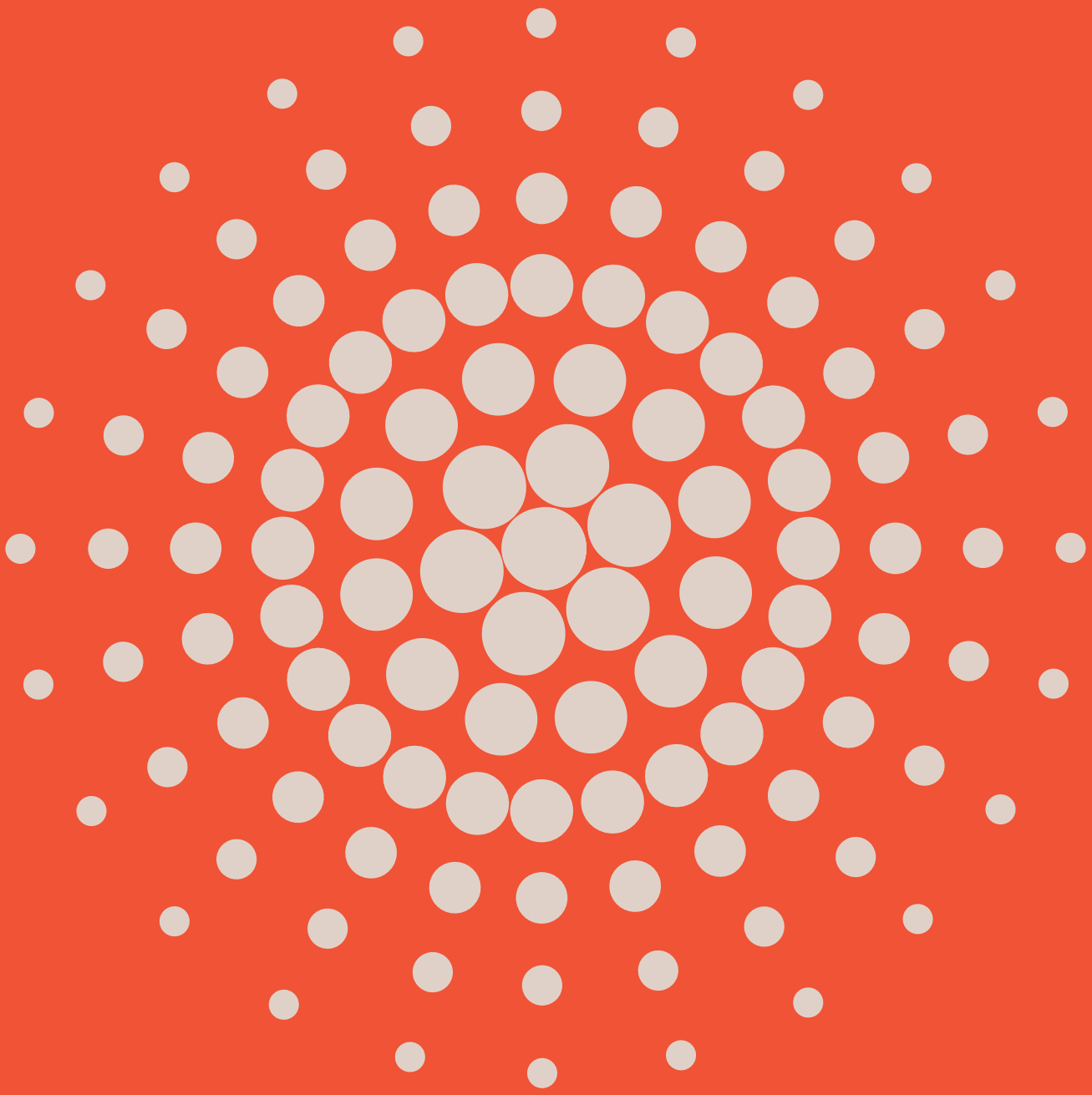
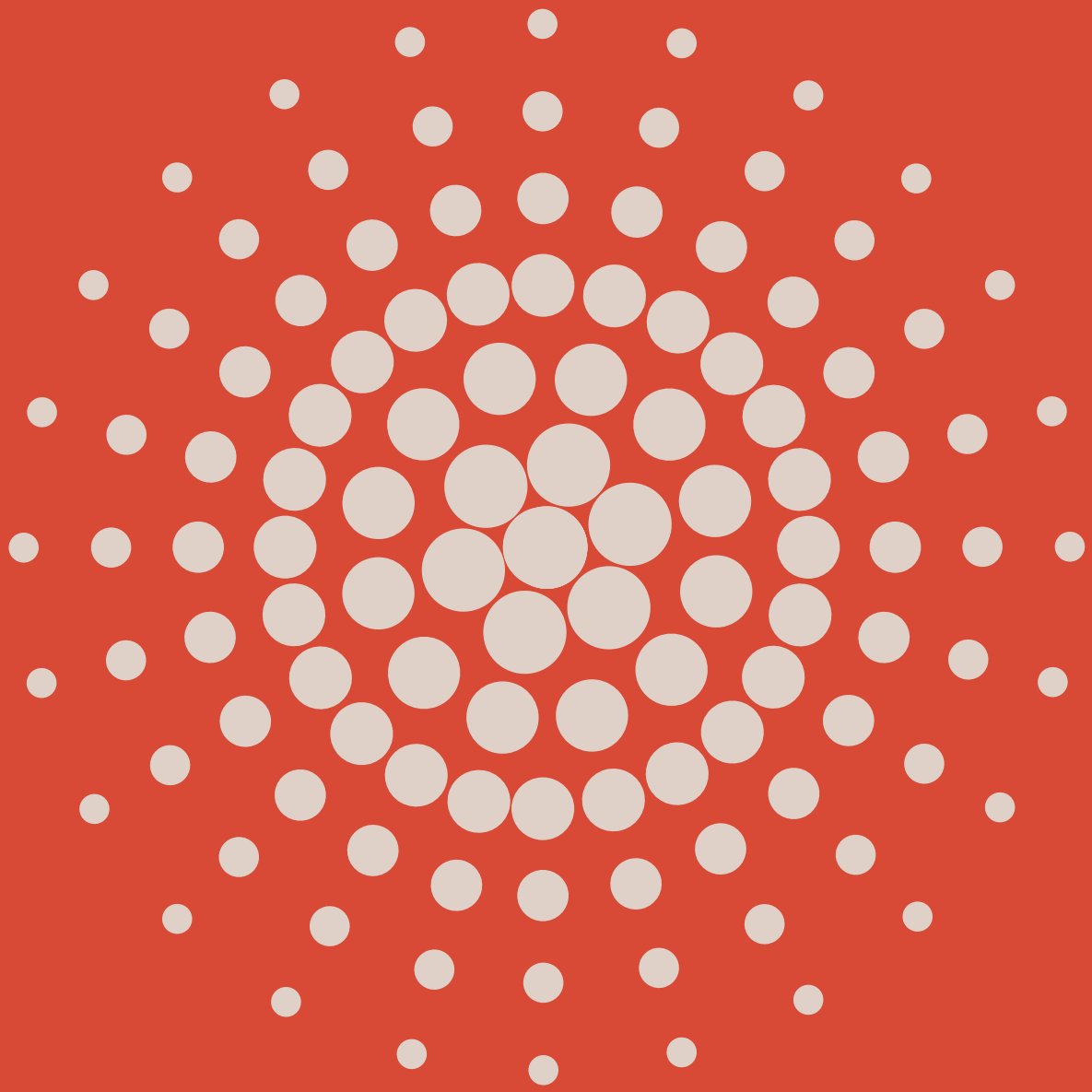


