lucas Heights, NSW, Australia.

Runoff generated during intense storm events often results in an increase in the contaminant loading in urban aquatic environments, where stormwater discharge flushes large quantities of metals into these ecosystems, subjecting resident fauna to short but intense exposures.

Currently, there exists an issue where the water quality guidelines for these urban aquatic environments are derived using data from continuous (chronic) metal exposure tests, with the assumption that chronic exposures are able to predict the effects short-term pulsed exposures may have on resident biota.

Aquatic animals can take up metals from the surrounding water and through their diet, where uptake response is highly varied among taxa, complicating our understanding of how these pulsed discharge events affect resident biota. My research aims to understand the response of local aquatic organisms—the glass shrimp (*Paratya australiensis*) and blue-spot goby (*Pseudogobius sp.*)—to metal pollutants at exposure concentrations and patterns observed during storm events, as a way of assessing the effects these events pose on the urban aquatic environment.

Radiotracing, involving the detection of gamma-emitting metal isotopes, is an effective tool for following the movement (kinetics) and final organ distribution of metals in an organism. Shrimp and fish were exposed to the metals cadmium (^{109}Cd) and zinc (^{65}Zn) during multiple short-term pulses in the ANSTO Aquatic Ecology lab, where the amount of metal was measured in live animals over time.

Following exposure to cadmium and zinc, individually and in a binary mixture, shrimp accumulated both metals over the three consecutive pulses, where the rate of cadmium uptake decreased over each successive pulse. This suggests that repeated exposures, such as those experienced during a storm event, may influence the kinetics of metal uptake.

In the week following exposure, shrimp were able to efficiently eliminate most zinc (75%)

Figure 1: Sampling at a constructed wetland. These wetlands are very common additions to large housing estates in greater Melbourne and tend to have a legacy of metal pollution.

Photo credit: Kathryn Hassell

from their bodies, in contrast to cadmium where whole body levels did not decrease during this time. As part of processing the metals after exposure, shrimp where shown to effectively partition both metals to their liver-like organ, the hepatopancreas, for detoxification and/or storage.

While shrimp readily accumulated metals from water, fish did not take up these metals from water, even after the exposure period was lengthened. Rather, for fish, diet was the primary route of metal uptake, where fish assimilated (retained) both metals after a single feeding event. When fish were fed food over multiple consecutive feeding events, they assimilated a greater amount (almost 5 times the quantity) of both metals, even though the total metal burden received was the same. This may be due to the limited amount of time between exposures for fish to aptly recover and eliminate metals from their whole body.

Zinc, an essential metal required for animal functioning, was readily taken up by the gut and transported by the circulatory system throughout the fish. Consequently, the majority of zinc in the fish was found in the muscles. In contrast, cadmium, a non-essential metal, was primarily detected in the gut, where the metal may have become 'trapped' in mucus following ingestion.

Developing a deeper understanding of the metal uptake preferences among a variety of species will assist in informing current and future stormwater management regimes and regulatory guidelines. From this research I was able to identify that shrimp are sensitive to metal uptake over short exposure periods and may be a fitting biomonitoring species for short-term pulsed metal pollution. In contrast, the reduced ability of the fish to accumulate metals from the surrounding water, and their low to moderate (20-50%) assimilation efficiencies

Figure 2: A blue-spot goby Pseudogobius *sp. in a specially-made radioanalysis container. The aim is for the fish to be kept still for live-animal radioanalysis, which is achieved using a plastic tube and sponge insert.*

Figure 3: Getting ready to place the blue-spot goby into the gamma spectrometer (encased in a lead chamber, behind) for live-animal radioanalysis.

..shrimp are sensitive to metal uptake over short exposure periods and may be a fitting biomonitoring species for short-term pulsed metal pollution.

(i.e. percentage of metal retained), indicated that this species is somewhat tolerant to metal pollution, reflected in their occurrence in some heavily polluted waterways throughout greater Melbourne.

Having taxa-specific knowledge of metal uptake and assimilation is especially pertinent for the continued management of urban aquatic systems that are susceptible to regular fluctuation in pollution input. This research demonstrates how repeated exposures can influence the bioaccumulation and retention of common metal pollutants, highlighting the importance of considering the inclusion of pulsed toxicity tests when deriving water quality guidelines.

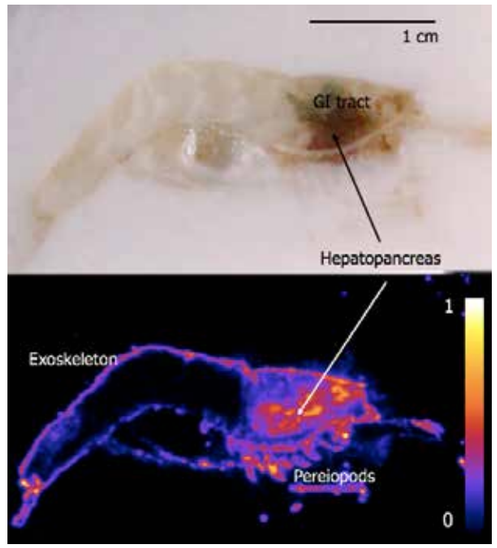

Figure 4: A tissue section (above) and corresponding false coloured autoradiograph (below) illustrating the distribution of ^{65}Zn in the shrimp Paratya australiensis. *Here zinc is found mostly in the liver-like detoxifying organ, the hepatopancreas*

This work was made possible through the generous support from AINSE in the form of a Postgraduate Research Award (PGRA). This work was also supported by the Ecological Society of Australia in the form of the Holsworth Wildlife Research Endowment (HWRE) and The University of Melbourne and ANSTO Animal Ethics Committees. We would like to thank ANSTO staff Emma Davis and Charmaine Day for their help and support with the shrimp and fish cultures, An Nguyen for his assistance in conducting shrimp autoradiography and Adam Sarbutt for 3D printing wizardry.

Chronology development of Auckland Maar Lake sediment records

Leonie Peti[1], Paul C. Augustinus[1]

[1] School of Environment, The University of Auckland, Auckland, New Zealand.

Understanding recent and future climate change relies on reliable reconstructions of past climates in space and time. In this context, the SW Pacific is a crucial but understudied region of the global climate system where long high-resolution and continuous terrestrial records of palaeoclimatic and -environmental change are few and commonly suffer from poor age control.

Orakei Basin (Figure 1), a former volcanic crater (maar) lake in Auckland City, northern New Zealand, provides a continuous and high-resolution sediment record that spans the Last Glacial Interval (Augustinus 2016, Peti and Augustinus 2019). In order to facilitate the reconstruction of palaeoclimatic changes therein, this project developed the chronological framework for the long lacustrine sediment core from Orakei Basin.

A multi-method approach to age modelling was necessary and included radiocarbon dating on organic macrofossils and bulk sediment samples, tephrochronology, post infrared-infrared stimulated luminescence (pIR-IRSL) dating on feldspars, meteoric Beryllium-10 and palaeomagnetic intensity as indicators of the Earth magnetic field's strength. Fifty-four radiocarbon ages and six known age rhyolitic tephra marker layers resulted in a well-constrained age model for the period ca. 45,000 years to 9,750 calendar years before present (BP).

Figure 1: Drilling platform on Orakei Basin in Auckland (northern New Zealand) in early 2016. Photo credit: Elaine Smid.

The lower part of the Orakei sequence to the core base at ca. 105 m depth was dated through wiggle matching of the relative palaeointensity of the Earth's magnetic field (natural remanent magnetisation/anhysteretic remanent magnetisation) to a dated global reference curve from marine sediment cores, guided by pIR-IRSL age estimates and constrained by a basaltic tephra tie-point correlated to a known-age eruption from the Auckland Volcanic Field.

The new chronology for the Orakei palaeolake sediment sequence produced an age for the maar-forming phreatomagmatic eruption of 139,200 ± 820 (2σ) years, as opposed to earlier estimates of about 126,000 years (Hopkins et al. 2017). This shifts the eruption into the penultimate glacial (marine isotope stage (MIS) 6) instead of the early interglacial (MIS 5) and thus enables investigations of palaeoclimatic and environmental change over the entire Last Glacial Interval. Environmental proxy data viewed in the new chronological context calls for a re-interpretation of the climatic history of northern New Zealand and allows the comparison with local to global records in unprecedented detail.

Environmental proxy data viewed in the new chronological context calls for a re-interpretation of the climatic history of northern New Zealand and allows the comparison with local to global records in unprecedented detail.

Tephrochronology, the dating of sediment sequences based on embedded volcanic ash of known-age eruptions, is a crucial tool for Quaternary environmental studies in New Zealand. To ascertain the source eruption of a tephra deposit, glass shards are extracted and embedded in epoxy before their chemical composition is measured with an electron microprobe. While this process is comparatively time consuming, it is also now routine in lake sediment-based Quaternary environmental reconstructions to record elemental variation in sediment sequences with fast and non-intrusive µ-XRF core scanning (Figure 2). In the same process, the Itrax µ-XRF core scanner automatically also records the chemical composition of the tephra layers, enabling demonstration that the whole core µ-XRF-signals allowed discrimination between tephra deposits sourced from different eruptions (Peti et al. 2019b)–a basic requirement for tephrochronology. Optimal scanning parameters and procedures were developed to allow this approach to be used for fast, non-intrusive first order core correlations and tephra identifications supporting preliminary age models for similar sediment records (Peti et al. 2019a).

The continuous record of geochemical variation in the Orakei sediment sequence based on µ-XRF core scanning allows a first-order reconstruction of the climatic and environmental history of Orakei Basin using the new chronological framework. Following the maar-forming phreatomagmatic eruption at 139,200 ± 820 (2σ) years BP, a shallow lake developed in the crater basin. Rapid deepening of the lake with anoxic bottom water is inferred from a sudden onset of fine laminations (Figure 2) which dominated MIS 5 and 4. Wind and wave action led to the partial erosion of the crater rim and thus a widening of the lake as seen in intervals dominated by coarse sediment influx and mass movement deposits as opposed to fine laminations rich in diatoms. Enhanced calcium content of the lake sediment is interpreted as evidence of

Figure 2: Visual and geochemical (Itrax µ-XRF core scanning) observations of finely-laminated sediment cores from Orakei Basin are of paramount importance to the success of reliable palaeoclimatic interpretations in the SW Pacific over the period of ca. 140,000 to 10,000 years before present. Photo credit: Paul C. Augustinus.

peak glacial conditions (ca. 25,000 cal year BP) when the significantly lower sea level left the surrounding shelf exposed and increased wind transported abraded shell material to Orakei Basin. The tuff ring that delineated the rim of Orakei maar was breached around 9,750 calendar years BP by post-glacial sea-level rise.

This project would not have been possible without the effort of a great team of collaborators: at ANSTO (Australia), ITRAX Facility Officer Patricia Gadd, Principal Research Scientist Dr. David Fink and Earth Scientist/Accelerator Physicist Dr. Toshiyuki Fujioka, Cosmogenic Laboratory Manager Charles Mifsud, Radiocarbon AMS Laboratory Manager Alan Williams and the ^{14}C-AMS-Dating team; at Lund University (Sweden), palaeomagnetism specialist Dr. Andreas Nilsson and Beryllium-10 expert Prof. Dr. Raimund Muscheler as well as AMS-Physicist Marcus Christl at ETH Zürich (Switzerland); at the Max-Planck-Institute for Chemistry (Germany), luminescence dating expert Dr. Kathryn Fitzsimmons; and at the University of Wellington (New Zealand), volcanologist and tephrochronologist Dr. Jenni Hopkins. The project was funded by DeVORA (funded by New Zealand's Earthquake Commission and the Auckland Council), and a grant from the Royal Society of New Zealand Marsden Fund (UOA1415 to Paul C. Augustinus) as well as an AINSE Postgraduate Research Award to L. Peti.

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Central nervous system ionizing radiation-induced changes in translocater protein expression

Calina Betlazar-Maseh[1,2], Ryan J. Middleton[1], Richard Banati[1,2], Guo-Jun Liu[1,2]

[1] Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Lucas Heights, NSW, Australia.

[2] Discipline of Medical Imaging & Radiation Sciences, Faculty of Medicine and Health, Brain and Mind Centre, The University of Sydney, Camperdown, NSW, Australia.

Ionizing radiation is used therapeutically and diagnostically in the central nervous system (CNS), though the neurobiological responses to high, and in particular, lower dose ionizing radiation have not yet been well-characterised.

Among the cellular responses to higher dose ionizing radiation, neuroinflammation and altered neurogenesis have been reported, underpinned by mitochondrial mechanisms—an important extranuclear target of ionizing radiation. Given the prevalence of radiation exposures, understanding these phenomena after low dose exposure is of great importance (Betlazar et al. 2016).

In the brain, the innate immune response is orchestrated by microglial cells, capable of shifting from a resting to an activated pro-inflammatory state. A prominent and widely studied biomarker of neuroinflammation is the mitochondrial translocator protein (TSPO), due to its almost exclusive upregulation in activated microglia. Despite its extensive use, the exact cellular function of TSPO has not yet been determined, though it has been linked to mitochondrial energy production, immunomodulation and reactive oxygen species formation (Liu et al. 2014).

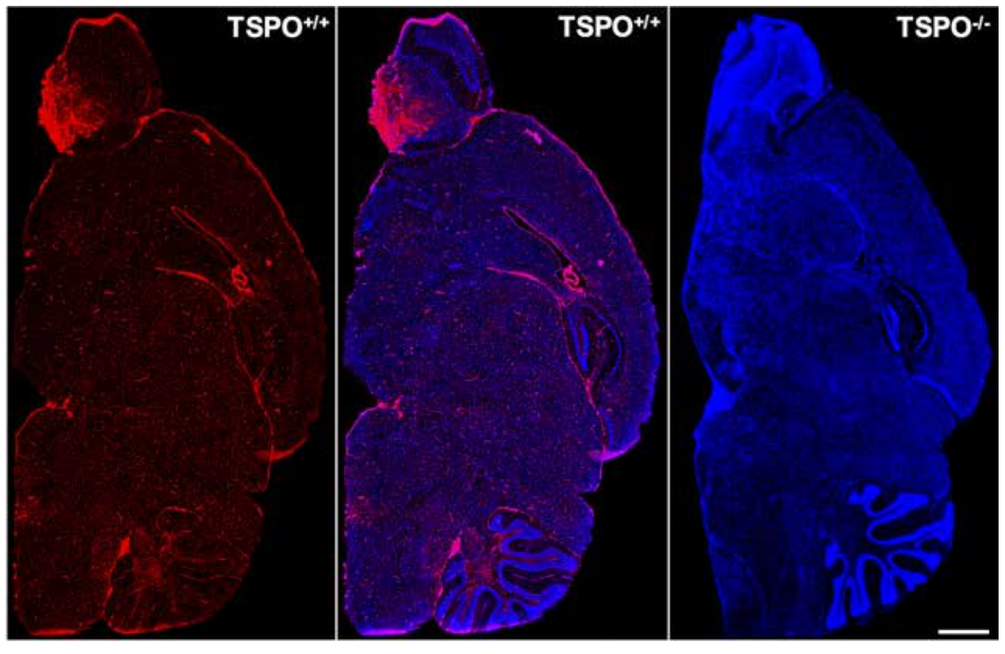

Figure 1: Sagittal brain sections from TSPO knockout (TSPO$^{-/-}$) and wildtype (TSPO$^{+/+}$) mice immunostained with a TSPO specific antibody (red) and DAPI (blue). TSPO is ubiquitously expressed across the brain in vascular endothelial cells, with other regions of strong expression in the circumventricular system, neurogenic regions and the olfactory nerve tracts. Scale bar = 500μm.

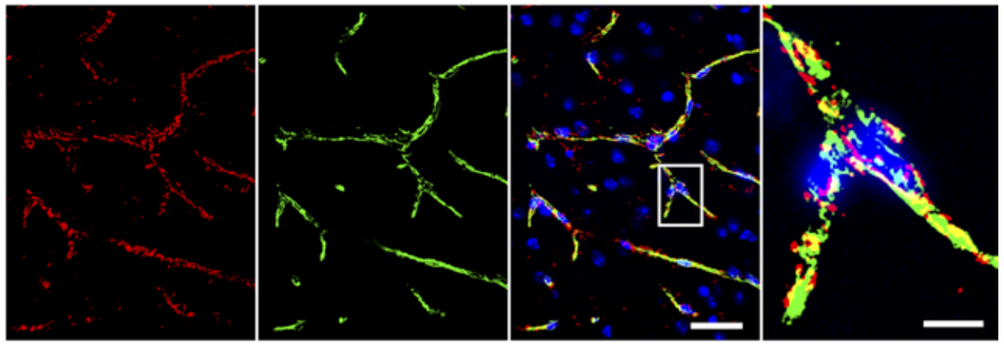

Figure 2: TSPO expression in vascular endothelial cells of the normal brain. Immunofluorescence staining for TSPO (red) demonstrates punctate staining which colocalises strongly with vascular endothelial cells (green). DAPI is in blue. Scale bars = 20μm, 5μm for box inset.

1), with regions of stronger expression including the lateral olfactory bulbs, the circumventricular system, and neurogenic regions in the hippocampus and subventricular zone.

On closer examination, the source of the distributed TSPO expression was from vascular endothelial cells (Figure 2). TSPO expression was also observed in neural stem cells/immature neurons of neurogenic regions. The expression of TSPO in energy intensive cells, including neural stem cells and rapidly dividing microglia, is consistent with the putative functioning of TSPO in mitochondrial energy production. This work also has important implications for the interpretation of TSPO molecular imaging studies, in order to account for this vascular signal (Betlazar et al. 2019).

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

Given the fundamental interaction between ionizing radiation, mitochondria and inflammation, an exploration of microglial responses and TSPO expression after both high and low dose ionizing radiation exposure was performed. Additionally, due to the importance of TSPO as a marker of microglial reactivity and mitochondrial processes, this project also served as a deeper investigation into the expression of this protein TSPO under normal and stress conditions in the CNS.

In order to better understand the cellular and regional expression of TSPO under physiological conditions in the brain, immunostaining on mouse brain tissue sections using a specific TSPO antibody was performed. We demonstrated widespread expression of TSPO across the brain (Figure

The expression of TSPO was then examined after ionizing radiation exposure, both *in vivo* and *in vitro*. Mice were exposed to whole body 0.01 Gy, 0.1 Gy or 2 Gy gamma irradiation, with a sham-irradiated 0 Gy control. Primary microglial cell cultures were also exposed to these doses. Analysis of TSPO gene expression in irradiated brains demonstrated a decrease after 0.01 Gy exposure compared to controls. Concomitantly, IBA1 gene expression, a marker of activated microglia,

also decreased at this dose. Primary microglial cell cultures also demonstrated decreased immunocytological TSPO staining after 0.01 Gy (Figure 3).

This work suggests that low dose ionizing radiation may alter neuroinflammatory processes, and consequently, this project will have significant implications for the broader understanding of neurobiological responses after low dose ionizing radiation exposure. This project also unveils a greater understanding of the expression of TSPO under healthy and stress conditions.