MacDiarmid Institute *2023* Annual Report



MacDiarmid Institute
2023 Annual Report

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Nicola Gaston and Justin Hodgkiss

Co-Directors

2023 was a year full of activity, and we are pleased to share this report on the Institute's progress across a range of areas. Our research programmes are going full steam ahead: designing low energy alternatives to current computing technology, working at the interface of Mātauranga Māori with materials science, developing new materials for CO_2 management and using nanotechnology to understand and address Kauri dieback.

We want to send a big thank you to our previous Deputy Directors, Professor Geoff Willmott and Professor Paul Kruger, and also a big welcome to our new Deputy Directors – Associate Professor Anna Garden and Associate Professor Natalie Plank. We are really privileged to have a deep pool of leadership talent within the Institute, and a shared commitment to our collective purpose that makes these moments of succession really uncomplicated to navigate. Thank you all for your support and work on behalf of the MacDiarmid Institute.

We worked closely with KiwiNet and others to start a conversation about the need for scale-up support for start-up companies as they outgrow their university origins, and brought together scientists, entrepreneurs and investors in the commercial stream of our AMN conference. Deep tech start-ups attracted 49% of total capital funding in Aotearoa New Zealand in the first half of 2023; our researchers deliver IP and new start-up companies into this ecosystem and our stream of highly skilled graduates are increasingly going on to work in deep tech, underpinning this sector of critical importance to Aotearoa New Zealand's economic and sustainability ambitions.