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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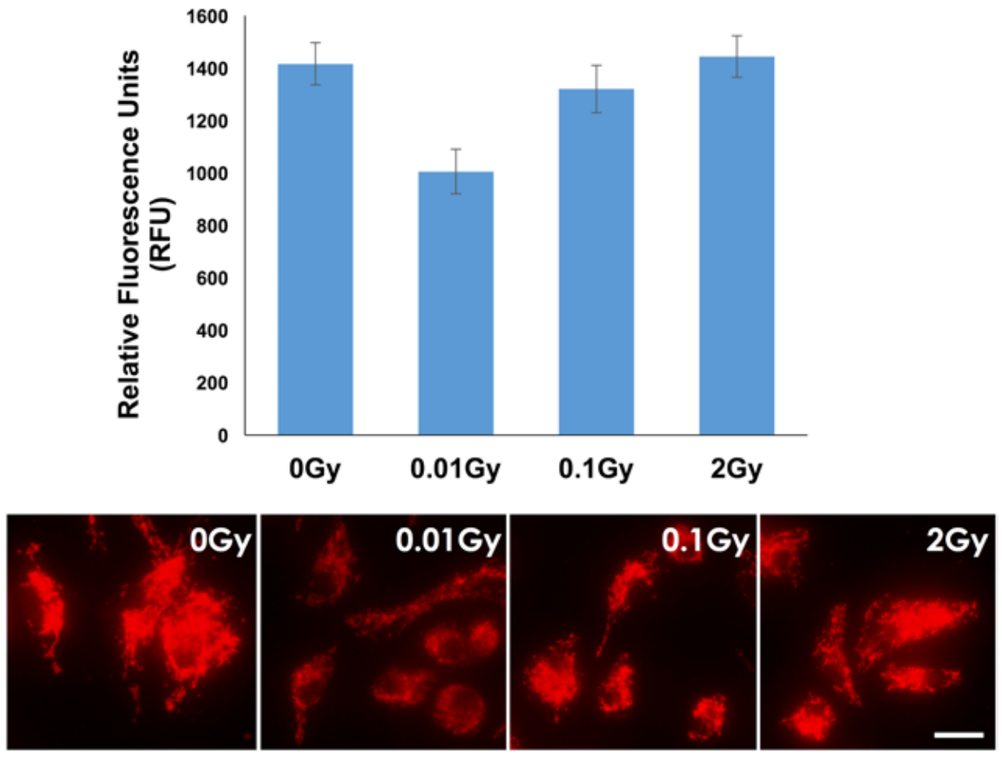

Figure 3: Immunocytochemical staining of TSPO after irradiation of primary microglia demonstrates decreased TSPO expression after 0.01 Gy irradiation, compared to 0 Gy control cells. Scale bar = 10 µm.

Understanding the activation of a killer protein

Katherine A. Davies[1,2], Cheree Fitzgibbon[1], Sam N. Young[1], Diane Coursier[1], Richard W. Birkinshaw[1,2], Emma J. Petrie[1,2], Peter E. Czabotar[1,2], James M. Murphy[1,2]

[1] Walter and Eliza Hall Institute of Medical Research, Parkville, VIC, Australia.
[2] Department of Medical Biology, University of Melbourne, Parkville, VIC 3052, Australia.

Multi-cellular organisms have evolved a plethora of mechanisms by which cells can choose to die. Though it seems counter-productive for a cell to kill itself, these mechanisms are important when one cell dying can benefit the well-being of the entire organism.

Our research is focused on necroptosis, a programmed cell death pathway that has an important role in defending against pathogen infection. When a cell is infected by a virus, it may choose to undergo necroptosis to alert the immune system to the threat, by inducing inflammation. Whilst this is useful in the context of infection, when necroptosis occurs to excess this inflammation can be detrimental, and necroptosis is linked to multiple human pathologies.

Necroptosis is mediated by a protein called Mixed Lineage Kinase domain-Like (MLKL). It is expressed fairly ubiquitously in the body, and under the steady state exists as an inert monomer (one copy of the protein) in the cell cytoplasm. Once the cell decides to die, MLKL becomes activated by a phosphorylation event at its pseudokinase domain, which leads to MLKL forming an oligomer (multiple copies of the protein bound together in a complex), which translocates to the cell membrane and permeabilises it, causing the cell to die (Petrie et al. 2019).

The transition that MLKL undergoes from being an inert protein to a killer is still poorly understood. We do know that the mouse and human proteins, which are often studied interchangeably, actually have slightly different activation mechanisms. These interspecies differences become important when MLKL is considered as a candidate for therapeutics. Development of drugs to treat human pathologies requires the use of an animal model, usually mice—however, if the mouse MLKL protein behaves too differently to the human protein, this would not be appropriate.

The structure of the mouse and human MLKL proteins have been solved (Murphy et al. 2013,

Our study suggests that rat MLKL share many similarities with the human counterpart, and that rats may be a better candidate as a model organism than mice for the necoptosis system.

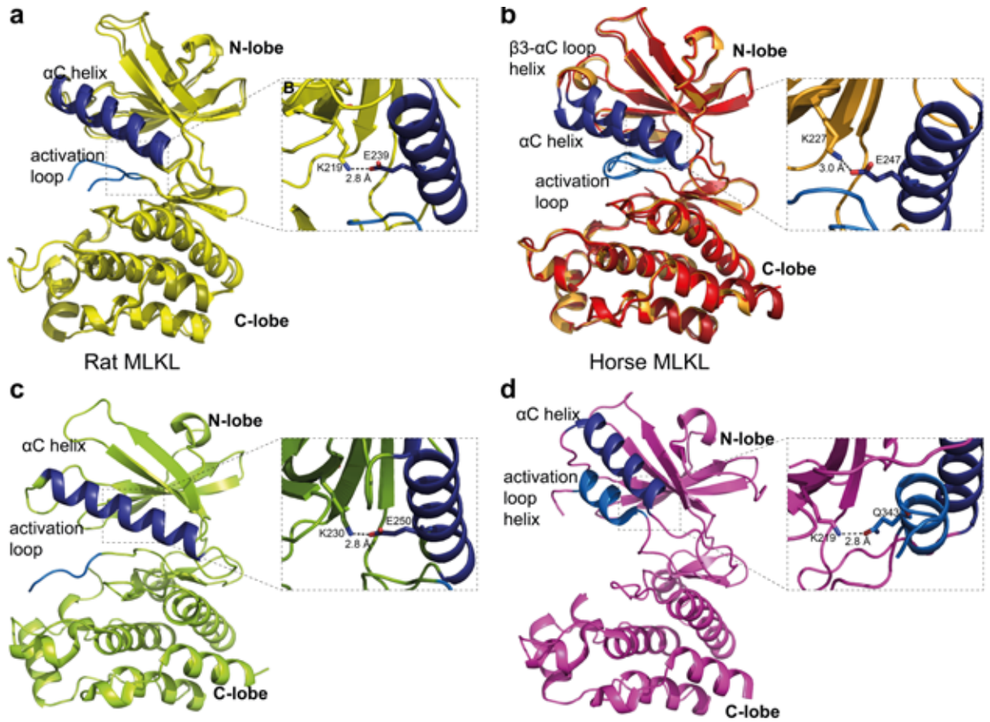

Figure 1: Crystal structures of MLKL from different species. The structure of (a) rat, (b) horse, (c) human (PDB:4mwi) and (d) mouse (PDB:4btf) MLKL pseudokinase domains. Various structural motifs known to regulate MLKL's activation are labelled such as the activation loop and αC helix. The rat and human protein shown overall structural similarity, whereas the structure of mouse and horse show differences.

Murphy et al. 2014) and show key differences to one another. To understand the significance of the structural differences between mouse and human MLKL, and to more broadly understand how the MLKL protein has evolved, we chose to study the structure of the pseudokinase domain of MLKL from different animal species.

The structure of proteins can be determined using X-rays, which have a small wavelength (in the nanometre range) that is similar to the length scale of a protein. The interaction of a single protein with X-rays would only yield a weak and difficult-to-measure signal, so protein crystals, containing millions of copies of the same protein arranged in a regular lattice, are used to amplify the signal. We successfully grew crystals of the rat and horse MLKL pseudokinase domain and solved their structure using datasets generated at the Australian Synchrotron MX_2 beamline.

Though mice and rats are closely related, the rat MLKL protein structure was found to be more similar to human MLKL than to mouse MLKL. This unexpected finding gives credence to a model proposed in the MLKL literature; namely, that the respective structures of human and mouse MLKL represent different conformations that both proteins can take on, corresponding to different stages of the activation event. Since the mouse and rat proteins are so closely related and have very similar amino acid sequences, it is unlikely that the mouse and rat proteins could not take on each others' conformation. Another implication of this finding is that because the rat protein may favour a conformation that is more similar to the human structure, rats might be a more useful model organism than mice for MLKL drug discovery efforts.

The structure of horse MLKL displayed new features that had not been seen before in other MLKL structures, such as the activation loop binding in the pseudoactive site and an extra helix above the αC helix. We hypothesise that this conformation could be important for MLKL activation in other species as well, as the amino acids required to form this conformation are highly conserved throughout MLKL species.

To complement our X-ray crystallography studies, we also performed Small Angle X-ray Scattering (SAXS) at the Australian Synchrotron SAXS/WAXS beamline. This technique also uses X-rays to interrogate protein structure, but in solution rather than in a crystal. We were able to generate a model of the mouse and rat MLKL oligomers using SAXS and found that the rat protein is more similar to human MLKL than mouse, forming a tetramer (four copies of protein) in solution, unlike mouse, which forms a trimer. The oligomer is key to MLKL executed cell death, and understanding the differences between species will help determine how different species' MLKL act to kill cells.

This study has highlighted intriguing differences in MLKL structures from species that are quite closely related. Our study suggests that

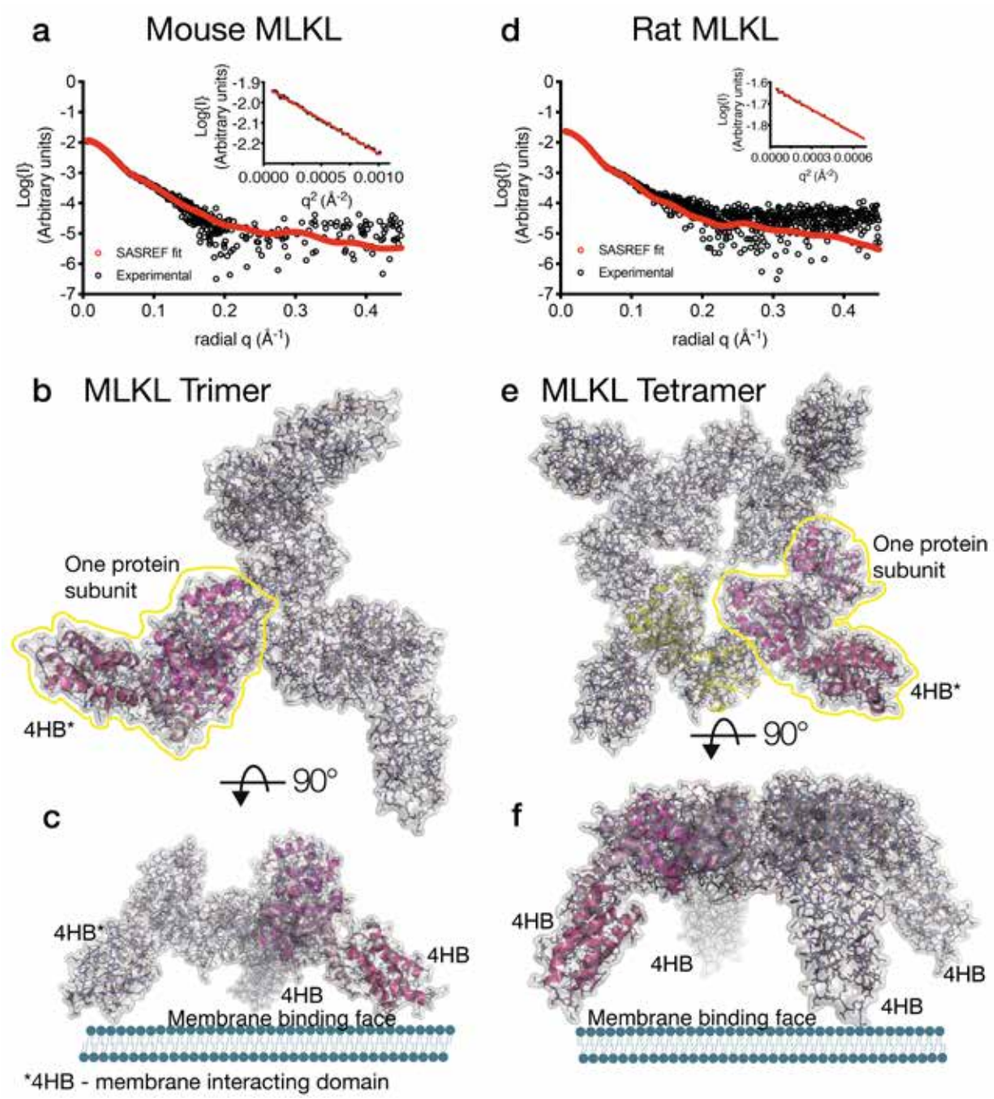

Figure 2: Models of the rat and mouse MLKL oligomer. SAXS scatter data (a, d) of the mouse and rat protein in solution was use to derive the oligomer models in b and e. The data for mouse MLKL best supported a trimer model and the data for rat best supported a tetramer model. In these models, the membrane interacting domain of MLKL (4HB) is oriented on one face and this could form the membrane interacting region of the MLKL oligomer (c, f).

rat MLKL shares many similarities with the human counterpart, and that rats may be a better candidate as a model organism than miceouse for the necroptosis system.

This study was made possible through the use of the Australian Synchrotron, and with the help of the staff at the MX_2 and SAXS/WAXS beamlines. Complementary studies to this work have also been performed with collaborators Dr Anton Le Brun and Karyn Wilde at the Australian Centre for Neutron Scattering and National Deuteration Facility, to examine how MLKL permeabilises the cell membrane in the final step of necroptosis using neutron reflectometry. 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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Unveiling the chemistry of Titan's atmosphere

Rebecca Auchettl[1,2], Dominique R. T. Appadoo[2], Courtney Ennis[1]

[1] Department of Chemistry and Physics, La Trobe Institute of Molecular Science, La Trobe University, Melbourne, VIC, Australia.

[2] Australian Synchrotron, Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Clayton, VIC, Australia.

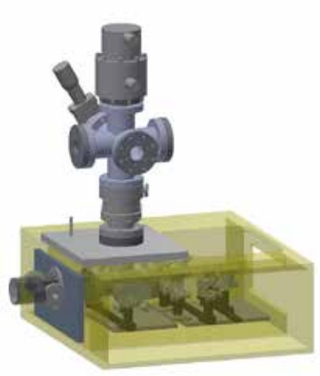
Titan, Saturn's largest moon, is the only planetary body in our solar system that resembles Earth.

The two main constituents of Titan's dense atmosphere are gaseous molecular nitrogen (N_2) and methane (CH_4). Bombardment of Titan's N_2 and CH_4 atmosphere by energetic particles produces an array of nitriles and hydrocarbons that aggregate into particles and ice in the stratosphere of Titan. These species, such as HCN and CH_3CN, are thought to build up to more complex molecules and form amino acids and nucleobases - the molecular building blocks of life.

The Cassini-Huygens probe showed that seasonal processing of nitrogen-bearing clouds in the atmosphere produces an unknown molecular band at 220 cm^{-1} in the far-infrared region that appears in the summer and disappears in the winter seasons. The molecular carrier (or carriers) of this band has not yet been identified.

In order to unravel the formation processes of Titan's atmosphere and identify the 220 cm^{-1} far-infrared nitrile band, laboratory far-IR spectra are needed to aid the identification of individual molecules from spectroscopic observations. Previously, however, no comprehensive far-IR laboratory nitrile spectra have been available for comparison.

To bridge this gap, we constructed a thin film setup which is coupled to the THz/Far-IR beamline at the Australian Synchrotron to investigate planetary ice in the far-IR region (Figure 1). We used this setup and an existing collisional cooling cell to investigate several important interstellar and planetary solid-state condensates.



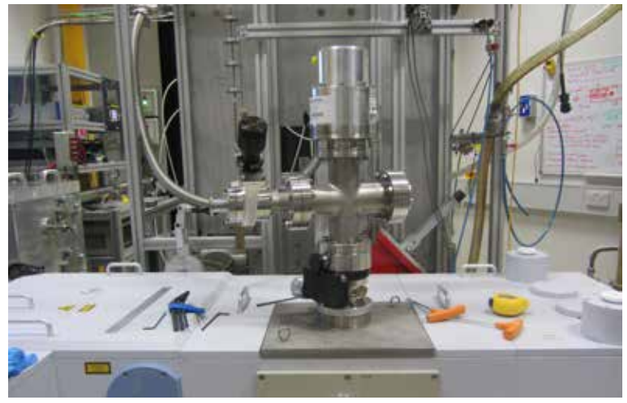


Figure 1: The new reflection-absorption-infrared-spectroscopy (RAIRS) setup at the Australian Synchrotron.

...the far-IR signatures we recorded will aid the future detection of interstellar ices and the search for prebiotic molecules imperative to the chemical genesis of life.

At the Australian Synchrotron we recorded signatures of CO_2, CH_3OH and H_2O binary and ternary interstellar ice over the complete far-IR region at Titan's atmospheric temperatures. We demonstrated that type II methanol clathrate hydrate forms after warming of ternary CO_2, CH_3OH and H_2O ice. This shows for the first time that the methanol clathrate hydrate has a unique far-IR band at 545 cm^{-1}, which has not been previously reported (Figure 2). We also showed that CO_2 has translational phonon modes located at 114 cm^{-1} and 65 cm^{-1} that are highly sensitive to the ice composition and can be used as a temperature sensor for observational detection.

We also measured the first complete far-IR signatures of pure and binary nitrile aerosols and thin films of acetonitrile (CH_3CN), propionitrile (CH_3CH_2CN) and water (H_2O) under the atmospheric conditions of Titan's stratosphere. For the first time, we were able to compare our experimental lattice band profiles to Cassini-Huygens mission data and rule out pure CH_3CN, pure CH_3CH_2CN, and CH_3CN-H_2O aerosols as the origin of unknown 220 cm^{-1} feature.

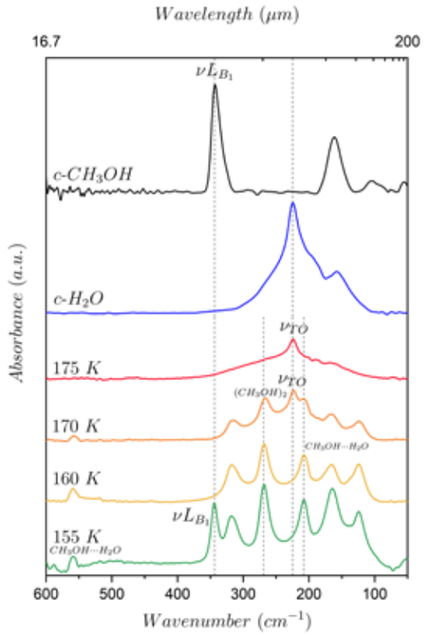


Figure 2: Newly-reported methanol clathrate hydrate type II bands formed at 155 K to 175 K with comparison to pure crystalline CH_3OH and pure crystalline H_2O ice.