Please enjoy these snapshots of the work of our people, scientists who comprise the pipeline of talent that will enable Aotearoa New Zealand to prosper in the face of increasing global sustainability challenges.

Hēmi Rolleston
Board Chair

Tēna koutou katoa

It is my absolute privilege to provide you with my second Chair's report. I continue to be amazed as I look across the breadth of mahi undertaken by the Institute and am inspired by the researchers leading the way united in a common goal.

Like all years there has been change. We farewelled from our directorship team two people who have been vital to the Institute's success over the past six years. Professor Geoff Willmott has led the Commercialisation and Industry Engagement area and Professor Paul Kruger has helmed the Outreach and Education portfolio. Both Geoff and Paul played significant roles in the Institute's successful rebid in 2020. We also welcome two new Deputy Directors – Associate Professor Anna Garden who steps into the Outreach and Education portfolio, and Associate Professor Natalie Plank who will lead the Commercialisation and Industry portfolio. We also established a new position – Strategic Manager Māori, and welcomed Kirsty Doyle to this role.

We created a new Institute Affiliate status that recognises outreach partnerships, research collaborations and other contributions that complement and strengthen our activities and welcomed Dr Dave Warren from University of Otago as our very first Institute Affiliate.

We continue to support and foster our Discovery Scholarship cohort, with connections and ongoing mentoring and skill development, connecting them internationally. Our outreach and education continued to reach into key communities this year, with our AMN10 science activities delivered to over 320 school students over four days in Rotorua in February, and Dave Warren's work with Northland schools over the year, and more.

Like always our scientists have been busy doing what they do best, developing new materials to convert CO_2, finding low energy alternative computing options, weaving Mātauranga Māori with contemporary science and tackling Kauri dieback.

I would like to once again thank the Board and the leadership team for their unwavering commitment to the kaupapa of the MacDiarmid Institute and our partners and stakeholders for your continued support.


Alaska


Te Mana Tangata
Whakawhanake
MacDiarmid
Institute
Advanced Materials
& Nanotechnology
macdiarmid.ac.nz

Te Moana Nui a Kiwa

This year *Te Moana Nui a Kiwa* made some new and exciting additions to its programme and people. Highlights include our new te reo Māori class, the establishment of our Strategic Manager Māori position and important new international relationships.

We also saw our cohort of Discovery Scholarship recipients grow. We are so proud to be supporting them along the way with opportunities and support to help them build their capability.

Fostering connections in our Discovery Scholarship community

As we watch our Discovery Scholars grow and flourish, we are grateful for our co-sponsors' support with the Discovery Scholarship programme, for Māori and Pacific Island students in science. This is an extension of our long running DiscoveryCamp programme, that supports students studying in the fields of physical sciences, chemical and process engineering, chemical and materials engineering, Māori sciences and sciences related to sustainable innovation.

In the dynamic landscape of academia, the essence of growth and collaboration lies in the strength of connections. Within our Discovery Scholarship programme, we not only empower our Scholars financially but also cultivate a community where whanaungatanga (connections) and manaakitanga (support) can grow and flourish.

Our engagement strategy with our Discovery Scholars encompasses diverse channels to ensure meaningful engagement. Facebook serves as a vibrant platform for group discussions, updates, and shared achievements. Group online hui (meetings) provide a virtual space for scholars to come together, exchange insights, and collectively navigate the academic landscape while one-to-one conversations foster individual connections that extend beyond the academic realm.

This year we have been able to bring our recipients together to share kai and kōrero across Aotearoa: in Auckland, Christchurch, Dunedin and Wellington. We feel so privileged to be catching up and seeing how our Scholars are doing.

The Discovery Scholarship programme is more than financial support; it's about creating a network that supports them and helps propel them forward. These gatherings are comfortable, informal and welcoming; they are opportunities to nurture a sense of belonging, collaboration and shared achievement. As we celebrate the successes of our Scholars, we also celebrate the robust connections that make these successes possible. Looking ahead, more catch-ups are in the pipeline, ensuring that we continue to grow our community.

A huge acknowledgement and thanks to our co-sponsors, the GNS Science Aotearoa: Green Hydrogen Platform and Bioprotection Aotearoa.

In 2023 we offered 18 scholarships across the following categories:

Te Huarahi Ki Mua Award for previous Discovery Scholarship recipients

Te Mātauranga Pūtaiao Award (Māori Science Award)

Te Taumata Award (High Achiever Award)

Piki Ake Award (Step It Up Award)

Te Kainga Rua Award (Second Chance Learner Award)

"It was nice to do a tour of GNS Science and learn about career pathways in science. Now I realise that the only crazy scientists are the ones who gave up on their dreams and didn't follow their passion. GNS Science was full of sane scientists following their heart.