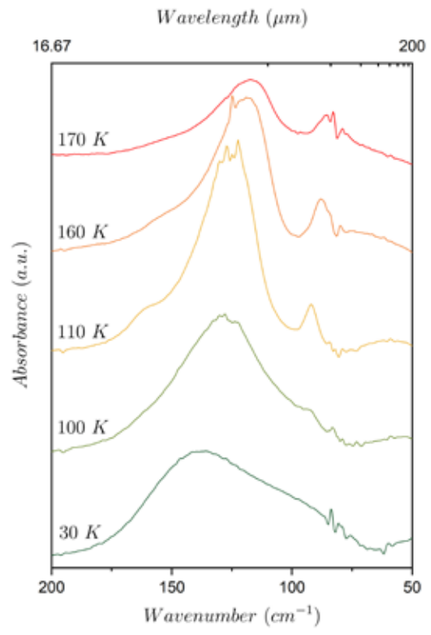


Figure 3: Acetonitrile thin film temperature dependent spectra.

Finally, we measured the first pure and binary β-phase CH_3CN, CH_3CH_2CN and H_2O thin film far-IR spectra over the 30–180 K temperature range. We showed that the lattice modes for CH_3CN and CH_3CH_2CN observed at 85 and 108 cm^{-1} are sensitive to the ice composition and environment (Figure 3). We investigated the experiment peak positions and widths, together with their temperature dependence. These characteristics will assist solid-state detection of these planetary ices. We also rule out pure CH_3CN and CH_3CH_2CN, and binary CH_3CN, CH_3CH_2CN and H_2O ice, as the origin of the 220 cm^{-1} feature observed in Cassini CIRS far-IR spectra.

Far-IR instrumentation has now been proposed for the future exploration of distant icy environments. As far-IR instrumentation becomes more prevalent, the far-IR signatures we recorded will aid the future detection of interstellar ices and the search for prebiotic molecules imperative to the chemical genesis of life.

This work would not have been possible without the generous support from AINSE, the PGRA program and the Australian Synchrotron, as well as my supervisors Dr Courtney Ennis and Dr Dominique Appadoo.

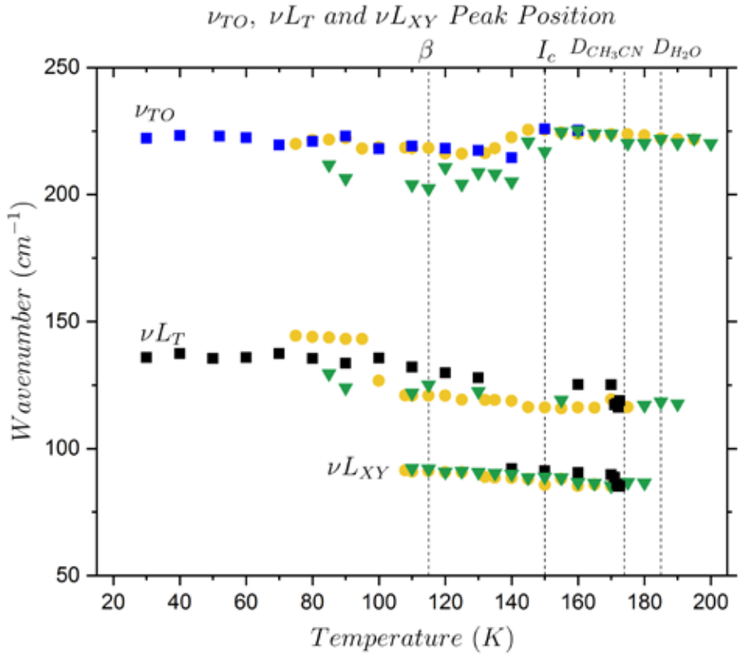


Figure 4: Temperature-dependent peak shifts for lattice modes of pure H_2O (blue), pure CH_3CN (black), CH_3CN deposited on top of H_2O (yellow) and H_2O deposited on top of CH_3CN (green).

Probing the internal nanostructure of PNIPAM brush modified silica particles

Ben Humphreys[1], Andrew Nelson[2], Elliot P. Gilbert[2], Stuart W. Prescott[3], Timothy J. Murdoch[4], Edwin C. Johnson[1], Grant B. Webber[1], Erica J. Wanless[1]

[1] The University of Newcastle, Callaghan, NSW, Australia.
[2] Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Lucas Heights, NSW, Australia.
[3] The University of New South Wales, Kensington, NSW, Australia.
[4] University of Pennsylvania, Philadelphia, PA, United States.

Stimuli- responsive surface coatings are becoming increasingly popular due to their wide range of possible applications.

A stimulus responsive surface can be prepared through end tethering polymer chains to a substrate at a high enough grafting density to force neighbouring polymer chains to interact—the polymer brush regime.

Advances in polymerisation techniques have enabled polymer brushes to be prepared on a wide range of surfaces, including colloidal particles, planar substrates, porous membranes and fibres. With the appropriate choice of polymer, one can create a responsive surface with the ability to reversibly alter interfacial properties such as hydrophobicity and lubricity, as well as the thickness of the polymer brush in response to environmental changes such as temperature, light or pH, in addition to salt identity and concentration (Murdoch et al. 2018).

The ability to reversibly manipulate surface properties is desirable in a wide range of applications, such as switchable colloidal stability, targeted and controlled drug delivery, environmental remediation, membranes, biotechnology, and sensors.

One area of my research focussed on colloidal silica particles that were modified with a temperature responsive poly(N-isopropylacrylamide) (PNIPAM) brush (Figure 1). The hydrodynamic diameter temperature response of the brush modified silica particles dispersed in water measured via dynamic light scattering (DLS) is shown in Figure 2.

PNIPAM is a well-known temperature responsive polymer which, when dispersed

The ability to reversibly manipulate surface properties is desirable in a wide range of applications, such as... targeted and controlled drug delivery,... biotechnology, and sensors.

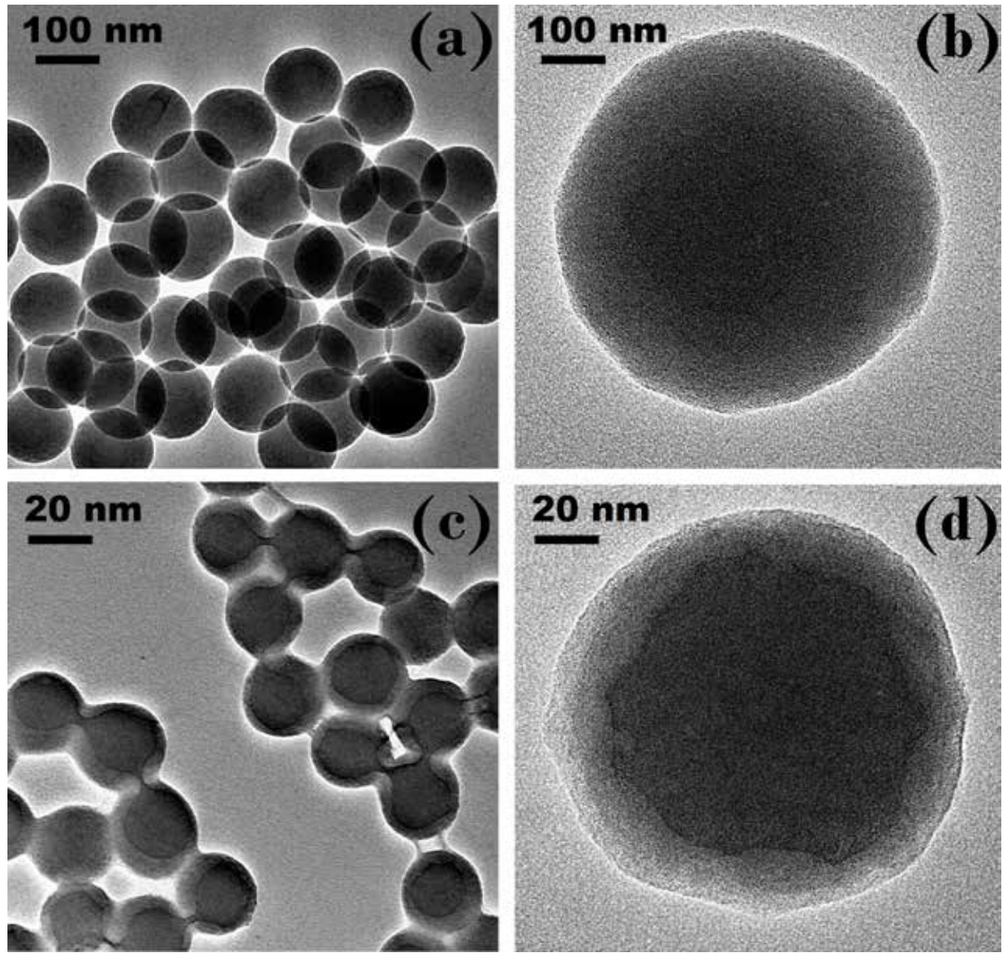


Figure 1: TEM images of (a & b) unmodified silica core particles and (c & d) PNIPAM brush modified silica particles. (Humphreys et al. 2018, Humphreys et al. 2019).

as a free polymer in water, has an entropically driven lower critical solution temperature (LCST) around 32 °C. Below this temperature, the polymer brush is hydrophilic and prefers a swollen conformation (Figure 2, left). Above 32 °C, the polymer becomes hydrophobic and reverts to a collapsed state (Figure 2, right) (Humphreys et al. 2019). While techniques such as TEM and DLS provide valuable information about the brush coating, they provide little information related to the internal nanostructure of the polymer brush layer and how this changes as a function of temperature.

Small angle neutron scattering (SANS, QUOKKA) was utilised to probe the internal nanostructure of the PNIPAM brush with the experiment conducted using the QUOKKA instrument in a D_2O/H_2O solution contrast matched to the scattering length density of the silica core. Measurements on QUOKKA were performed at five key regions throughout the swollen-to-collapsed temperature transition as indicated by the vertical dashed lines in Figure 2. Figure 3 (a) shows the SANS results with the corresponding modelled fits and (b) the volume fraction profiles for the polymer brush layer as a function of radial distance from the core particle surface.

This study revealed three different structures throughout the transition. At 18 °C and 25 °C, the brush layer was in a swollen state with the polymer volume fraction being relatively low. Vertical phase separation of the polymer brush was evident at 30 °C and 32.5 °C, where the inner region of the brush was collapsed, highlighted by a much higher volume fraction of polymer, while the peripheral region was still in a swollen confirmation. At 40 °C, well

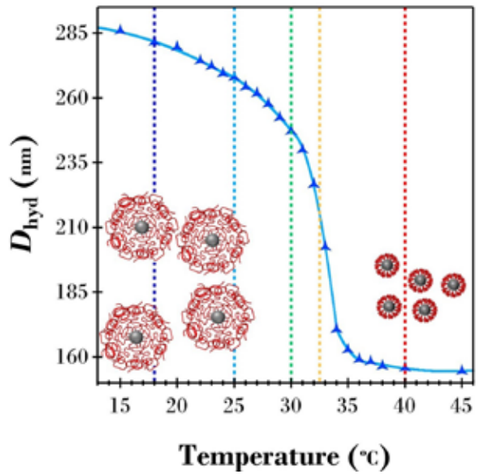


Figure 2: DLS D_{hyd} increasing temperature results and modelled temperature transition for the PNIPAM brush modified silica particles with vertical dashed lines indicating the temperatures at which the SANS measurements were performed.

above the LCST of PNIPAM, the brush layer is in a collapsed conformation with the majority of the polymer condensed near the core silica surface (Humphreys et al 2019).

This project is a collaboration between UoN, UNSW and ANSTO. SANS experiments were undertaken as part of ACNS Neutron Scattering Proposal grants P5945 and P5950. BAH, ECJ and TJM gratefully acknowledge the support of AINSE (PGRA).

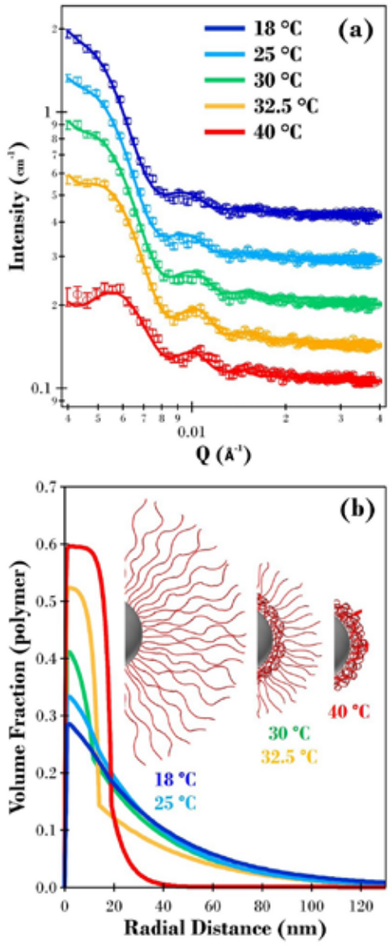


Figure 3:. SANS results as a function of temperature (open circles) for (a) PNIPAM brush modified silica particles sample including modelled fits (solid lines) with the curves offset on the intensity axis for clarity. (b) The corresponding volume fraction profiles for the polymer brush layer as a function of radial distance from the substrate

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Tight plasma polymerized thin films composite ultrafiltration membranes

Jinshi Wang[1], Jitraporn Vongsvivut[2], Andrea Merenda[1], Jiangting Wang[1], Zhiqiang Chen[1], Nick Milne[3], Ilana Timokhina[1], Mark Tobin[2], Ludovic Dumée[1] and Lingxue Kong[1]

[1] Institute for Frontier Materials, Deakin University, Waurn Ponds, VIC, Australia.

[2] Australian Synchrotron, Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Clayton, VIC, Australia.

[3] School of Engineering, Deakin University, Waurn Ponds, VIC, Australia.

Plasma polymerisation can produce homogenous and highly cross-linked thin films that are promising candidates for membrane materials to be used in water and wastewater treatment.

The aims of this study were to identify the homogeneity and degree of polymerisation and of the cross-linked structure of the plasma-induced polymer. These properties are closely correlated with the performances of the plasma polymerised thin films as membrane materials in terms of water permeability and selectivity. These material properties can be finely tuned by changing plasma treatment parameters, such as plasma input power and treatment duration, to meet membrane application such as salt rejection. However, it is challenging to characterise these material properties at the micron and sub-micron levels, especially for films with a thickness of 100 nm.

In this study, the thin films were prepared from acrylic acid via plasma polymerisation and deposited on top of an ultrafiltration membrane to enhance its selectivity. The impact of the plasma conditions on the chemical composition and homogeneity of the plasma polymerised thin films was studied using an in-house adapted macro attenuated total reflection-Fourier transform infrared (macro ATR-FTIR) device (Vongsvivut et al. 2019), coupled to the synchrotron-IR radiation at the Australian Synchrotron's Infrared Microspectroscopy (IRM) Beamline.

This study opens more opportunities for the application of membrane materials fabricated by plasma polymerisation.

The synchrotron macro ATR-FTIR technique, which is based on the use of a germanium (Ge) hemispherical crystal (*n*Ge = 4) and a 20x IR objective (NA = 0.60), allows us to probe the surface of the delicate thin films at an enhanced spatial resolution down to 1.9 µm (Vongsvivut et al. 2019). The spatial resolution in this range is not achievable using laboratory-based FTIR microspectroscopic instruments with an internal Globar™ IR source, which generally limits spatial resolution to be within 40–50 µm.

All the synchrotron macro ATR-FTIR spectra were acquired using a Bruker Vertex 80v

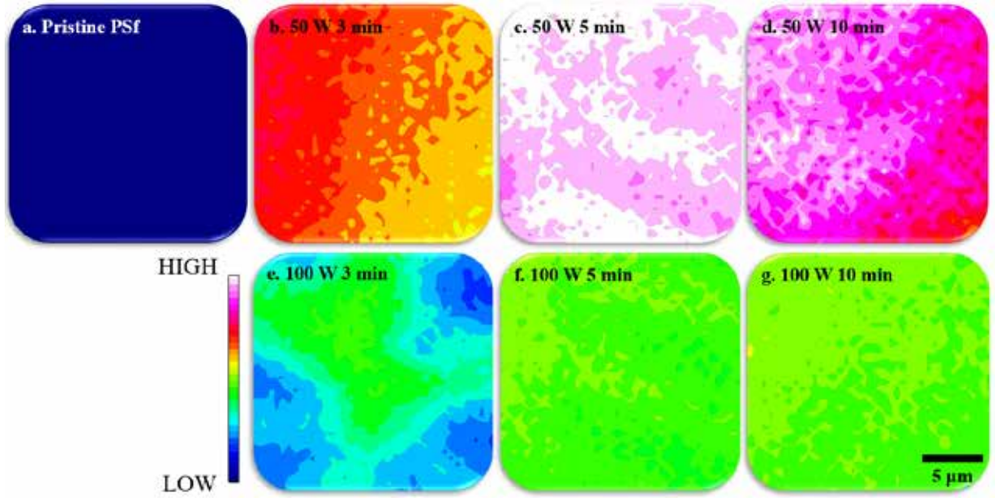

Figure 1: The chemical maps of the pristine PSf (a), and with the ppAAc depositions for different plasma-polymerisation durations (3–10 min) at 50 W (b–d) and 100 W (e–g). The chemical maps of the carbonyl group were acquired after normalising the synchrotron FTIR spectra over the range of 1530–1620 cm^{-1} and integrating the absorbance over the range of 1690–1750 cm^{-1}. The colored scale bar was subsequently normalised from 0 to 20 for all the synchrotron FTIR maps to present the same scale range with blue to white indicating low to high absorbance, respectively.

spectrometer coupled with a Hyperion 2000 FTIR microscope and a liquid nitrogen-cooled narrow-band mercury cadmium telluride (MCT) detector (Bruker Optik GmbH, Ettlingen, Germany) within a spectral range of 3800–700 cm^{-1} using 8 cm^{-1} spectral resolution. A total of 1600 measurement points were recorded on each membrane sample using an effective beam size of 3 µm and a 0.5 µm step size between each point.

The acquired synchrotron FTIR chemical map (Figure 1) revealed the distribution of the domain functional groups, which is ν(C=O) carbonyl stretching mode in the example shown from the acrylic acid monomer precursor across the surface. The higher the absorbance (i.e. color intensity towards pink), the higher the concentration of the carbonyl functional groups deposited at the surface (Rytwo et al. 2015). On the other hand, the lower the variation in the color scale, the higher the homogeneity of the carbonyl domain distributed across the surface of the plasma polymerised thin films.

The chemical maps show that the concentration of carbonyl functional groups increased significantly as the plasma duration increased from 3 min to 5 min at both 50 W and 100 W treatments, but appeared to change insignificantly and reached their plateaus after 5 min. The results indicated that the longer treatment allowed the competition between the plasma deposition and ablation to reach a certain equilibrium for the plasma polymerisation, in an agreement with the competitive ablation and polymerisation (CAP) principle (Yasuda and Yasuda 2000). Furthermore, it was found that the power level used for the plasma treatment affected the carbonyl contents in the ppAAc membrane products, resulting in twice-higher carbonyl content in the thin films prepared at 50 W compared to those prepared at 100 W.

Nevertheless, the distribution of carbonyl domain was more homogeneous in the films treated at 100 W than 50 W. These results suggest that plasma polymerisation induced at a higher plasma energy input level produce more homogenous thin films with fewer carbonyl domains. The fragmentation model could explain the loss of the carbonyl contents, where the monomer broke into small fragments, and formed a highly cross-linked and homogenous structure with less chemical similarity to its monomer precursors when the plasma polymerisation was carried out at a higher plasma power (Friedrich 2011).