Jesse Wood, Discovery Scholarship alumnus

"Thank you again for the amazing scholarship opportunities I have been able to receive! It has helped so much!"

Discovery Scholarship alumnus

Empowering our Discovery Scholars and alumni with capacity development opportunities

Our shared goal is to support our students with opportunities to develop them professionally. We have supported our Scholars to attend conferences, leadership events, and cultural learning opportunities.

New Zealand Institute of Physics (NZIP) Conference

Three Discovery Scholarship recipients attended the NZIP Conference 2023 in Auckland: Te Whare Wānanga o Otāgo University of Otago–based student Maia Dean (Rarotonga), Te Herenga Waka Victoria University of Wellington-based student Jesse Teumohenga (Tonga, Samoa, Tokelau), and Waipapa Taumata Rau University of Auckland–based student Chez Panapa(Ngāti Tuwharetoa, Ngā Puhi, Te Rarawa). These Scholars attended with a shared objective: to enhance and expand their capabilities and capacities within the field of physics. The conference served as a valuable platform for them to engage in knowledge exchange. We actively seek opportunities and encourage our Scholars to attend such events to further enhance their experiences and prepare them for their future careers.

Maia Dean (Te Whare Wānanga o Otāgo University of Otago), Assoc Prof Pauline Harris (Te Kunenga ki Pūrehuroa Massey University), Jesse Teumohenga (Te Herenga Waka Victoria University of Wellington)

Maia Dean and Mohsin Ijaz (both from Te Whare Wānanga o Otāgo University of Otago)

Global Young Scientists Summit

Maia Dean attended the Global Young Scientists Summit held in Singapore in January. This international gathering brought together aspiring young minds from various corners of the globe, creating a platform for knowledge exchange, collaboration and innovation. During her time at the summit, Maia immersed herself in a rich tapestry of experiences, collaborating with fellow young scientists, researchers and thought leaders. The summit provided a unique space for fostering connections, sharing insights and engaging in discussions that spanned a wide array of scientific disciplines.

Maia Dean has shared some thoughts on her experience:

“This once in a lifetime opportunity gave me the chance to develop as a young scientist as well as experience the rich culture of Singapore. Through the summit I was able to make connections with scientists across the globe and encounter new ideas through plenary lectures given by Nobel Laureates, Field’s Medallists and Millennium Technology Award Winners...On top of the phenomenal speaker line-up, I was able to get a glimpse at the latest scientific and technological advances from the young scientist presentations and poster sessions. It has been an incredible experience and I look forward to applying the knowledge I have gained from this trip into the rest of my studies."

“It has been an incredible experience and I look forward to applying the knowledge I have gained from this trip into the rest of my studies.”

Maia Dean

Empowering futures

Discovery summer internships

We had two talented recipients of Discovery Scholarships placed into summer internships. Te Whare Wānanga o Waitaha University of Canterbury–based students Zack Avery and Vincent Lomas both embarked on enriching experiences that align with their academic pursuits.

Zack Avery (Te Arawa) collaborated with Te Whare Wānanga o Waitaha University of Canterbury-based Principal Investigator Professor Paul Kruger, delving into the project titled 'Synthesis of novel porous materials for carbon capture.' During the project, he gained hands-on experience in screening various reaction conditions to create new types of metal organic frameworks (MOFs).

Simultaneously, Vincent Lomas (Ngāi Tahu) worked alongside Te Whare Wānanga o Waitaha University of Canterbury-based Associate Investigator Professor Catherine Bishop on the project 'High-throughput characterisation for alloy development.' During the project Vincent gained hands-on experience with mechanical engineering concepts and worked with a variety of software in the analysis of electron diffraction data.

Navigating global challenges through international collaboration: International Standards Organisation Conference

In a gathering of minds from around the world, Te Herenga Waka Victoria University of Wellington-based Principal Investigator Professor Derek Kawiti attended the ISO (International Standards Organisation) conference in Brisbane, where the conference began with a moving welcome ceremony by Ngā Tāngata Moemoea, first nations people of Australia. Drawing a staggering 2000 attendees, the event centered around the crucial theme of "Preserving Paradise – Climate Change in the Pacific."

Derek's engagement was multi-faceted, showcasing his commitment to addressing urgent challenges faced by Pacific nations. His impactful contributions included a resonant keynote address, providing insights into critical issues surrounding climate change in the Pacific.