Deionised (DI) water permeance and salt rejection of ppAAc deposited (poly)sulfone membranes revealed the correlation of the

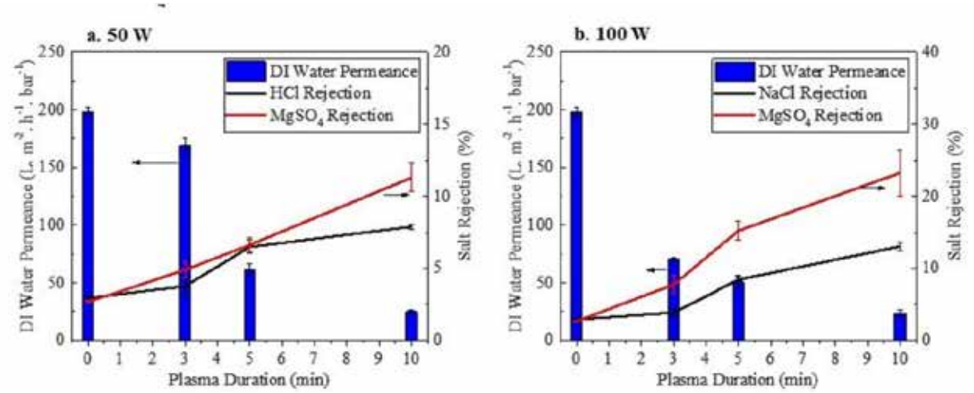

Figure 2: The DI water permeance of the pristine PSf, with the ppAAc produced from plasma duration series at 50 W (a) and 100 W (b). Cross-flow test conditions: 5 bar inlet pressure at 20 °C. The present data were the average of three replicates and error bars corresponding to the standard deviation of the average.

new surface properties and membrane performance. In an agreement with the synchrotron FTIR chemical maps, the ppAAc films prepared at 100 W for 10 min provided the optimum filtration performance, owning to its highly cross-linked and homogenous structure. The membranes were able to reject 13.07 ± 0.53 % of NaCl and 23.25 ± 3.19 % of $MgSO_4$ and provided water permeance of 23.99 ± 2.19 L. m^{-1} h^{-1} bar^{-1}. The product membranes can be categorised as tight ultrafiltration membranes after comparing NaCl rejection performance with the commercial reverse osmosis and nanofiltration membranes (BW30-400 and NF270, FILMTECTM), which were observed to achieve 99.5 ± 0.5 % 5 and 56.07 ± 0.55 %, respectively.

Our results provide a fundamental understanding of the cross-linking structure and the distribution of the chemical domain induced by plasma polymerisation, and the correlation between material properties and membrane performance. This study opens more opportunities for the application of the membrane materials fabricated by plasma polymerisation.

We would like to acknowledge the Australian Institute of Nuclear Science and Engineering (AINSE) for providing a Postgraduate Research Award (PGRA) to J.W. This research was undertaken on the IRM beamline at the Australian Synchrotron, part of ANSTO.

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Boosting high-rate electrochemical energy storage from topological insulators

Zhibin Wu[1], Bernt Johannessen[2], Wei Kong Pang[1], Zaiping Guo[1]

[1] Institute for Superconducting & Electronic Materials, The University of Wollongong, Wollongong, NSW, Australia.

[2] Australian Synchrotron, Nuclear Science & Technology and Landmark Infrastructure (NSTLI), ANSTO, Clayton, VIC, Australia.

High-power mechanical and portable electronic devices require the development of ever faster charging/discharging and higher energy density batteries.

Current Li-ion batteries (LIBs) based on graphite anodes cannot fulfill this increasing demand due to the disadvantages of low specific capacity (theoretically 372 mAh g^{-1}), poor rate performance, and a low voltage platform that easily induces the uncontrolled growth of lithium dendrites at high rates. New high-rate electrode materials are urgently needed to increase power and decrease charging time for batteries.

Our team prepared a $SnSb_2Te_4$-Graphene ($SnSb_2Te_4$/G) composite electrode by a facile and scalable ball-milling method for high-rate lithium-ion batteries and potassium-ion batteries (PIBs). It exhibits a high capacity (574 mAh g^{-1} at 0.1 A g^{-1}), ultralong cycle lifespan (478 mAh g^{-1} at 1 A g^{-1} after 1000 cycles) and excellent rate capability for Li-ion storage (remaining as high as 373 mAh g^{-1} even at 10 A g^{-1}), owing to the rapid ion transport accelerated by the PN heterojunction, virtual electron highways provided by the conductive topological surface state, and extraordinary pseudocapacitive contribution (Figure 1). Surprisingly, durable lifespan even at commercialize levels of mass loading (>10 mg cm^{-2}) for Li-ion storage and excellent high-rate K-ion storage capacbility were also observed.

Synchrotron X-ray powder diffraction (XRPD) and X-ray absorption spectroscopy (XAS) were employed to uncover the electrochemcial energy storage mechanism of the $SnSb_2Te_4$/G composite electrode. The excellent phase reversibility of the composite electrode (Figure 2a and Figure 2b) was confirmed by synchrotron *in situ* XRPD, where the composite should undergo the typical three-step insertion/conversion/alloying process upon lithiation and a reversible dealloying/recombination/extraction process upon delithiation.

An advanced understanding of the electrochemical reaction mechanism gained via synchrotron techniques will assist us in... further improving the electrochemical performances of these batteries.

The development of this excellent composite for high-rate energy storage falls in an area of great importance to Australian energy security and international climate treaty obligations.

Due to the low degree of crystallization of the $SnSb_2Te_4$/G composite, the small $SnSb_2Te_4$ nanodots within the composite and the size-reduced products, synchrotron XRPD cannot tell the full story of the electrochemical mechanism with the composite electrode. *Ex situ* X-ray absorption near edge structure analysis (XANES) was conducted to investigate the $SnSb_2Te_4$ electrode at different charge states. The charge transfer process upon lithiation and de-lithiation was uncovered by detecting the partial densities of unoccupied

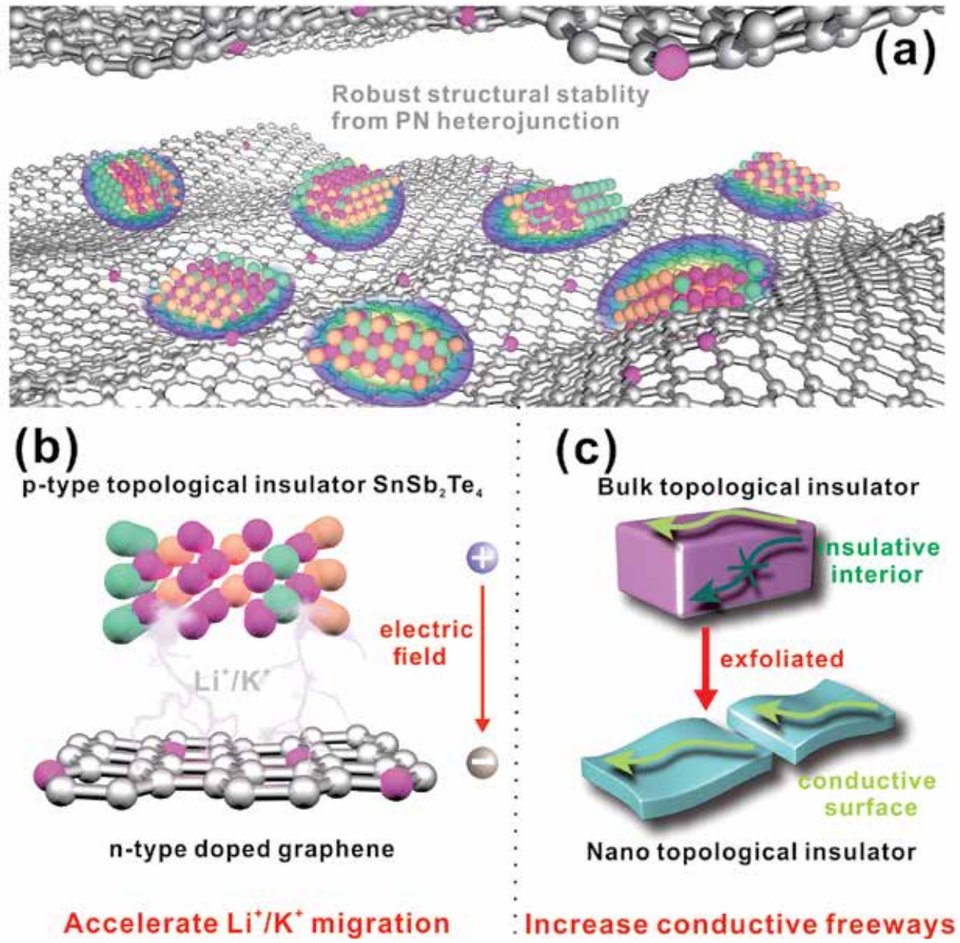

Figure 1: Summary of the high-rate lithium/potassium storage mechanism of the $SnSb_2Te_4$/G composite.

Figure 2: (a and b) Contour plots of in situ synchrotron XRPD with superimposed voltage profiles for selected 2θ ranges of the $SnSb_2Te_4$/G anode for LIBs; (c and d) Normalized Sb K-edge XANES spectra and their corresponding normalized second derivative spectra of the ex situ *$SnSb_2Te_4$ electrodes at different cut-off voltages, respectively. D stands for discharge and C stands for charge*

states of Sb element using XANES (Figure 2c and Figure 2d). An advanced understanding of the electrochemical reaction mechanism gained via synchrotron techniques will assist us in finding effective means of further improving the electrochemical performances of these batteries.

These results demonstrate that, by boosting conductive topological surfaces, atomic doping, and the interface interaction, the $SnSb_2Te_4$/G composite could form practical and high functioning anodes for both LIBs and PIBs for future energy storage requiring high-rate capability. The development of this excellent composite for high-rate energy storage falls in an area of great importance to Australian energy security and international climate treaty obligations. The outcomes of this project will help Australia occupy an advantageous position in the world to win the rechargeable battery market, which is worth billions of dollars.

We would like to acknowledge financial support from the Australian Research Council (ARC) (FT150100109, FT160100251, DP170102406, DE190100504). The authors also would like to thank AINSE Limited for providing financial assistance (Award - PGRA) and instrumental support (XAS and XRPD). The outcomes of this work would not have been possible without the supervision of Dr. Bernt Johannessen (ANSTO beamline scientists) and Prof. Zaiping Guo (University of Wollongong), as well as the support from Dr. Wei Kong Pang (University of Wollongong).

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Outreach Activities

February 2019

Embassy of France in Australia, Canberra, ACT, Australia | Science Diplomats Club

Michelle Durant attended the launch of the Stories of French-Australian Innovation collection on behalf of AINSE.

Canberra, ACT, Australia | Universities Australia Higher Education Conference 2019

Michelle Durant and Michael Rose attended the conference. AINSE sponsored the Information Kiosk as a Bronze Partner of the event.

March 2019

Sydney, NSW, Australia | Science and Technology Australia President and CEO Forum

Michelle Durant and AINSE President Prof. Claire Lenehan attended on behalf of AINSE, alongside representatives of more than 70 STEM organisations.

April 2019

Parliament House, Canberra, ACT, Australia | Women in STEM Decadal Plan Launch

Michelle Durant attended this event on behalf of AINSE. The Women in STEM Decadal Plan was developed by the Australian Academy of Science in collaboration with the Australian Academy of Technology and Engineering.

Melbourne, VIC, Australia | Pathways to Equity in STEM Symposium

Michelle Durant attended this event on behalf of AINSE. The event was organised by the Australian Academy of Science and the Australian Academy of Technology and Engineering as the first implementation activity of the Women in STEM Decadal Plan.

May 2019

Sydney, NSW, Australia | AINSE Members Networking Dinner

AINSE staff and AINSE delegates from across Australia and New Zealand attended.

Lucas Heights, NSW, Australia | AINSE Specialist Committee meetings

AINSE delegates from across Australia and New Zealand attended.

Lucas Heights, NSW, Australia | AINSE Annual General Meeting

Attended by 30 Australian and New Zealand university representatives, in addition to representatives from industry members, ANSTO, CSIRO and AINSE.

Clayton, VIC, Australia | Nuclear Science and Technology for Health Satellite Symposium

Michael Rose represented AINSE at a meeting of world leaders in particle therapy as part of the NST4Health conference.

June 2019

Lucas Heights, NSW, Australia | 2019 University of Wollongong - ANSTO Annual Joint Networking Workshop

Michelle Durant attended as a representative of AINSE.

Brisbane, QLD, Australia | Rural Universities Network Board Meeting

Michelle Durant met with representatives of the Rural Universities Network and presented at their Board Meeting.

Sydney, NSW, Australia | ANSTO-HZB Neutron School

Michelle Durant and Michael Rose attended the dinner and met with delegates of the school.

July 2019

The University of NSW, Sydney, NSW Australia | Women in Nuclear STEM Careers Panel

Michelle Durant attended as a guest speaker representing AINSE and spoke to approximately 30 students as a member of a 5-person panel.

Tsuruga and Osaka, Japan | Research Reactor School on Reactor Physics, Neutron Applications and Reactor Operations for the Asia-Pacific Region

Michael Rose attended on behalf of Australia as an observer of the international school.

August 2019

Sutherland Entertainment Centre, Sutherland, NSW Australia | ANSTO Fact or Fiction Show

Michael Rose participated in an interactive quiz show alongside ANSTO researchers. The event was organised by ANSTO's Discovery Centre for a general audience local to south Sydney.

Lucas Heights, NSW, Australia | ANSTO Industry Engagement Event

Michael Rose presented an overview of AINSE to visiting students from Macquarie University.

Lucas Heights, NSW, Australia | ANSTO Graduate Institute Supervisors' Workshop

Michelle Durant and Michael Rose represented AINSE at the workshop.

Lucas Heights, NSW, Australia | nandin Networking Meeting

Michelle Durant presented an overview of AINSE to six members of the nandin Innovation Centre. Michelle Durant and Cara Smith facilitated a networking morning tea.

Michael Rose (back row, 4th from left) at the Atomic Energy Research Institute, Kindai University, alongside the delegates attending the Research Reactor School on Reactor Physics, Neutron Applications and Ractor Operations for the Asia-Pacific Region, July 2019

September 2019

Clayton, VIC, Australia | ANSTO User Meeting

Mchelle Durant presented an overview of AINSE to approximately 70 attendees of the annual ANSTO User Meeting.

Lucas Heights, NSW, Australia | ANSTO Young Researcher Conference

Michael Rose prensented an overview of AINSE to attendees and participated in a follow-up Q&A session and networking afternoon tea.

Sydney, NSW, Australia | Australian Nuclear Association Conference

Michelle Durant presented an overview of AINSE to approximately 100 assembled delegates.

NSW Parliament House, Sydney, NSW, Australia | NSW Universities' Research Impact Showcase

Michelle Durant and Michael Rose represented AINSE at the launch of the NSW Universities' Research Impact Showcase.

November 2019

Gymea, NSW, Australia | Toyota Community Foundation Presentation

Michelle Durant, Kim Shields and Cara Smith attended on behalf of AINSE as invited guests.

The University of Wollongong, Wollongong, NSW, Australia | ANSTO NSTLI Awards Dinner

Michelle Durant and Michael Rose attended as representatives of AINSE.

Cronulla, NSW, Australia | AINSE Members Networking Dinner

AINSE staff and AINSE delegates from across Australia and New Zealand attended.

Lucas Heights, NSW, Australia | AINSE General Meeting

Attended by over 30 Australian and New Zealand university representatives, in addition to representatives from industry members, ANSTO, CSIRO and AINSE.

Lucas Heights, NSW, Australia | Department of Industry, Innovation and Science Graduates Visit

Michael Rose presented an overview of AINSE to over 20 new DIIS graduates.

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

AINSE was represented at the Science Meets Parliament event by AINSE Councillor Dr. Rezwanul Haque of the University of the Sunshine Coast and Dr. Agathe Lise-Pronovost, McKenzie Fellow at the School of Earth Sciences at the University of Melbourne. The event was organised by Science and Technology Australia.

December 2019

Lucas Heights, NSW, Australia | ANSTO Graduate Institute Launch

Michelle Durant, Michael Rose, and several AINSE postgraduate scholars represented AINSE at the event.

Lucas Heights, NSW, Australia | ANSTO ACNS Awards and Lunch

Michelle Durant attended the event and present the award for outstanding Research Engagement in 2019.

Member Universities Visited in 2019

The University of Adelaide

Curtin University

Deakin University

Edith Cowan University

Federation University

The University of Melbourne

Murdoch University

The University of New South Wales

The University of Western Australia

National Science Week and New AINSE Website

From 10-18 August 2019, AINSE joined the Australian scientific community in the annual celebration of National Science Week.

AINSE celebrated National Science Week 2019 with the launch of a brand new website. As part of the launch, AINSE featured four Student Research articles on the front page of the new website that shone a spotlight on some of the high-impact research being conducted by AINSE scholars across Australia and New Zealand.

The new AINSE website can be viewed at ainse.edu.au.

Video: Particle Therapy in Japan

A video showcasing the 2018 AINSE Study Tour, produced by Australia's Science Channel in collaboration with AINSE and ANSTO, was released in 2019. The video can be viewed on the AINSE Website at ainse.edu.au/particle-therapy-tour.

The tour, hosted by AINSE Managing Director Michelle Durant and ANSTO Physicist Dr. Dale Prokopovich, illustrated Japan's development of proton and carbon ion therapy from early experimental stages through to patient treatments in the hospital setting.

The video was showcased at a number of AINSE events and will be used to promote further AINSE study tours of Particle Therapy in Japan.

A section of synchrotron beamline at the National Institute of Radiological Science (NIRS) in Chiba, featured in the video showcasing the 2018 AINSE Study Tour of Particle Therapy in Japan.

Meetings and Committees

AINSE Council

Member Organisations and Representative at Council

Two Meetings of Council were held in 2019. There was an Annual General Meeting held on 22 May and a General Meeting held on 27 November.

(b) denotes AINSE Board Member.