A highlight was Derek's moderation of a session with four Pacific leaders, delving into the magnitude and speed of climate change and sea level rise in their respective countries. This dialogue extended to the strategies employed by these leaders in response to the escalating environmental crisis, fostering collaboration and solidarity.

Climate solutions for small islands featuring (from left) Derek Kawiti, Professor, Māori Designed Environments and Indigenous Technologies and Architect; Hon Crossley Tatui, Minister for Infrastructure and Finance (Niue); Kushaal Raj, Director of Climate Change, Fiji Climate Change and National Designated Authority; Esline Garaebiti, Director General, Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management (Vanuatu); and Hon Vaimu'a Muliava, Minister of Digital transformation, Technological innovation, Construction and Public Service (New Caledonia). (Photo obtained from https://www.iso.org/news/am23/iso-annual-meeting-breaks-records)

Te Reo Māori

During Māori Language Week, we started a brand-new online eight-week beginners programme for our research community. The response was overwhelming, with all available spaces being quickly snapped up. Due to popular demand, we'll be running another session in 2024.

Adding new kupu to our kete. We celebrated Te Wiki o te Reo Māori by sharing some kupu Māori related to the mahi we do:

Toitūtanga = Sustainability

Kaipūtaiao = Scientist

Kairangahau = Researcher

Hangarau = Technology

Hangarau mōkitokito = Nanotechnology

Hangarau rawa ōkiko = Materials Technology

New staff

We warmly welcomed Kirsty Doyle (Ngāti Kahungunu, Rongomaiwahine and Ngāti Rakaipaaka) who assumed a newly-established position within the Institute's management team as the Strategic Manager Māori. In this role, Kirsty provides strategic advice and implements initiatives aimed at enhancing the capability and capacity of Māori research within the MacDiarmid Institute, and oversees strategic relationships with Māori stakeholder partners. Kirsty also takes the lead in managing our Discovery Scholarship programme, with the aim of increasing the representation of Māori and Pacific peoples within the science sector. Kirsty has a deep passion for fostering capability and capacity development to support others to see and realise their potential.

"Our Discovery Scholarship programme goes beyond providing financial support; it is dedicated to cultivating positive outcomes for our Scholars. We aim to facilitate valuable experiences for our students to gain insight and experience through internships, placements, connections with industry, and connecting with those further along in their academic or professional journey."

"Our Discovery Scholarship programme goes beyond providing financial support; it is dedicated to cultivating positive outcomes for our Scholars."

Kirsty Doyle

Out of the lab

As our cohort of early career researchers grows, their stories encapsulate what the MacDiarmid Institute is all about. Computational approaches to emissions reduction, or reimagining the hardware for tomorrow's computation – very different problems linked by materials optimisation challenges. Learning from nature – whether CO_2 transformation in plants or computing in networks of neurons – brings us inspiration, and learning from Mātauranga Māori how to apply harakeke for water purification in rural communities puts that inspiration into practice.

AMN10

New funding initiatives, biggest ever AMN10 outreach programme and the conference's first ever commercial stream.

After four years of COVID-related postponements, we held the tenth in our series of Advanced Materials and Nanotechnology conferences (AMN10) in Rotorua in February. The conference was attended by nearly 500 scientists, mostly from overseas, who were welcomed with a pōwhiri from Ngāti Whakaue. In her opening speech, the Minister for Research, Science and Innovation, Hon Dr Ayesha Verrall, announced new initiatives supporting Māori and Pacific people into the Research, Science and Innovation (RSI) system and workforce. The Minister congratulated the Institute for leadership in this space, citing our longstanding DiscoveryCamp, and commended the Institute for our Discovery Scholarships for undergraduate students in physics, chemistry, and materials engineering.

Minister for Research, Science and Innovation, Hon Dr Ayesha Verrall with Institute Board Chair Hēmi Rolleston and Co-Directors Nicola Gaston and Justin Hodgkiss

The opening ceremony and welcome from Ngāti Whakaue set the stage for collaborative discussions that embraced Mātauranga Māori and acknowledged longstanding partnerships, particularly with Whakarewarewa Village. Keynotes by Deputy Director Māori Associate Professor Pauline Harris and Dr Charles Royal illuminated historical contexts and the symbiotic relationship between indigenous wisdom and scientific advancements.

Professor Charles Royal's thought-provoking keynote delved into Mātauranga Māori, referencing the science and Mātauranga Māori debate initiated by non-Māori academics the previous year. Charles' address underscored the importance of respectful dialogue and collaboration between diverse knowledge traditions, while Pauline's talk described the context of Māori in science and the initiatives that have been developed by the MacDiarmid Institute to develop capacity and capability in sciences in the MacDiarmid Institute.