MEMBER CODE	ORGANISATION	MEMBERSHIP COMMENCED	COUNCILLOR	MEETINGS ATTENDED
ACU	Australian Catholic University	2001		0
ADE	The University of Adelaide	1958	Professor Chris Sumby	2
AKL	The University of Auckland	1995	Professor Jadranka Travas-Sejdic	2
ANS	ANSTO	1958	Professor Andrew Peele (b)	1
			Mrs Roslyn Hatton (b)	1
			Dr Suzanne Hollins (b)	1
ANU	The Australian National University	1958	Dr Anton Wallner	1
CAN	University of Canterbury	2005	Dr Vladimir Golovko	2
CBR	University of Canberra	1996	Professor Bill Maher	0
CBR	University of Canberra	1996	Professor Duanne White	1
CDU	Charles Darwin University	1995	A/Professor Krishnan Kannoorpatti	2
CQU	CQ University	1991	Professor Owen Nevin	2
CSI	CSIRO	2010	Dr Nathan Webster	1
CSU	Charles Sturt University	1995	Dr Julia Howitt	1
CUR	Curtin University	1989	Professor Craig Buckley	1
DEA	Deakin University	1997	Professor Aaron Russell	0
ECU	Edith Cowan University	1996	A/Professor Stephen Hinckley	0
FED	Federation University Australia	1997	A/Professor Kim Dowling	2
FLI	Flinders University	1966	Professor Claire Lenehan (b) (President)	2
GRI	Griffith University	1975	Professor Evan Gray	1
JAM	James Cook University	1970	A/Professor Scott Smithers	1
LAT	La Trobe University	1966	Dr Andy Herries	0
MAC	Macquarie University	1966	Professor Barbara Messerle	0
			Professor Bridget Mabbutt	1
MAS	Massey University	2014-2017 (rejoined 2018)	Professor Richard Haverkamp	1
MEL	The University of Melbourne	1958	Professor Colette Boskovic	2
MON	Monash University	1961	Ms Julie Rothacker	1
MUR	Murdoch University	1985 -1997 (rejoined 1998)	Dr Aleks Nikoloski	2
NCT	The University of Newcastle	1965	Dr Grant Webber	0
NSW	The University of New South Wales	1958	A/Professor John Stride	2
OTA	University of Otago	2007	Professor Gary Wilson	1
			Dr Chris Moy	0
QLD	The University of Queensland	1958	Professor Ian Gentle (b) (President)	2
QUT	Queensland University of Technology	1992	Professor Godwin Ayoko	2
RMI	RMIT University	1988	Professor Gary Bryant	2
SCU	Southern Cross University	1994	Professor Bill Boyd (b)	1
SWI	Swinburne University of Technology	1991	Professor Saulius Juodkazis	2
SYD	The University of Sydney	1958 - 2015 (rejoined 2017)	Professor Peter Lay	1
TAS	University of Tasmania	1958	A/Professor Zanna Chase	1
THE	Theranostics Australia	2017	Dr Jerome Barley	0
UNE	The University of New England	1958	Dr Brendan Wilkinson	1
USA	University of South Australia	1991	Professor Enzo Lombi	0
USC	University of Sunshine Coast	2010	Professor Roland De Marco (b)	1
			Dr Rezwanul Haque	1
UTS	University of Technology Sydney	1988	Professor Michael Cortie	2
UWA	The University of Western Australia	1958	A/Professor Pauline Grierson	0
VAC	The Vacuum Society of Australia	2018	Dr Anton Stampfl	2
VIC	Victoria University	2019	A/Professor Khalid Moinuddin	1
VUW	Victoria University of Wellington	2010	Professor David Harper	0
WAI	The University of Waikato	2011	A/Professor Graham Saunders	1
WOL	University of Wollongong	1975 - 2014 (rejoined 2016)	Professor Will Price	2
	AINSE		Michelle Durant, Managing Director	2
	Independent Director		Ms Helen Liossis (b)	2
	Independent Director		Dr Peter Coldrey (b)	1

Alternate Representatives and Other Attendees at Council

MEMBER CODE	ORGANISATION		REPRESENTATIVE	MEETINGS ATTENDED
CSI	CSIRO		Dr Aaron Seeber	1
CUR	Curtin University		Dr Terry Humphries	1
DEA	Deakin University		Dr Ludovic Dumee	2
LAT	La Trobe University		Dr Matthew Meredith-Williams	1
MAC	Macquarie University		Professor Bridgett Mabbutt	1
SCU	Southern Cross University		A/Professor Malcom Clark	1
UNE	University of New England		Professor Trevor Brown	1
USA	University of South Australia		A/Professor Ivan Kempson	2
UWA	The University of Western Australia		Dr Greg Skrzypek	1

OTHER ATTENDEES		REPRESENTATIVE	MEETINGS ATTENDED
AINSE		Dr Michael Rose (Minute Secretary)	1
AINSE		Ms Kim Shields (Minute Secretary)	1
Delante Accountants & Business Advisors Pty Ltd		Mr David Aston (AINSE Auditor)	1
The University of Melbourne		Dr Agathe Lise-Pronovost	1

Seven private members were invited to attend.

AINSE Board Meetings

Four Board Meetings were held in 2019.

EXECUTIVE MEMBER	OFFICE/POSITION	ORGANISATION	MEETINGS ATTENDED
Professor Claire Lenehan	President, University Representative	Flinders University	2*
Professor Ian Gentle	President, University Representative	The University of Queensland	4#
Ms Michelle Durant	Managing Director	AINSE	4
Ms Helen Liossis	Independent Director	Independent	4
Dr Peter Coldrey	Independent Director	Independent	3
Ms Roslyn Hatton	ANSTO Representative	ANSTO	4
Dr Suzanne Hollins	ANSTO Representative	ANSTO	4
Professor Andrew Peele	ANSTO Representative	ANSTO	4
Professor Roland De Marco	University Representative	University of the Sunshine Coast	4
Professor Bill Boyd	University Representative	Southern Cross University	2^

* Retired from the Board August 2019.

Appointed as President May 2019.

^ Appointed to the Board August 2019.

AINSE Winter School Planning Committee

Dr Keith Bambery	ANSTO
Dr John Bennett	ANSTO
Dr Paul Callaghan	ANSTO
Professor David Cohen	ANSTO
Dr Tom Cresswell	ANSTO
Ms Kelly Cubbin	ANSTO
Dr Justin Bryan Davies	ANSTO
Mr Rod Dowler	ANSTO
Ms Michelle Durant	AINSE
Dr Benjamin Fraser	ANSTO
Ms Patricia Gadd	ANSTO
Professor Henk Heijnis	ANSTO
Professor Mihail Ionescu	ANSTO
Professor Mike James	ANSTO (Australian Synchrotron)
Dr Geraldine Jacobsen	ANSTO
Mr Mitchell Klenner	AINSE
Mr Henry Lake	ANSTO
Dr Lidia Matesic	ANSTO
Dr Ryan Middleton	ANSTO
Dr Arvind Parmar	ANSTO
Mr Andrew Popp	ANSTO
Dr Michael Rose	AINSE
Dr Mitra Safavi-Naeini	ANSTO
Dr Jamie Schulz	ANSTO
Dr Ken Short	ANSTO
Dr Katie Sizeland	ANSTO
Dr Andrew Studer	ANSTO
Dr Gordon Thorogood	ANSTO
Dr Kathleen Wood	ANSTO
Dr Craig Woodward	ANSTO
Dr Alan Xu	ANSTO
Ms Atun Zawadzki	ANSTO

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, (a) indicates 'alternate',(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 Henk Heijnis	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 Stephen Holt	ANSTO
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

AINSE Gold Medal

In May 2019, Dr. Lydia Mackenzie (right) from the University of Queensland was presented with an AINSE Gold Medal in front of an audience of assembled AINSE Councillors.

At the General Meeting of AINSE in November 2019, members voted to award Dr. Cynthia Isley from Macquarie University and Dr. Gabriel Murphy from the University of Sydney each with an AINSE Gold Medal for outstanding PhD research.

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.

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 2019

Contents

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Director's Report
For the Financial Year Ended 31 December 2019

Your Directors present their report on AINSE Limited (AINSE) for the financial year ended 31 December 2019.

Directors

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

Professor Claire Lenehan (cessation date 22 August 2019)
Professor Ian Gentle
Ms Michelle Durant
Dr Peter Coldrey (cessation date 31 December 2019)
Ms Helen Liossis
Professor Roland De Marco
Ms Roslyn Hatton
Dr Suzanne Hollins
Professor Andrew Peele
Professor William Boyd (commencement date 23 August 2019)
Dr Leonie Walsh (commencement date 1 January 2020)

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

Principal Activities

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

AINSE's short-term objectives are to:

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

AINSE's long-term objectives are to:

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

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Director's Report
For the Financial Year Ended 31 December 2019

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
AINSE Limited
ABN 18 133 225 331
Director's Report
For the Financial Year Ended 31 December 2019

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

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

Helen Liossis – Independent Director.
Board member since January 2018.
32 years' experience in finance roles (including Chief Operating Officer, Head of Investor Relations and other senior executive roles).
Currently the Head of Corporate Strategy and Business Planning at Sydney Water.
BBus (Accounting and Economics), MBA, CPA, GAICD.

Leonie Walsh – Independent Director.
Board Member since January 2020.
38 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.
29 years' experience in CSIRO, academia, scientific research as well as Research Leadership and Management.
BSc, MSc, PhD, FRACI, MACS, MEUAS.

William Boyd – University Representative Director.
Board Member since August 2019.
38 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
AINSE Limited
ABN 18 133 225 331
Director's Report
For the Financial Year Ended 31 December 2019

Information on Directors continued

Suzanne Hollins – ANSTO Representative Director.
Board member since May 2018.
22 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.
27 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
AINSE Limited
ABN 18 133 225 331
Director's Report
For the Financial Year Ended 31 December 2019

Meetings of Directors

During the financial year, 4 meetings of directors were held. Attendances by each director were as follows:

	Number eligible to attend	Number attended
Professor Claire Lenehan	2	2
Professor Ian Gentle	4	4
Ms Michelle Durant	4	4
Dr Peter Coldrey	4	3
Ms Helen Liossis	4	4
Professor Roland De Marco	4	4
Ms Roslyn Hatton	4	4
Dr Suzanne Hollins	4	4
Professor Andrew Peele	4	4
Professor William Boyd	2	2

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 2019, the total amount that members of AINSE are liable to contribute if AINSE is wound up is $530 (2018: $520).

Auditors Independence Declaration

The lead auditor's independence declaration for the year ended 31 December 2019 has been received and can be found on page 59 of the report.

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

Director Michelle Durant

Director Suzanne Hollins

Dated this 25th day of March 2020

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Auditor's Independence Declaration to the Directors
For the Financial Year Ended 31 December 2019

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 2019 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 25 March 2020

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 2019

	Note	2019 $	2018 $
Revenue	2	1,678,120	1,671,605
External grants	2	266,684	129,182
Other income	2	68,896	106,299
Total income		2,013,700	1,907,086
Employee benefits expense		(582,117)	(554,214)
Depreciation expense	3	(3,587)	(4,056)
Audit, legal and consultancy expense		(22,395)	(29,869)
AINSE Awards		(1,194,687)	(909,402)
Other expenses		(223,740)	(332,681)
Total Expenses		(2,026,526)	(1,830,222)
Surplus/(deficit) before income tax		**(12,826)**	**76,864**
Income tax expense		-	-
Surplus/(deficit) for the year		**(12,826)**	**76,864**

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Statement of Financial Position
As At 31 December 2019

	Note	2019 $	2018 $
ASSETS			
CURRENT ASSETS			
Cash and cash equivalents	4	3,643,339	3,501,658
Trade and other receivables	5	239,742	177,791
Other	6	60,674	17,767
TOTAL CURRENT ASSETS		3,943,755	3,697,216
NON-CURRENT ASSETS			
Property, plant & equipment	7	52,145	11,355
TOTAL NON-CURRENT ASSETS		52,145	11,355
TOTAL ASSETS		**3,995,900**	**3,708,571**
LIABILITIES			
CURRENT LIABILITIES			
Trade and other payables	8	782,051	501,095
Employees provisions	9	73,943	64,630
TOTAL CURRENT LIABILITIES		855,994	565,725
NON-CURRENT LIABILITIES			
Employees provisions	9	26,818	16,932
TOTAL NON-CURRENT LIABILITIES		26,818	16,932
TOTAL LIABILITIES		**882,812**	**582,657**
NET ASSETS		**3,113,088**	**3,125,914**
EQUITY			
Awards reserve	12	818,924	736,769
Accumulated surplus		2,294,164	2,389,145
TOTAL EQUITY		**3,113,088**	**3,125,914**

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Statement of Changes in Equity
For the Financial Year Ended 31 December 2019

	Awards Reserve $	Accumulated Surplus $	Total $
Balance at 1 January 2018	**716,676**	**2,332,374**	**3,049,050**
Net surplus/(deficit) attributable to AINSE	-	76,864	76,864
Transfers to and from awards reserve	20,093	(20,093)	-
Balance at 31 December 2018	**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**

The accompanying notes form part of these financial statements

The Australian Institute of Nuclear Science and Engineering
AINSE Limited
ABN 18 133 225 331
Cash Flow Statement
For the Financial Year Ended 31 December 2019

	2019 $	2018 $
CASH FLOWS FROM OPERATING ACTIVITIES		
Receipts from operations	1,826,600	1,874,458
Receipts from grants	526,075	532,895
Interest received	68,413	83,889
Award related payments	(1,157,597)	(1,075,474)
Payments to suppliers and employees	(1,077,433)	(998,751)
Net cash generated from operating activities	**186,058**	**417,017**
CASH FLOWS FROM INVESTING ACTIVITIES		
Payment for property, plant and equipment	(44,377)	-
Net cash used in investing activities	**(44,377)**	**-**
Net increase / decrease in cash held	**141,681**	**417,017**
Cash and cash equivalents at beginning of financial year	3,501,658	3,084,641
Cash and cash equivalents at end of financial year	**3,643,339**	**3,501,658**

The accompanying notes form part of these financial statements

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 2019

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 20 March 2020 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 2019

Significant Accounting Policies

Revenue and Other Income

Grant revenue is recognised in the statement of comprehensive income when AINSE obtains control of the grant, it is probable that the economic benefits gained from the grant will flow to AINSE and the amount of the grant can be measured reliably.

If conditions are attached to the grant which must be satisfied before it is eligible to receive the contribution, the recognition of the grant as revenue will be deferred until those conditions are satisfied.

When grant revenue is received whereby AINSE incurs an obligation to deliver economic value directly back to the contributor, this is considered a reciprocal transaction and the grant revenue is recognised in the statement of financial position as a liability until the service has been delivered to the contributor, otherwise the grant is recognised as income on receipt.

Donations and bequests are recognised as revenue when received.

Interest revenue is recognised using the effective interest method, which for floating rate financial assets is the rate inherent in the instrument.

Revenue from the rendering of a service is recognised upon the delivery of the service to the customers.

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

Property, Plant and Equipment

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

Plant and Equipment

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

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

Depreciation

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

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

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

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

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

Financial Instruments

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

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

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.

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 2019

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 derecognized.

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 derecognized.

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.

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 2019

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 2019

	Note	2019 $	2018 $
Note 2 – Revenue and Other Income			
Revenue			
Payments from members		1,239,920	1,228,455
ANSTO promotion fee		438,200	443,150
		1,678,120	1,671,605
External grants	13	266,684	129,182
		1,944,804	1,800,787
Other income			
Conference registrations		-	25,751
Sponsorships		-	-
Interest received		65,951	75,537
Other income		2,945	5,011
		68,896	106,299
Total revenue and other income		2,013,700	1,907,086
Note 3 – Surplus for the Year			
The surplus for the year has been determined after charging as expenses:			
Depreciation of property, plant and equipment		3,587	4,056
Bad and doubtful debts		-	-
Note 4 – Cash and Cash Equivalents			
Cash at bank		3,642,339	3,500,658
Cash on hand		1,000	1,000
Total cash and cash equivalents		3,643,339	3,501,658
Note 5 – Trade and Other Receivables			
Trade receivables		87,617	12,346
Less: Provision for impairment		-	-
		87,617	12,346
Other receivables		152,125	165,445
Total trade and other receivables		239,742	177,791
Note 6 – Other Current Assets			
Accrued interest		3,581	6,043
Prepayments		57,093	11,724
Total other current assets		60,674	17,767

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 2019

	Note	2019 $	2018 $
Note 7 – Property, Plant and Equipment			
Plant and equipment – cost		17,300	17,300
Less: Accumulated depreciation		(8,792)	(8,042)
		8,508	9,258
Furniture and fittings – cost		32,362	10,485
Less: Accumulated depreciation		(10,850)	(8,388)
		21,512	2,097
Motor vehicles – cost		68,113	45,613
Less: Accumulated depreciation		(45,988)	(45,613)
		22,125	-
Total property, plant and equipment		52,145	11,355

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 2019	9,258	2,097	-	11,355
Additions	-	21,877	22,500	44,377
Depreciation	(750)	(2,462)	(375)	(3,587)
Balance at 31 December 2019	8,508	21,512	22,125	52,145

		2019 $	2018 $
Note 8 – Trade and Other Payables			
Trade and other payables		40,519	24,488
Grants received – in advance	13	732,759	472,676
Employees – accrued salary and wages		8,773	3,931
Total trade and other payables		782,051	501,095

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 2019

	2019 $	2018 $
Note 9 – Employee Provisions		
CURRENT		
Annual leave	44,890	39,232
Long service leave	29,053	25,398
	73,943	64,630
NON-CURRENT		
Long service leave	26,818	16,932
	26,818	16,932
Total employee provisions	100,761	81,562

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:

Key management personnel compensation	212,845	219,769

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.

Note 12 – Awards Reserve

Opening balance at 1 January	736,769	716,676
Transfer to and (from) awards reserve	82,155	20,093
Balance as at 31 December	818,924	736,769

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 2019

	2019 $	2018 $
Note 13 – External Grants		
GRANTS REVENUE		
New Fund	153,045	75,090
Continuing Residential Student Scholarship Funding	79,426	35,500
Women in STEM and Entrepreneurship (WISE)	10,000	3,000
Scholarship AINSE ANSTO French Embassy (SAAFE)	24,213	15,592
	266,684	129,182
Grants Received in Advance		
New Fund	702,274	446,160
Women in STEM and Entrepreneurship (WISE)	-	10,000
Scholarship AINSE ANSTO French Embassy (SAAFE)	30,484	16,516
	732,759	472,676

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:

Financial Assets		
Cash and cash equivalents	3,643,339	3,501,658
Trade and other receivables	239,742	177,791
Total financial assets	3,883,081	3,679,449
Financial Liabilities		
Trade & other payables	782,051	501,095
Total financial liabilities	782,051	501,095

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 2019

Note 16 – 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 2019

The Directors of AINSE Limited (AINSE) declare that:

1. The financial statements and notes, as set out on pages 60 to 73 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 2019 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 25th day of March 2020

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 2019

Audit Opinion

Opinion

We have audited the financial report of AINSE Limited (AINSE), which comprises the statement of financial position as at 31 December 2019, 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 2019 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 2019

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 25 March 2020

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 2019

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 2019

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 2019.

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 25 March 2020

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 2019

		2019 $		2018 $
Operating Revenue				
Payments from Members		1,239,920		1,228,455
ANSTO Promotion Fee		438,200		443,150
External Grants		266,684		129,182
Interest Received		65,951		75,537
Conference Registrations		-		25,751
Other Income		2,945		5,011
Total Operating Revenue		2,013,700		1,907,086
Operating Expenses				
Wages & Salaries		453,972		461,500
Superannuation		65,557		67,442
AINSE Awards				
Postgraduate Awards				
ANSTO Facility Consumables	2,500		11,800	
Travel & Accommodation	159,996		88,500	
Stipends	754,374		736,339	
		916,870		836,639
Research Awards				
AINSE Supported Facility	2,475		2,273	
Early Career Researcher Grant	100,000		-	
		102,475		2,273
Conference Support		33,016		128,878
Events and Schools		175,342		98,188
Publication & Promotions		15,369		42,485
Meetings & Committees		81,214		72,832
AINSE Secretariat				
Administration & Staff Training	8,664		5,646	
Audit Fees	22,395		23,180	
Bank Charges	(85)		1,129	
Books & Software	5,137		-	
Consultancy Fees	-		6,689	
Contractors – Office Staff	62,588		25,272	
Credit Card Expense	31		29	
Depreciation	3,587		4,056	
Entertaining	619		377	
FBT Expense & Payments	3,224		1,201	
Insurance	7,839		13,644	
Miscellaneous	31,639		17,651	

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 2019

		2019 $		2018 $
Office Supplies	7,119		6,493	
Postage & Telephone	1,003		838	
Staff Recruitment	2,294		1,035	
Travel & Accommodation	12,497		6,736	
Vehicle Expenses	14,160		6,009	
		182,711		119,985
Total Operating Expenses		2,026,526		1,830,222
Surplus/(deficit) for the Year		(12,826)		76,864

WISE School

Women in STEM and Entrepreneurship

Inspiring and supporting the next generation of female leaders in STEM

AINSE held its third annual Women in STEM and Entrepreneurship (WISE) School in December 2019, with a record sixty-two first-year female students from thirty-five Australian and New Zealand member universities participating.