Talks by Geological and Nuclear Sciences Stakeholder Relations Partner Iwi Diane Bradshaw and Whakarewarewa Village researcher Ringahora Huata highlighted their research activities, with Ringahora describing her work in historical recording and education for the village, while Diane described her research around the convergence of West Coast terrestrial ecosystems from the great fish of Māui.

Outreach and engagement

AMN10 saw us run our biggest ever outreach and engagement programme alongside the conference, with researchers from the MacDiarmid Institute and our partners at Australia's Future Low-Energy Electronics Technologies (FLEET) supporting our outreach partners at Tūhura Otago Museum to deliver science outreach workshops to 320 Rotorua school students. Over four days, Tūhura Otago Museum's Dr Marijn Kouwenhoven and 25 volunteers from FLEET and the MacDiarmid Institute visited seven schools to present a variety of hands-on science workshops to students ranging from primary school to early high school age.

This was a rare opportunity for students to experiment with the properties of materials at the nanoscale and to meet and talk with real scientists about their research and science as a career.

Deputy Director Pauline Harris presenting at AMN10

"I have heard nothing but praise for what you all did with our students. The teachers found it had great value, very engaging, and pitched at the right level for the students...I have been given very positive feedback from all involved."

Teacher, Westbrook School

Students from John Paul College met women scientists from the MacDiarmid Institute in an informal 'People like me' workshop, where researchers shared stories about their research and career paths and answered students' questions. Students from Westbrook School, Rotorua Primary School, Lake Rotoma School, Whangamarino School, Te Rangihakahaka and Te Koutu Māori Medium Schools dived into hands-on activities such as building balloon rockets, miniature catapults and graphite circuits, and participated in general learning about materials science and nanotechnology.

Associate Investigator Dr Luke Liu with students at Rotorua Primary School

"What struck me most about the schools we visited was how strong and integrated the Māori culture and language was in the local education system and daily life. This includes the Māori-based science that helps them understand their environment."

Jason Major, Outreach Coordinator, FLEET

Tūhura Otago Museum-based Senior Science Engagement Co-ordinator Dr Marijn Kouwenhoven talks to students at Westbrook School about materials science

Students at Te Rangihakahaka launch balloon rockets as part of a session on mass, force, and acceleration

Students at Rotorua Primary School exploring graphite circuits and connecting with MacDiarmid Institute students and researchers

Fractal fluency: Using fractal designs to promote health and performance

University of Oregon Professor Richard Taylor delivered the AMN10 public talk at Scion in Rotorua, speaking about fractal patterns in nature, using architecture and design to adapt these to home and work environments to create wellbeing and citing the neuroscience behind this effect.

Making machines at the atomic limit

AMN10 Plenary Speaker Professor Michelle Simmons from Silicon Quantum Computing at the University of New South Wales (UNSW) spoke with Kim Hill on RNZ's *'Saturday Morning'* about Professor Simmons' UNSW team's recently-built quantum processor in silicon that simulates the behaviour of a small organic molecule - a major milestone towards the world's first quantum computer.

First ever AMN commercial stream

This year for the first time we ran a full-day commercial stream alongside AMN10. The commercial stream brought together advanced materials scientists, entrepreneurs, investors, tech transfer professionals and others in the wider ecosystem and included top tier speakers such as Dr Sean Simpson (co-founder, LanzaTech), Dr Brandon Swanepoel (Vice President Technical and Project Director, Avertana), Associate Professor Franck Natali (Co-founder and Chief Technical Officer, Liquium) and early career scientists from academic and start-up groups. Commercially relevant science presentations covered a broad range of technology areas including carbon capture and utilisation and the CO_2 economy, logic devices for quantum computing and extraction of raw materials from waste streams.

Alongside our university and corporate sponsors, we were pleased to have sponsors from investor groups (Matū, BridgeWest and WNT Ventures) support commercial segments of the conference. The WNT Ventures-sponsored session was a masterclass in advanced materials commercialisation delivered by Erin Rayment (Executive Director of Industry Engagement, Queensland University of Technology, and Director of Knowledge, Commercialisation Australasia).

We had a lively exhibitor hall with the following exhibitors showing off their commercial portfolios and start-ups seeking collaborations: Nanovacuum, ATA Scientific Instruments, Plasmonique, Scitek, Aspiring Materials, Risos Enterprises, Advemto, Humble Bee Bio, Litmaps, Ligar and White Rabbit Scientific.