AINSE received funding from ANSTO and the Office of the NSW Chief Scientist & Engineer within the NSW Department of Industry to host the 2019 WISE school, which focusses on Women in STEM and their career opportunities within nuclear science and engineering.

AINSE Managing Director Michelle Durant opened the school on December 5, presenting an overview of AINSE and the invaluable opportunities it provides to students and early-career researchers. Michelle also shared her personal STEM journey through a career spanning from research, to science outreach, to becoming the Managing Director of a STEM-focused organisation.

The lessons learned through personal career journeys was a key theme among all 2019 WISE guest speakers, providing

"This was an incredible experience that has completely changed and really clarified my understanding of workplaces in engineering."

The 2019 WISE student cohort spent three and a half days at ANSTO's Lucas Heights campus in south Sydney. During this time they engaged with a diverse group of scientists, engineers and distinguished guests, participating in seminars, panel discussions and networking events, and initiated mentor-mentee discussions that will continue throughout 2020 via the WISE Mentorship Program.

ANSTO's Discovery Centre also hosted tours of some of the landmark research facilities at ANSTO, presenting the cohort with additional insight into ANSTO's research programs, services and innovation activities, and the breadth of STEM career opportunities available to students within Australia.

students with a wealth of insight on successfully overcoming diverse personal and academic challenges that can occur on the path to a successful career in STEM.

The opening was followed by a keynote presentation from ANSTO CEO Dr. Adi Paterson, who discussed strategies to close the gender gap together with his goals and experiences as a Male Champion of Change, and shared his personal accounts of the inspiring female trailblazers in his family.

Over the course of the WISE School, students heard from distinguished guest speakers who spoke to their individiual STEM journeys and presented students with invaluable advice gained on their paths to established and successful careers. We would like to extend our sincere thanks to all our amazing guest speakers in 2019: Isabelle Kingsley, Research Associate and Office of the Women in STEM Ambassador, UNSW; Dr. Joanne Lackenby, President, Women in Nuclear Australia Chapter and STA Superstar of STEM; Prof. Madhu Bhaskaran, Research Leader at RMIT University; Dr. Cathy Moloney, Australian Defence College; Karlie Noon, Master of Astronomy and Astrophysics graduate, ANU; Dr. Erica Smyth AC, professional Company Director; and Prof. Tim Wess DVC (Academic), University of the Sunshine Coast.

In addition to these guests, students had the opportunity to hear from AINSE scholars past and present, and representatives from the Women in Nuclear (WiN) Australia Chapter and the Australian Young Generation in Nuclear (AusYGN). They also participated in networking and entrepreneurship panels with Katrina Van De Ven, Prof. Anna Paradowska and Dr. Tim Boyle (ANSTO), and Kim Herbert (Cyntropy).

A networking dinner was held on the final night of the school to allow students to engage with their mentors face-to-face at the start of the year-long 2019-20 WISE Mentorship Program. The Mentorship Program is a cornerstone of the WISE School keeping WISE alumni connected to ANSTO staff and mentors throughout the following year. AINSE and ANSTO staff volunteer their time to keep in touch with students via monthly online chat sessions and videoconferences, allowing mentors and mentees to discuss the opportunities—and strategies to overcome the challenges—in STEM careers generally, and in the fields of nuclear science and engineering specifically.

AINSE would like to extend our gratitude to all our guest speakers and mentors for their key efforts in making the 2019 WISE School a success, and thank both ANSTO and the Office of the NSW Chief Scientist & Engineer within the NSW Department of Industry for their funding support. We look forward to hearing from our 2019 WISE alumni as they continue on their own journeys towards successful careers in STEM.

Dr. Joanne Lackenby, president of WiN Australia and one of Science & Technology Australia's Superstars of STEM, addresses the 2019 WISE cohort.

p.81, clockwise from top: Isabelle Kingsley from the Office of the Women in STEM Ambassador discussing her ongoing career journey in STEM; students meeting their mentors for the first time at the dinner on the final night; and the WISE students and WiN Australia representatives (back row) alongside Dr. Cathy Moloney from the Australian Defence College.

2019 AINSE WISE School Students

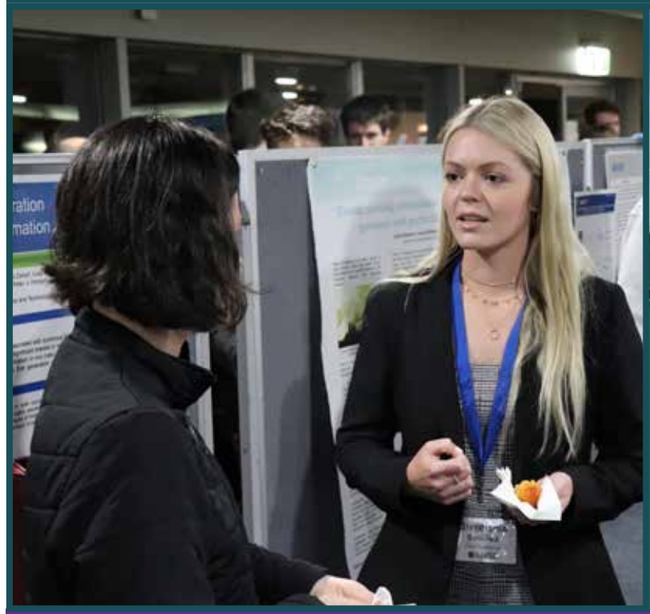
Grace Abbott	TAS	Scarlett Kroon	MEL
Caroline Andersson	FLI	Beth Legg	UNE
Georg Armstrong	USA	Gabrielle Leslie	SWI
Meaghan Ashton	ADE	Sophia Lin	MEL
Jade Audino	MUR	Julie Lloyd	MEL
Lauren Blackwell	QUT	Arden Loye	WAI
Jaqueline Bodill	UTS	Wye Xin Lye	USA
Sophie Bonnington	OTA	Heather Mackay	RMI
Abigail Christian	UNE	Abi Meehan	CQU
Shimay Clark	SCU	Anna Michael	SYD
Anthea Coleman*	OTA	Lucia Milne	VIC
Jaimie Cook	ADE	Lucia Neilson-Senise	QLD
Stephanie Cowling	WOL	Suraya Newell	MAC
Sophie Deam	CAN	Minh Nguyen	SYD
Claire Dempsey	GRI	Alice Oliver	SCU
Cherie Deng	VUW	Katherine Osborne	WAI
Rose Dowling	CSU	Pippa Pryor	UNE
Chloe Duffield	MAC	Haylea Purnell	ADE
Emma Earley	SCU	Chloe Rout	UWA
Ruby Friend	VUW	Jemima Ruming	NCT
Andrea Guan	CAN	Olivia Secoulidis	MON
Vanshika Gupta	SYD	Ella Smith	WAI
Elizabeth Hall	ACU	Sophie Steel*	CSU
Georgina Harris	MAS	Madeleine Stewart	ANU
Yukta Hegishte	USA	Mikayla Stokes	AKL
Rosemarie Henderson	DEA	Michaela Sullivan	UTS
Pearl Hoile	GRI	Aubree Taffinder	FED
Antoinette Indrawidjaja	AKL	Olivia Taifalos	ANU
Beth Jones	CAN	Cindy Tran	UTS
Tenisha Jones	USC	Maria Victorova	QLD
Lauren Kosovich	VIC	Monique Yakas	NSW

* Participation via mentorship program only.

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:

Agriculture
Archaeology
Biology
Biomedical Physics
Biomedical Science
Chemical Engineering
Chemistry
Civil Engineering
Creative intelligence and innovation
Earth Sciences
Ecology
Engineering
Environmental Engineering
Environmental Science and Management
Geology
Innovation Design
Marine Science & Management
Mathematics
Medical Science
Molecular and Cellular Biology
Nanoscience
Pharmaceutical Science
Physical Geography
Physics
Rural Science
Science and Media



Winter School

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

The AINSE Winter School is a week-long program held annually each July at ANSTO's Lucas Heights campus in south Sydney. The Winter School has been running successfully since 1997, with the aim to provide senior undergraduate STEM students with a connection to both researchers and research opportunities at ANSTO.

The twenty-third annual AINSE Winter School in 2019 saw a record sixty-two students attend from thirty-nine member universities across Australia and New Zealand. AINSE industry members also nominated students to attend.

The school was opened on July 8 by AINSE Managing Director Michelle Durant and AINSE President Prof. Ian Gentle alongside outgoing AINSE President Prof. Claire Lenehan. An Acknowledgment of Country was presented by Brett Rowling, including an informative and entertaining history of Australian science over the course of tens of thousands of years.

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. This was followed by a radiation safety workshop and a panel discussion exhibiting research from ANSTO's Environment, Human Health and Nuclear Fuel Cycle research themes. The first day ended with a trivia night, the first social activity to help foster strong connections within the Winter School cohort.

The second day commenced with further panel sessions that gave students an understanding of the research projects undertaken using ANSTO's infrastructure, including the Australian Centre for Neutron Scattering at Lucas Heights and the Australian Synchrotron at Clayton. Senior Instrument Scientist (Neutron Imaging) and AINSE alumnus Dr. Joseph Bevitt gave a special lecture about his research in palaeontology, archaeology, and cultural heritage. At the end of the day students spent time in Sydney CBD with AINSE staff in a continuation of the school's social program.

"I made so many new connections and friends and am now aware of more options in my field of study. I feel more motivated to go into research now."

The Facility Sessions, the central activities of the Winter School, also began on the second day. These sessions gave students the opportunity to gain hands-on experience with the ANSTO research facilities that they had learned about in the previous panel discussions and presentations, including the Australian Centre for Neutron Scattering, Centre for Accelerator Science, Isotope Tracing in Natual Systems laboratories, and Nuclear Materials and Electron Microscopy laboratories. The Facility Sessions continued through days three and four, along with presentations from guest speaker CSIRO Chief Scientist Dr. Cathy Foley and representatives from the Women in Nuclear (WiN) Australia Chapter and the Australian Young Generation in Nuclear (AusYGN). Students also had the chance to tour the ANSTO Lucas Heights campus with ANSTO's Discovery Centre team.

The final night of the Winter School was devoted to the Research Roundup Networking Dinner, which gaves students the opportunity to connect with ANSTO researchers one-on-one and ask detailed questions about their ongoing research projects at ANSTO. The connections formed over the course of the evening have led to numerous collaboration between ANSTO researchers and Winter School students on their honours (and other postgraduate) research projects.

On the final day of Winter School, students heard from current and former AINSE PGRA students and Winter School Alumni with a focus on their postgraduate student experiences. The school was closed by Michelle Durant and Dr. Joanne Lackenby, President of the WiN Australia Chapter.

AINSE would like to thank all the ANSTO staff and our guest speakers for their key role in making the Winter School a success, with a feedback survey indicating that 100% of respondents found the Winter School to be a worthwhile event. We look forward to seeing participating students back on ANSTO campuses for their research projects in the coming years.

Winter School students and ANSTO staff discussing ongoing research projects at the Research Roundup Networking Event.

p.85, clockwise from top: the 2019 Winter School alumni (photo credit: Bruce Hudson); the Student Project panel discussion hosted by Mitch Klenner (AINSE/ANSTO) and featuring Dr. Helen Maynard-Casely, Dr. Jessica Veliscek-Carolan and Dr. Benjamin Fraser (ANSTO); the student audience for the panel discussion; and one of the conversations between ANSTO researchers and Winter School students at the poster session of the Research Roundup Networking Event.

2019 AINSE Winter School Students

Alexander Armstrong	SWI	Rania Mahjoub	DEA
Steven Best	VAC/QUT	Mark McLean	UNE
Archana Bulathsinghala	MAC	Caitlin McManus	FLI
Marcus Cai	ANU	Frazer Moore	AKL
Fionnuala Campbell	TAS	Shay Morrison	USC
Olivia Campisi	MEL	Clarecia Murray	ECU
Jarrod Curran	CSU	Lachlan Packman	QLD
Tayla Dahms	JAM	Eleanor Pease	QLD
Silviu Dobrota	NSW	Hailee Philipps	ECU
Thomas Eason	MON	Ezra Prattley	CAN
Valerio Falasca	THE/UWA	Stephanie Richter-Stretton	UNE
Claire Faulkner	ADE	Hollie Ryan	QUT
Kim Fowler	CAN	Stephanie Sanchez	CSU
Isaac Frith	MON	Seng Gi Saw	USA
Shannon Fuller	CDU	Lennart Schaefer	MUR
Jessica Gibbs	QLD	Daksh Shah	RMI
Joshua Gibson	GRI	Katherine Stockwell	UWA
Jorja Hackett	VUW	Claire Strong	USC
Michi Hartnett	ANU	Adnaan Thakur	ADE
Blair Haydon	LAT	Maggie Tong	SYD
Vivien Heng	ADE	Liam Turner	CUR
Nyssa Hewitt	WAI	Mark Villar	UTS
William Hinds	TAS	Shannon Waddy	SCU
William Hoskin	FED	Ben Walters	JAM
Ryan Husband	NCT	Henry West	MEL
Curtis Irvine	UTS	Saori Westworth	CQU
Tasha James	CBR	Holly Williams	OTA
Jessica Judd-Ireland	FLI	James Wrigley	VUW
Kaan Kaban	WOL	Kristen Yorker	MAS
Michael Lloyd	MEL	Amir Zaribaf	SYD
Timothy Magner	GRI	Jiajiia Zhao	CSI/RMI

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
Astronomy
Biochemistry
Biological Sciences & Applied Chemistry
Biomedical Science
Biotechnology
Chemical Engineering
Chemistry
Ecology and Biodiversity
Electrical Engineering
Engineering
Environmental Science
Forensic Science
Frontier Materials
Geology
Geosciences
Health and Medical Sciences
Immunology
Manufacturing Engineering
Maritime Archaeology
Materials Engineering
Mathematics
Mechanical Engineering
Mechatronics
Medical Radiation Science (Nuclear Medicine)
Medicinal Chemistry
Microbiology/Genetics
Nanotechnology
Pharmaceutical Sciences
Physics
Surface Science
Zoology

Top, and below: A high-schoool student engagement field trip co-designed and facilitated by former AINSE Honours scholar Luke Steller (alongside Bonnie Teece) in the Pilbara, Western Australia. Luke's Honours project focussed on studying fossils and mineral assemblages from the region using ANSTO's Neutron Radiography instrument DINGO. Photo credit: Lee Henderson, UNSW.

Honours Scholarships

In 2019, 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 thirty successful students representing thirteen universities who were awarded an Honours Scholarship in 2019.

Honours students supported in 2019: **30**

Students supported through an AINSE Honours Scholarship since 2011: **179**

Honours Scholars, and Their Projects, awarded in 2019:

Quantification of degradation of mechanical properties of P22 steel using FEM, neural networks and genetic algorithms.
Keshav Agarwal, The University of Sydney.

Characterisation of polyphenol distribution within *sorghum* grain using synchrotron infrared light.
Wendy Andrews, Curtin University.

Spin crossover complexes with functionalised ligands.
Ashley Brennan, The University of New South Wales.

Synthesis, structure and magnetic properties of transition metal honeycomb oxide materials.
Alexander Brown, The University of Sydney.

Effect of hot isostatic pressing on corrosion at waste glass-canister interface.
Keenan Burrough, The University of New South Wales.

The last termination record at Darwin Crater, Tasmania.
Sarah Cooley, The University of Melbourne.

Molten salt corrosion (FLiNaK) of Ni-Mo-Cr alloy welds for Molten Salt Reactor (MSR) systems.
Alexander Danon, The University of New South Wales.

Reconstructing climate variability in Australia using isotopes and lake sediments.
Chloe Dean, The University of Adelaide.

Applying a vacuum region to anisotropic ELM stability studies.
Joshua Doak, The Australian National University.

Prediction of creep and creep-fatigue damage of Alloy 617 for application in Very High Temperature Reactor (VHTR) Systems.
Garen Douzian, The University of New South Wales.

From producers to predators: ecosystem metrics of Tasman Sea oceanographic habitats.
Peter Garside, The University of New South Wales.

Investigating the potential of the Grey Mangrove as a source of palaeoclimate information.
Matthew Goodwin, The University of Newcastle.

Advancing a radiotherapy predictive model to incorporate nanoparticle radiosensitisation in head and neck cancers.
Myxuan Huynh, The University of South Australia.

Chaos in crystal catalysts: the effect of structural disorder on reactivity.
Caitlin Ingham, Swinburne University of Technology.

Small molecule reduction by nickel/iron sulphides.
Brittany Kerr, Swinburne University of Technology.

Photoswitchable catalysts - using light to remote-control chemical reactions.
Alicia Kim, The University of Queensland.

Can the flax rust effector protein AvrM14 target plant RNA biogenesis.
Carl McCombe, The Australian National University.

Hierarchical self-assembly of metal-organic frameworks.
Lachlan Modina, The University of Queensland.

Investigation of the magnetic and crystal field excitations in the orthorhombically distorted perovskites $TbVO_3$, $CeVO_3$, $ErFeO_3$ and $DyFeO_3$.
Joel O'Brien, The University of New South Wales.

East Australian current phytoplankton species and biomass patterns: past, present and future.
Bradley Paine, The University of Tasmania.

Assessment of the radiation damage of graphite for Molten Salt Reactor (MSR) systems.
Nicholas Palmer, The University of New South Wales.

Radiocarbon dating of extreme flood events at Nitmiluk Gorge, northern Australia.
Panayiotis Panaretos, The University of New South Wales.

Spatial and temporal variability in stable isotope composition of alpine streams in the Snowy Mountains region and Murrumbidgee River catchment.
Reuben Parige, The Australian National University.

An investigation into specific ion effects of multi-responsive polymers.
Hayden Robertson, The University of Newcastle.

Fire, drought and floods: an investigation into the palaeo-environments of Thirlmere Lakes NSW.
Bryce Sherborne-Higgins, University of Wollongong.

Temperature reconstructions at Thirlmere Lakes using chironomids and aquatic insects.
Elizabeth Swallow, University of Wollongong.

El Niño–Southern Oscillation at the mid-late Holocene boundary.
Patrick Wilcox, University of Wollongong.

Remodelling of SANS and rheo-SANS data for concentrated worm-like micelle and fibre-gel systems.
Ashley Williams, Monash University.

Effector–receptor interactions in wilt disease of tomato.
Daniel Yu, The Australian National University.

CFD analysis of liquid deuterium two-phase dynamics in OPAL CNS (NAS Task no. 290).
You Shi Zhu, The University of New South Wales.

PGRA student Mardi McNeil collecting Halimeda *bioherm sediment samples in the northern Great Barrier Reef.*

PGRA Scholarships

Postgraduate Research Award

p.89, clockwise from top: investigating the effects of contaminated sediment at the National Sea Simulator, Townsville (Francesca Gissi, far right), collecting samples from Mt. Taranaki (Geoffrey Lerner), and loading samples at the Australian Synchrotron SAXS/WAXS beamline (Emma Livingstone).

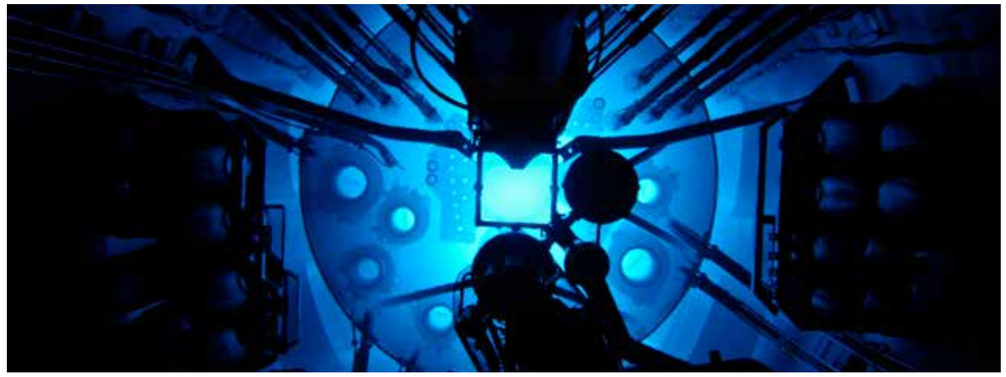
PGRA students supported in 2019:	**93**
New PGRA students in 2019:	**29**
Students trained in nuclear science and related fields under an AINSE PGRA:	**449**

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.

Twenty-nine new AINSE postgraduate research projects were supported by a PGRA in 2019. The total number of scholars supported in 2019 was ninety-three. AINSE received twenty-four theses this year and, through its PGRA program, has now helped train four hundred and forty-nine 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.



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

PhD Theses of Postgraduate Scholars received during 2019:

Mimicking microbial membranes.
Jakob Andersson, School of Chemical and Physical Sciences, Flinders University.
Commenced 01/07/2015.

Synchrotron spectroscopy of astrochemical condensed phase species: Terahertz far-infrated signatures of planetary aerosols and ice.
Rebecca Auchettl, Department of Chemistry and Physics, La Trobe University.
Commenced 01/07/2017.

Calcium carbonate prenucleation clusters: towards unification of classical and non-classical nucleation theory.
Jonathan Avaro, Southern Cross GeoScience, Southern Cross University.
Commenced 01/07/2015.

Speleothem-based palaeo-climate research-methodology, applications, and insight from the Snowy Mountains, southeast Australia.
Micheline Campbell, School of Earth and Environment, The University of Western Australia.
Commenced 01/07/2015.

Data synthesis and modern cave process studies in southeastern Australia: towards improving geional palaeoclimate records for the Common Era.
Bronwyn Dixon, School of Earth Sciences, The University of Melbourne
Commenced 01/07/2015.

Reconstructing Australia's late Quaternary climate from the geochemistry of lake sediments and snail shells.
Georgina Falster, Earth Sciences, The University of Adelaide.
Commenced 01/07/2015.

Nanoscale characterization of ZnO, $PbTiO_3$, $CH_3NH_3PbI_3$ and thin film growth of Cu_2OSeO_3
Nastaran Faraji Ouch Hesar, School of Materials Science and Engineering, The University of New South Wales.
Commenced 01/07/2016.

Forensic application of nuclear versus mitochondrial DNA and the formation of cholesterol oxidation biomarkers in human cells after gamma-irradiation.
Corey Goodwin, Forensic Studies, University of Canberra.
Commenced 01/07/2015.

Nanostructure of temperature responsive polymer brushes modulated by salt identity.
Ben Humphreys, Chemistry, School of Environmental and Life Sciences, The University of Newcastle.
Commenced 01/07/2016.

Soil organic matter turnover over decadal to millennial timescales.
Andrew Jones, School of Agriculture and Food Science, The University of Queensland.
Commenced 01/07/2015.

Mechanisms of hydrogen-induced cracking in ultrahigh-strength steels.
Oluwole Kazum, Chemical Engineering, James Cook University.
Commenced 01/07/2015.

Energy dispersive methods for polycrystalline materials characterisation.
Henry Kirkwood, Department of Chemistry and Physics, La Trobe University.
Commenced 01/07/2015.

A multi-basin approach to investigate Paleoclimate and carbon burial in Fiordland, New Zealand.
Cara Lembo, Department of Geology, University of Otago.
Commenced 01/07/2018.

Defining volcanic regimes at Mt Taranaki, New Zealand.
Geoffrey Lerner, School of Environment, The University of Auckland.
Commenced 01/07/2016.

Characterisation of proteins essential to vesicle membrane fusion.
Emma Livingstone, Institute for Molecular Bioscience, The University of Queensland.
Commenced 01/07/2016.

Metal organic framework based catalytic reactors for CO_2 conversion.
James Maina, Institute for Frontier Materials, Deakin University.
Commenced 01/07/2016.

Historical mine sites as modern-day sources of contamination: measurement and characterisation of arsenic in historical gold mine wastes to identify the potential for mobility and human exposure.
Rachael Martin, School of Science, Information Technology & Engineering, Federation University.
Commenced 01/07/2013.

Thermal scattering law uncertainties and propagation into small thermal fission reactors.
Lance Maul, School of Mechanical & Manufacturing Engineering, The University of New South Wales.
Commenced 01/07/2014.

Specific ion effects on stimulus-responsive polymer brushes.
Timothy Murdoch, Chemical Engineering, The University of Newcastle
Commenced 01/07/2015.

A fundamental and systematic investigation into the solid state chemistry of some ternary uranium oxides.
Gabriel Murphy, School of Chemistry, The University of Sydney.
Commenced 01/07/2017.

Common cores in the high country: the archaelology and environmental history of the Namadgi Ranges.
Fenja Theden-Ringl, Archaeology and Natural History, The Australian National University.
Commenced 01/07/2013.

Polarisation coherence imaging of electric and magnetic fields in plasmas.
Alexander Thorman, Plasma Research Laboratory, The Australian National University.
Commenced 01/07/2014.

Synthesis and investigation of polyoxometalate-supported lanthanoid single-molecule magnets.
Michele Vonci, School of Chemistry, The University of Melbourne.
Commenced 01/07/2014.

Controlling spin state switching in two-dimensional coordination framework materials using multiple stimuli.
Katrina Zenere, School of Chemistry, The University of Sydney.
Commenced 01/07/2017.

Research Highlights:

Postgraduate Scholars, and Their Projects, supported in 2019:

When was the Antarctic landscape last unfrozen?
Jacob Anderson, Department of Marine Science, University of Otago .
Commenced 01/07/2017.

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

Far and mid-infrared spectroscopy of astrochemical species and aerosols.
Rebecca Auchettl, Department of Chemistry and Physics, La Trobe University.
Commenced 01/07/2017.

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.

Characterisation and evolution of Rottnest Island salt lake microbialites, Western Australia.
Karl Bischoff, School of Earth Sciences, The University of Western Australia.
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.

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.

Exploring magnetoelectric coupling in ferroics; neutron scattering experiments probing the magnetic phases of $BiFeO_3$.
Stuart Burns, School of Materials Science and Engineering, The University of New South Wales.
Commenced 01/07/2016.

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

Landscape evolution of the Kimberley region and rock art dating using cosmogenic ^{10}Be and ^{26}Al.
Gael Cazes, School of Earth and Environmental Sciences, University of Wollongong.
Commenced 01/07/2016.

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.

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.

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.

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.

Uncovering the mechanisms of corrosion-resistant materials: towards developments of novel corrosion inhibition measures.
Deepak Dwivedi, Chemical Engineering, Curtin University.
Commenced 01/07/2017.

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.

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.

Stable carbon isotope analysis of *Pandanus* sp. drupes: a proxy for ancient foraging practices at Madjedbebe (Malakunanja II).
Stephanie Florin, School of Social Science, The University of Queensland.
Commenced 01/07/2015.

A breath of fresh air for cystic fibrosis.
Melanie Fuller, School of Chemical and Physical Sciences, Flinders University.
Commenced 01/07/2016.

Research Highlights:

Using *Casuarina cunninghamiana* as a record of floodplain deposition with C-14, Itrax, and radium isotopes.
Jonathan Garber, School of Geography,
The University of Melbourne.
Commenced 01/07/2018.

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.

Reconstructing the post-glacial history of the subantarctic Auckland Islands from marine sediment cores using ITRAX XRF and AMS radiocarbon.
Greer Gilmer, Geological Sciences,
University of Otago.
Commenced 01/07/2015.

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.

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

Synthesis of carbon-11 and fluorine-18 PET radiotracers for targeting the NOD-like receptor Protein 3 (NLRP3) - a key bio-marker of neurodegenerative inflammation.
James Hill, Institute for Molecular Bioscience,
The University of Queensland.
Commenced 01/07/2018.

Synthesis of carbon-11 and fluorine-18 PET radiotracers for targeting the NOD-like receptor Protein 3 (NLRP3) - a key bio-marker of neurodegenerative inflammation.
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.

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.

Mineral controls on soil carbon stability along the subtropical giant podzol Cooloola chronosequence.
Andrew Jones, School of Agriculture and Food Science, The University of Queensland.
Commenced 01/07/2015.

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.

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.

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.

Evaluation of 3D graphene scaffold for *in vivo* biocompatibility and its role in promoting bone regeneration.
Jianfeng Li, Intelligent Polymer Research Institute,
University of Wollongong.
Commenced 01/07/2018.

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.

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.

Early stage cancer diagnosis: SANS characterization of antigen-nanocubes (Au-NPFe_2O_3NC) interactions for the detection of p53 autoantibodies..
Mostafa Kamal Masud, Institute for Superconducting & Electronic Materials, The University of Queensland.
Commenced 01/07/2018.

Research Highlights:

Ben Humphreys - p.34

Probing the internal nanostructure of PNIPAM brush modified silica particles.
(PGRA scholarship concluded in 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.

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 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.

Investigating transfer and accumulation of trace metals up the food chain: using radiotracers to observe the uptake of contaminants in prawns and fish from seawater and dietary ingestion.
Kaitlyn O'Mara, Australian Rivers Institute,
Griffith University.
Commenced 01/07/2016.

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.

Chronology development of Auckland Maar Lake sediment records.
Leonie Peti, School of Environment,
The University of Auckland
Commenced 01/07/2017.

Exploring the potential of Mg/Ca ratios in sub-aqueous speleothems to reconstruct surface temperatures over multiple glacial-interglacial cycles.
Timothy Pollard, School of Geography,
The University of Melbourne.
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.

Fire and environmental change in Northern Australia during the Late Holocene.
Emma Rehn, College of Science and Engineering,
James Cook University.
Commenced 01/07/2017.

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.

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 Sacco, Applied Geology,
Curtin University.
Commenced 01/07/2017.

Using C-14 to resolve mangrove carbon cycling.
James Sippo, Centre for Coastal Biogeochemistry,
Southern Cross University.
Commenced 01/07/2016.

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.

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

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.

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 Childre's Health,
The University of New South Wales.
Commenced 01/07/2018.

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.

Research Highlights:

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.

Using ITRAX XRF, multi-dimensional isotope analysis and silica microfossils to study the palaeo-ecology of sclerophyll sites in the Atherton Tablelands, northeastern Australia.
Loraine Watson-Fox, School of Geography, Planning & Environmental Management,
The University of Queensland.
Commenced 01/07/2016.

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.

Novel fluorinated radioligands of the tyrosine kinase, MERTK, for imaging and diagnosis in multiple sclerosis.
Siu Wai Wong, Monash Institute of Pharmaceutical Sciences, Monash University.
Commenced 01/07/2016.

Operando X-ray absorption spectroscopy study of sodium storage mechanism of $ZnXP_2$ (X=Sn, Ge or Si) anodes.
Zhibin Wu, Institute of Superconduction & Electronic Materials, University of Wollongong.
Commenced 01/07/2017.

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.

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.

Nanostructures and their application for enhancing photocatalytic activity of CO2.
Jiajia Zhao, School of Engineering,
RMIT University.
Commenced 01/07/2019.

Research Highlights:

Zhibin Wu - p.40

Boosting high-rate electrochemical energy storage from topological insulators.

Residential Student Scholarships

In 2019 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 align with ANSTO's research programmes; The Environment, Human Health, Nuclear Fuel Cycle, Defence Industry and Fusion.

AINSE wishes to congratulate the successful RSS applicants for 2019 (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 2019:

Machine learning based treatment planning for laser-driven multi-ion particle therapy.
Roumani Alabd,
University of Technology, Sydney.

The role of the microbiome in Alzheimer's Disease.
Andrew Gia,
The University of New South Wales.

Evaluation of SF5-functionalised bioconjugates as tools for diagnostic imaging and drug development.
Hugh Hiscocks,
University of Technology, Sydney.

Peatland restoration in Indonesia: reconstruct past peat, hydrology and vegetation dynamics using palaeoecology and geochemical proxies .
Khairun Nisha Mohamed Ramdzan,
The University of Queensland.

Research Highlights:

Karthik Gopi - p.9

Using isotopic and elemental fingerprints to determine the provenance of tiger prawns *(continuing AINSE RSS scholar)*.

Postgraduate Orientation Week

The AINSE Postgraduate Orientation Week (formerly PGRA 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 14–16, AINSE welcomed thirty-three new postgraduate scholars to the annual Orientation Week at ANSTO's Lucas Heights campus in Sydney.

Over the course of the program, students attended a series of 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, Health, and the Nuclear Fuel Cycle. Past and present AINSE scholars Mitchell Klenner and Maja Dunstan also met with the new cohort to discuss their own student experiences and work-life balance.

Attendees also had the opportunity to tour a selection of ANSTO's landmark research infrastructure at Lucas Heights, including the OPAL multi-purpose reactor and the Australian Centre for Neutron Scattering. Afterwards, students met with their ANSTO co-supervisors who provided site-specific introductions to their individual research areas.

2019 AINSE Postgraduate Orientation Week Attendees

Roumani Alabd	UTS	Aidan McLean	AKL
Meltem Bayrak	RMI	Nur Maizura Mohd Darbi	AKL
Milos Dubajic	NSW	Eron Raines	VUW
Shankur Dutt	ANU	Khairun Nisha Mohamed Ramdzan	QLD
Mohammadali Faraji	NCT	Ruby Roach	MAS
Alissa Flatley	MEL	Vanessa Solano	CDU
Andrew Gia	NSW	Xin Fu Tan	QLD
Luke Giles	MON	Bryan Pi Ern Tee	ANU
Muhammet Kartal	MUR	Clare Wilkinson	CAN
Adam Kennedy	MON	Yunxiao Zhang	UWA
Joshua King	MON	Jiajia Zhao	RMI
Benjamin Laeuchli	AKL		

The new cohort of AINSE postgraduate scholars who attended the Postgraduate Orientation Week.

Dr. Simone Richter (Group Executive, ANSTO Nuclear Science & Technology, and Landmark Infrastructure) addresses the new AINSE PGRA and RSS cohort before dinner.

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 a networking dinner and a science trivia night, and 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 inttheir future research careers.

Guest speaker Prof. Maria Rost Rublee from Monash University provided the students with a thought-provoking presentation on 'The social construction of "nuclear" in Australia', an especially timely topic for Nuclear Science Week. Prof. Rublee spoke about her research into Australia's ideas about the word "nuclear", and how these ideas formed, and now shape, Australian policy.

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 another successful O'Week. We wish our new AINSE scholars all the best for their research endeavours in 2020 and beyond.

Students, AINSE staff and guest speakers at the Nuclear Science Week trivia night.

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 AINSE Early Career Researcher Grant was awarded for the first time in 2019, with 12 grants approved to researchers from 12 member institutions.

Early Career Researchers, and Their Projects, Awarded in 2019:

Rare-earth mediated dehydrocoupling.
Mathew David Anker,
Victoria University of Wellington.

Using light to remote control metal-coordination.
Kasun Sankalpa Athukorala Arachchige,
The University of Queensland.

Origin and age of riverine carbon across a land use gradient in tropical Australia.
Clement Duvert, Charles Darwin University.

Pre-targeting using porous silicon nanoparticles and radioisotopes - towards precision cancer theranostics.
Lars Esser, CSIRO.

Deciphering the interactions of polymyxins with Gram-negative membranes: integration of systems pharmacology with neutron reflectometry and molecular dynamics simulation.
Meiling Han, Monash University.

Charge density studies of photoredox metal complexes - an experimental study of the ground and lowest excited states.
Michael Craig Pfrunder,
Queensland University of Technology.

Examining the influence of seasonal variation on radionuclide association to fauna and microfauna in Australian arid environments.
Maria Angelica Rea, Flinders University.

Solubility measurements of benzene in methane at cryogenic conditions: from liquefied natural gas production to Saturn's moon Titan.
Arman Siahvashi,
The University of Western Australia.

Microbeam radiation therapy for the treatment of Osteosarcoma.
Lloyd Smyth, The University of Melbourne.

Exploiting nanocatalysts for clean energy applications.
Maria Veronica Sofianos, Curtin University.

Effect of helium bubble formation on recrystalisation and mechanical properties of tungsten.
Matt Andrew Trevor Thompson,
The Australian National University.

Multiferroic materials and unconventional superconductors in transition metal oxide superlattices.
Samuel Yick, The University of New South Wales.

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, seven PhD students were approved to travel either from Australia to France or from France to Australia as part of the third round of the Scholarship AINSE ANSTO French Embassy (SAAFE) research internship program in 2019.

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 2019:

STUDENT	UNIVERSITY OF ENROLMENT	HOST INSTITUTION(S)
Jeremy Davis	University of Wollongong (AUS)	CEA-LIST (FRA)
Melanie Ferlazzo	Centre National d'Etudes Spatiales (FRA)	ANSTO (AUS)
Hooman Hezaveh Hesar Maskan	The Australian National University (AUS)	ITER Organization (FRA)
Michael Moschetti	The University of New South Wales (AUS)	East Paris Institute of Chemistry and Materials Science (ICMPE) (FRA)
Oliver Paull	The University of New South Wales (AUS)	Université Paris Saclay (FRA)
Nicholas Ranson	The University of Sydney (AUS)	Aix-Marseille Université (FRA)
Nicolas Rosuel	Université Grenoble Alpes (FRA)	Australian Synchrotron - ANSTO (AUS)

SAAFE Report from Oswald Malcles: Understanding landscape evolution in Intra-plate zones

SAAFE Scholar Oswald Malcles

Our understanding of Earth's dynamics took a major step forward in the 1960's with the formulation of plate-tectonics theory.

According to this theory the Earth's crustal surface is divided into several connected but independent tectonic plates. At the plate boundaries, differential displacements lead to major surface variations that are observed as scenic and geomorphic deformation structures and patterns, as highlighted by the major inter-plate mountains belts (Himalayas, Andes) and the mid-oceanic ridges.

Terrestrial Cosmogenic Nuclide (TCN) techniques are a key method in our study to constrain the rate of landscape evolution in the Massif-Central.

This initial theory of plate tectonics assumed rigid plates, a necessary assumption for the efficient transfer of stress from one plate to another across the inter-plate boundary. The rigid plate model can explain the first-order dynamics of the lithosphere and the plate-boundary evolutions. However, this theory fails to explain intra-plate landscape geomorphology at the intraplate orogens, where boundary dynamics are no longer the primary force.

The Massif-Central in Southern France (Figure 1) is an excellent example of an intraplate domain, with deep canyons having elevation ranges varying from approximately 100 to 1800 metres, the result of intense river incision and quaternary volcanism. The question of whether this resulted from tectonic deformation is still debated.

Our study aimed to provide a more robust understanding of the surface dynamics related to the intraplate domain of the Massif-Central. This is a challenging objective because direct measurements of vertical deformations via satellite sensing data (e.g. GNSS: Global Navigation Satellite System or InSAR: Interferometric Synthetic Aperture Radar) lack the sensitivity and precision required to quantify deformation rates. Hence we must obtain the necessary data from the landscape itself.