Franck Natali, co-founder of Liquium and Breakthrough Energy Fellow

Dr Sean Simpson, co-founder of Lanzatech. Talk titled: Enabling a circular economy: carbon-negative fuel and chemical production by eliminating waste

AMN10 sponsors

Caitlin Casey-Stevens using the ultra-high vacuum set-up at the Australian Synchrotron

Catalysts for positive change

With climate scientists warning of the need to make significant progress in reducing greenhouse gases this decade, our researchers are on the hunt to find new materials and technologies that can help tackle the problem.

A promising area of development is in catalysts, materials that can efficiently speed up chemical reactions. Catalysts are stock-in-trade for the MacDiarmid Institute, including for early career researchers and computational chemists, Dr Caitlin Casey-Stevens and Dr Charlie Ruffman.

Caitlin, an Independent Postdoctoral Research Fellow at Te Herenga Waka Victoria University of Wellington, is investigating how to make ammonia, a key ingredient in the global fertiliser industry, more efficiently so it can be used as an alternative to fossil fuels.

“The current method for producing ammonia is the Haber-Bosch process, which was invented in the 1910s,” she says.

“It currently takes about 2 - 3% of the global energy use per year for this single process, because it has to be done at such high temperatures and high pressure.”

But new catalysts are paving the way for ammonia to be used for certain types of transport, such as the cargo freighters and tanks that ship goods and commodities all over the world.

MacDiarmid Institute Principal Investigator Associate Professor Franck Natali has done pioneering work on the synthesis of ammonia for the marine industry, founding the deep tech start-up Liquium to commercialise the technology. Caitlin was awarded one of four MacDiarmid Institute Independent Research Fellowships in May and collaborates with Franck’s team at Te Herenga Waka Victoria University of Wellington.

“The original research from Franck and a variety of collaborators around the Institute found that you could use rare earth nitrides to produce ammonia at room temperature and at low pressure,” she says. “That's a real paradigm shift.”

She is now employing computational chemistry techniques to study each individual step of the chemical reactions to understand how they work. This will inform future experiments undertaken by the team.

Materials to convert CO_2

Dr Charlie Ruffman is also focused on catalysis, but with a different application - converting the problematic CO_2 that’s warming the planet into fuel and chemicals.

“It's not yet economically feasible to try and pull carbon dioxide out of the atmosphere and turn it into other things,” he says.

“So we need materials that can do that quicker and cheaper. If we have those materials, then suddenly there's a business case to be made for actually capturing carbon, which would be really, really useful.”

> “Right now these catalysts are critical to the work that needs to happen.”
> Charlie Ruffman

One of the best materials widely used for converting CO_2 is solid copper. But Charlie is exploring a liquid metal alternative, gallium, which seems to be particularly effective at chemically reducing CO_2 into useful products like ethylene. His computational techniques attempt to answer what makes gallium such a good catalyst.

Caitlin and Charlie are both Te Whare Wānanga o Otāgo University of Otago graduates and share a common pathway to the MacDiarmid Institute - they studied under Associate Professor Anna Garden in the Garden chemistry research group.

Anna introduced them to the MacDiarmid Institute and in Charlie’s case, a collaboration with co-director Professor Nicola Gaston laid the foundation for a successful Rutherford Postdoctoral Fellowship application.

“That’s been a two-year project for me,” he says. “It wouldn’t have been possible without the connections I made and the research collaborations at the MacDiarmid Institute”.

Both Charlie and Caitlin have been active members of the MacDiarmid Emerging Scientists Association (MESA) and completed their PhD studies amidst the uncertainty of the pandemic.

They fondly remember the Friday night Zoom socialising calls during lockdown and the Science from the Supermarket outreach workshops which allowed students to come up with innovative experiments based on items in their shopping basket.

“We also managed to host the second largest MESA boot camp of all time in 2020, thanks in part due to the good COVID precautions,” says Caitlin.

Both emerging researchers feel incredibly fortunate to have postdoctoral research positions in their chosen fields in a research sector where competition for such positions is intense.

“I think it’s actually really difficult for researchers to stay in New Zealand more than a couple of years after a PhD, because there’s only a certain number of things they can apply for and dip into,” says Charlie, whose Rutherford Postdoctoral Fellowship will come to an end in early 2024.

Despite the uncertainty ahead, they both say the opportunities created through their MacDiarmid Institute collaborations have set them up well to pursue science that has the potential to make a real difference in lowering greenhouse gas emissions.

“We are trying to get these atomic-scale insights that can inform how we should design our materials at the macro scale,” says Caitlin.

Adds Charlie: “Emissions reduction is going to be a continual challenge for the next 50 years or more. These tools and these catalysts may well be superseded in the future, but right now these catalysts are critical to the work that needs to happen.”