Terrestrial Cosmogenic Nuclide (TCN) techniques are a key method in our study to constrain the rate of landscape evolution in the Massif-Central. This technique makes use of quartz minerals that are exposed at the Earth's surface and bombarded by energetic cosmic ray particles. The bombardment creates the cosmogenic radionuclides ^{10}Be (half-life of 1.4 million years) and ^{26}Al (half-life of 0.70 million years). Eventually, the exposed rock surfaces undergo erosion and release quartz grains containing ^{10}Be and ^{26}Al, which are transported along river networks.

The active river incision punctuating the Massif plateau results in the formation of deep canyons in which cave systems, laden with river sediments, sands and cobbles, are formed along vertical cliff flanks. The elevations at which these caves are formed represent the levels to which the river channel had incised. By measuring ^{10}Be concentrations in river sediments, it is possible to derive the average denudation-rate of the watershed (Lal, 1991). By measuring both ^{10}Be and ^{26}Al in cave sediments, we can determine the time when the caves were flooded. In this way, the caves act like 'dipsticks' that allow for measurement

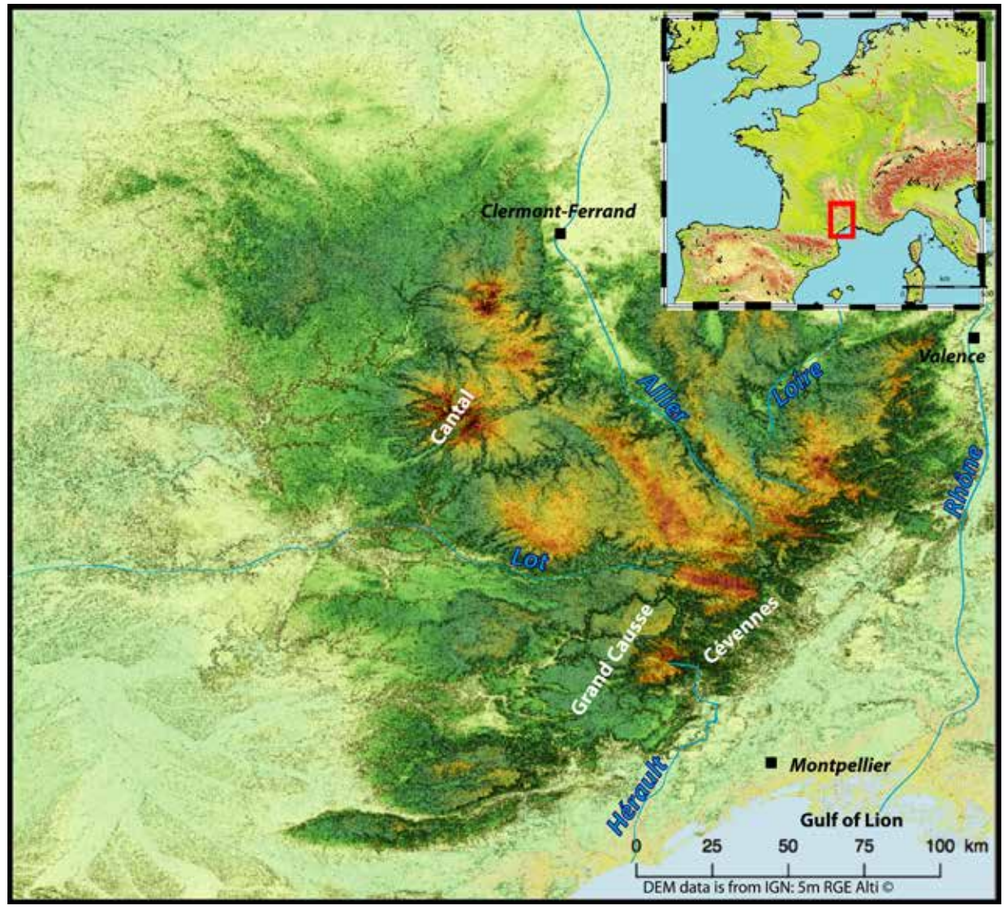


Figure 1: The Massif-Central study area. Blue lines indicate the main river channels that were sampled. Black squares locate some principal towns and white labels refer to major regional sectors of the Massif. The red square in the inset figure locates the Massif within Europe.

of the rate of river incision.

In addition to this technique, we also used the cosmogenic burial method. For cave sediments, this method is based on the idea that once sediment is deposited in a cave, cosmic ray production ceases completely. Given the two radionuclides ^{10}Be and ^{26}Al have very different half-lives, the difference in the measured ratio of ^{10}Be/^{26}Al in cave sediments compared to that in parent bedrock (or modern river sediments) provides us with a measure of the burial time (Granger et al., 1997). These two applications of cosmogenic radionuclides—burial dating and basin-wide average denudation rates—provide quantification of the landscape evolution from 5.10 million years ago to 10,000 years ago.

A first field campaign was undertaken in 2018, in which 27 samples were collected from 12 caves. Tests on four cave samples showed that the incision rate in the southern limit of the French Massif-Central was 80 metres per million years (Figure 3) during the last approximately 4 million years, validating our hypothesis (Malcles et al., 2019).

Cosmogenic ^{10}Be and ^{26}Al measurements performed at the Accelerator Mass Spectrometry facility at ANSTO's Centre for Accelerator Science confirm our earlier conclusion, bsed on numerical modelling, that this incision is more likely to be balanced by the regional uplift. Unexpectedly, the classical karst evolution scheme—used in virtually every study focusing on river incision rate—was challenged by our 2018 results.

It appears that the vertical height of the river is unlikely to be the main parameter leading to the cave-system evolution. Karst evolution

Figure 2: Sampling of quartz cobbles in the Escoutet Cave, Vis Valley, Southern France.

...our preliminary results show that the Massif-Central deformation is the sum of at least two processes.

in the center of intra-plate plateaus is likely to be more complicated, involving structural inheritance and ghost rock process.

In 2019, a second sampling campaign was performed in order to construct a map of denudation rate encompassing the whole Massif-Central, and to provide new incision rate constraints from the Northeastern and Southwestern borders of the Massif-Central. This new dataset will provide invaluable constraints to test the regional uplift hypothesis and possible lateral or time-span variations in the surface processes.

In summary, our preliminary results show that the Massif-Central deformation is the sum of at least two processes. First, a triggering event which generates regional uplift. Second, a subsequent increase in uplift by isostatic adjustment induced by basin wide erosion. In order to validate this two-step model, our next project objective is to test our model at other intraplate orogens (for example, the Great-Dividing Range in Australia or Sero del Mar in Brazil).

Oswald Malcles was awarded a SAAFE Scholarship in 2018 and travelled from France to Australia for the purposes of this research project in 2019.

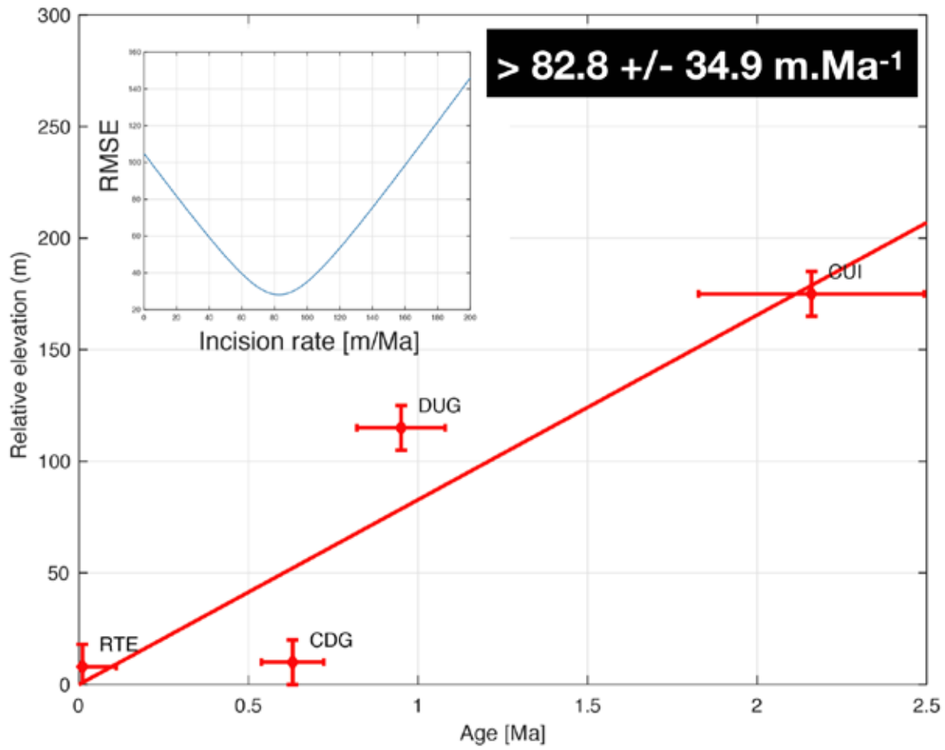


Figure 3: Relative elevation between modern river channel and sampled cave sediments versus comsogenic $^{10}Be/^{26}Al$ burial age. To first order, burial age is linearly correlated with elevation, i.e. the larger the burial age (cave formation), the higher the elevation above the modern river channel. The linear regression gives the mean incision rate of 83 m/Ma during the past 2 or 3 million years.

References:

Lal, D 1991, 'Cosmic ray labeling of erosion surfaces: *in situ* nuclide production rates and erosion models', *Earth and Planetary Science Letters*, vol. 104, pp. 424–439.

Granger, D E, Kirchner, J W & Finkel, R C 1997, 'Quaternary downcutting rate of the New River, Virginia, measured from differential decay of cosmogenic ^{26}Al and ^{10}Be in cave-deposited alluvium', *Geology*, vol. 25(2), pp. 107–110.

Malcles, O, Vernant, P, Chéry, J, Camps, P, Cazes, G, Ritz, J-F & Fink, D 2019, 'Determining the Plio-Quaternary uplift of the southern French Massif-Central; a new insight for intraplate orogen dynamics', *Solid Earth Discussions*, https://doi.org/10.5194/se-2019-99, in review.

Masson, C, Mazzotti, S, Vernant, P & Doerflinger, E 2019, 'Extracting small deformation beyond individual station precision from dense Global Navigation Satellite System (GNSS) networks in France and western Europe', *Solid Earth*, vol. 10, pp. 1905–1920, https://doi.org/10.5194/se-10-1905-2019.

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 2019, 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	STUDENTS SUPPORTED	STUDENT UNIVERSITIES / ORGANISATIONS
9th Australian Colloid and Interface Symposium	Symposium	3–7 February	Hotel Grand Chancellor, Hobart	1	The University of Sydney
Universities Australia Higher Education Conference 2019	Conference	27 February –1 March	National Convention Centre, Canberra	-	(Event Sponsorship)
NST for Health Symposium 2019	Symposium	25 May	Australian Synchrotron, Clayton, VIC	2	The University of Sydney University of Wollongong
ANSTO-HZB Neutron School	School	23–28 June	ANSTO (Lucas Heights including AINSE Theater)	11	Charles Darwin University Griffith University Monash University Murdoch University RMIT University Swinburne University of Technology The University of Adelaide The University of Western Australia
Mini-course/workshop on the Application of Computational Mathematics to Plasma Physics	Workshop	24–27 June	The Australian National University, Canberra	3	The University of Sydney Murdoch University
ANSTO New User Symposium	Symposium	11 September	Australian Synchotron, Clayton, VIC	11	Charles Sturt University Curtin University Edith Cowan University Macquarie University Queensland University of Technology The Australian National University The University of Adelaide The University of Queensland University of South Australia University of Wollongong
Australian Nuclear Association (ANA) 2019 Conference	Conference	27 September	University of Technology Sydney	1	RMIT University
Particle Accelerator Physics Strategy Meeting	Meeting	3–4 October	AINSE, Lucas Heights	-	(Event Sponsorship)
New Zealand Institute of Chemistry Conference 2019 (NZICXIX)	Conference	24–28 November	Christchurch, New Zealand	-	(Event Sponsorship)
27th Annual Royal Australian Chemical Institute Research and Development Topics Conference	Conference	1–4 December	Flinders University, Adelaide	9	Curtin University Monash University The University of Sydney Macquarie University University of Technology, Sydney RMIT University University of Tasmania
ANSTO User Meeting 2019	Conference	2–3 December	Macquarie University, Sydney	14	The University of Melbourne The University of Western Australia University of South Australia La Trobe University The University of Queensland Monash University Murdoch University
2019 Australasian Community for Advanced Organic Semiconductors (AUCAOS) Symposium	Symposium	2–4 December 2019	Katoomba, NSW	5	Flinders University Queensland University of Technology University of Otago The University of Adelaide The University of Melbourne

International Travel Scholarships

Throughout the year, students from AINSE-member organisations who are presenting research conducted with an ANSTO collaborator are invited to apply for travel support to attend international conferences. AINSE International Travel Scholarships encourage students to participate in conferences in order to network and exchange ideas with the worldwide nuclear science and engineering community.

AINSE International Travel Scholarships offer up to A$1,000 towards travel expenses. In 2019, AINSE awarded scholarships to twenty-seven students to present at numerous high-profile international conferences.

AINSE International Travel Scholarships Awarded in 2019:

STUDENT	MEMBER CODE	CONFERENCE ATTENDED	CONFERENCE LOCATION
Calina Betlazar-Maseh	SYD	16th International Congress of Radiation Research (ICRR)	Manchester, UK
Andrew Chacon	WOL	2019 IEEE Nuclear Science Symposium (NSS) and Medical Imaging Conference (MIC)	Manchester, UK
Jeremy Dobrowolski	NSW	27th International Society of Heterocyclic Chemistry Congress	Kyoto, Japan
Stephanie Anna Florin	QLD	18th Conference of the International Working Group for Palaeoethnobotany	Lecce, Italy
Dillon Frost	NSW	The Minerals, Metals and Materials Society Meeting 2020 (TMS 2020)	San Diego, California, USA
Jonathan Garber	MEL	American Geophysical Union 2019 Fall meeting	San Francisco, California, USA
Jacinta Greer	ADE	International Quaternary Association Conference	Dublin, Ireland
Hugh Hiscocks	UTS	International Symposium of Radiochemical Sciences (ISRS)	Beijing International Convention Center, Beijing, China
Edwin Johnson	NCT	European Colloid and Interface Society (ECIS) International Conference	Leuven, Belgium
Farzana Kastury	USA	The 15th International Conference on the Biogeochemistry of Trace Elements (ICOBTE)	Nanjing, China
Shinji Kihara	AKL	Okinawa Colloids 2019	Okinawa, Japan
Liam Koehn	MEL	2019 Cold Spring Harbor meeting: Blood Brain Barrier	New York, USA
Jiatu Liu	SYD	3rd Asia-Oceania Conference on Neutron Scattering 2019 (AOCNS 2019)	Taiwan
Michael Moschetti	NSW	THERMEC'2020 - International Conference on Processing and Manufacturing of Advanced Materials	Vienna, Austria
Samantha Pandelus	FLI	JRNC-RANC, 2nd International Conference on Radioanalytical and Nuclear Chemistry 2019	Budapest, Hungary
Leonie Peti	AKL	European Geosciences Union (EGU) General Assembly 2019	Vienna, Austria
Priya Priya	ADE	International Union for Quaternary Research	Dublin, Ireland
Eron Raines	VUW	GRS/GRC Geobiology meeting	Galveston, Texas, USA
Emma Rehn	JAM	International Quaternary Association Congress	Dublin, Ireland
Yuexiao Shao	ADE	Goldschmidt 2019	Barcelona, Spain
Martin Spasovski	AKL	2019 Asia-Oceania Conference on Neutron Scattering (AOCNS 2019)	Hengchun Township, Pingtung County, Taiwan
Luke Steller	NSW	Astrobiology Graduate Conference (AbGradCon) 2019	Salt Lake City, Utah, USA.
Praceen Vadakkedath	AKL	2nd European Conference on Smart Nanomaterials	Paris, France
Gaurav Vats	NSW	Joint ISAF-ICE-EMF-IWPM-PFM conference - 2019	Lausanne, Switzerland
Anne Whitworth	MON	Goldschmidt 2019	Barcelona, Spain
Keenan Wilson	UTS	Engineering in Medicine and Biology Conference 2019	Berlin, Germany
Yunxin Xiao	MON	International Polymer Colloids Group Conference (IPCG)	Sentosa Island, Singapore

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 in 2019.

ANSTO-Funded Travel and Accommodation Support in 2019:

ADE	The University of Adelaide	MUR	Murdoch University
AKL	The University of Auckland	NCT	The University of Newcastle
ANU	The Australian National University	NSW	The University of New South Wales
CAN	University of Canterbury	QLD	The University of Queensland
CBR	University of Canberra	QUT	Queensland University of Technology
CSI	CSIRO	RMI	RMIT University
DEA	Deakin University	SWI	Swinburne University of Technology
ECU	Edith Cowan University	USA	University of South Australia
FLI	Flinders University	USC	University of the Sunshine Coast
GRI	Griffith University	UWA	The University of Western Australia
MAS	Massey University	VUW	Victoria University of Wellington
MEL	The University of Melbourne	WOL	University of Wollongong
MON	Monash University		

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

Supported Publications

The University of Adelaide

Martin Ankor

Ankor, M J, Tyler, J T & Hughes, C E 2018, 'An autonomous, monthly and daily, rainfall sampler for isotope research', Poster presented at the Australasian Quaternary Association (AQUA) Biennial Conference 2018, Canberra, Australia, December 2018.

Ankor, M J & Tyler, J T 2019, 'Development of a spreadsheet based model for transient groundwater modelling', *Hydrogeology,* vol. 27(5), pp. 1865–1878.
Available from: doi:10.1007/s10040-019-01996-z.

Ankor, M J, & Tyler, J T 2018, 'Hydrologic and isotopic modelling of lakes: towards mechanistic understanding of proxy data', Oral presentation delivered at the Australasian Quaternary Association (AQUA) Biennial Conference 2018, Canberra, Australia, December 2018.

Chloe Dean

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Georgina Falster

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Emma Dodd

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Tara Brown

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Elizabeth Swallow

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Zhibin Wu

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Member Codes

ACU	Australian Catholic University
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
CSU	Charles Sturt University
CSI	CSIRO
CUR	Curtin University
DEA	Deakin University
ECU	Edith Cowan 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
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

** Membership confirmed by AINSE Council November 2019*

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The Australian Institute of Nuclear Science and Engineering, AINSE Ltd.

EMAIL
ainse@ainse.edu.au

PHONE
+61 2 9717 3376

WEBSITE
www.ainse.edu.au

AINSE Ltd. ABN:
18 133 225 331

MAIL
Locked Bag 2001
Kirrawee DC NSW 2232
Australia

ADDRESS
New Illawarra Road
Lucas Heights NSW 2234
Australia

AINSE Ltd.

Cover Image: A computer simulation models the velocity streamlines of boiling liquid hydrogen. The simulation was created by You Shi Zhu, an Honours student at the University of New South Wales and recipient of a 2019 AINSE Honours Scholarship. Based on real-world data from hydrogen boiling experiments, the simulation aims to provide deeper insights into the behaviour of boiling liquid deuterium—an isotope of hydrogen used in the Cold Neutron Source of ANSTO's OPAL multi-purpose reactor.
Image credit: You Shi Zhu, AINSE 2019 Honours Scholar.