Inspired by the brain: Networks of nanoparticles can compute like 'spiking' neurons

The human brain is likely the most energy efficient computing system to have ever existed. Despite the astonishing depth, breadth and complexity of tasks it routinely carries out, it does so on just 12 watts of power, all sourced from the food we eat. By comparison, a typical laptop draws around 60 watts of electricity, and a desktop PC needs closer to 175 watts[1] and data centres use many times more. With big data and artificial intelligence placing huge energy demands on today's computers, it's no wonder that those seeking to push the boundaries of computing are finding inspiration in neuroscience. This includes MacDiarmid Institute scientists at Te Whare Wānanga o Waitaha University of Canterbury, who are developing novel neuromorphic devices based on nanoparticle networks. Their latest advance – enabled by the intrinsic neuron-like spiking from their devices – demonstrates that they can perform a range of complex tasks, including image recognition.

Much of the brain's unrivalled computational ability derives from its structure and the way in which it processes information. The brain consists of dense, interconnected networks of elementary units called neurons, which generate spikes of electrical signals that transmit information via their frequency and timing. Neuronal networks seem to operate at what's known as a 'critical point', where their behaviour is poised between stability and instability. It's believed that this criticality is what gives the brain its computational superpowers.

Networks of nanoparticles

To emulate the behaviour, Professor Simon Brown – who leads our Future Computing Research Programme – looked to self-organised networks of metallic nanoparticles. Back in 2013[2], his team showed that when you apply a voltage to these networks, atomic-scale filaments form between the nanoparticles, producing electrical spikes similar to those seen in the brain. The work has continued apace ever since. In a new paper published in Nano Letters, the team have demonstrated a breakthrough – the spiking behaviour from Percolating Networks of Nanoparticles (PNNs) can even be used to classify handwritten numbers.

> "Computers have completely changed the world. To enable further progress, especially around artificial intelligence, we need to either be thinking about different algorithms or different hardware, or both."
>
> Sofie Studholme

The lead author on the paper is PhD student Sofie Studholme, who has been relishing the challenges of this area of research. Following completion of her undergraduate electrical engineering degree at Te Whare Wānanga o Waitaha University of Canterbury, Sofie considered her next steps: "I like really complex problems; the ones that have you waking up in the middle of the night because you might have a solution." Her final-year project supervisor, Emeritus Professor Phil Bones, told Sofie about a PhD opportunity at the MacDiarmid Institute, focused on neuromorphic computing. "As soon as I heard about the research, I decided to apply. I started the PhD in July 2022."

For this, her inaugural first-author paper, Sofie set out to investigate the types of computing that a PNN could do. She started by testing it with standard logic operations (AND, OR, XOR, etc.) which are widely used to establish the computational capability of any network. The XOR task in particular is challenging, because it requires the network to perform a non-linear transformation. "The simulations showed that with optimal parameters, our system can compute all possible logical operations on a 2-bit input with 99% accuracy," she says.

Next, Sofie set a more difficult challenge for the PNN – to successfully complete the Modified National Institute of Standards and Technology (MNIST) handwritten digit classification task. She describes this as "...kind of like the 'hello world' of machine learning." The MNIST database consists of 70,000 greyscale images of handwritten numbers[3]. While our brains are expert at classifying images and patterns like these, traditional computers find them far more challenging. So, Sofie was thrilled to find that the neuromorphic PNN "achieve(d) a test accuracy of up to 96.2%, comparable to the best previous results from in-materia systems."

Her PhD supervisor, and paper co-author, Simon, says, "Sofie's done incredibly well to get this research done in such a short space of time. And the resulting paper received remarkably positive feedback from reviewers – I think the best I've ever seen."

The next stage will be to implement Sofie's results on the latest PNN devices fabricated by her colleagues in the lab at Canterbury. Alongside that, she'll be extending her simulation-based work, to investigate the computing potential of PNNs operating together. The goal, she says is to "...develop computational schemes that can more fully exploit these critical spikes for information processing."

"Training AI tools like ChatGPT consumes enormous, unsustainable amounts of electricity. So finding alternative computing approaches – ones that can do the same computation with less power – is an absolute must."

Simon Brown

Within the wider research network of the Institute

Sofie's work is just one of a diverse range of projects in the MacDiarmid Institute's Future Computing Research Programme. Alongside neuromorphic architectures, our scientists are also investigating novel devices that utilise superconductivity, topological insulators, and biological cells; all in an effort to cut the energy consumption of computers.

"Computers have completely changed the world," explains Sofie. "But transistor-based hardware is reaching fundamental limitations. To enable further progress, especially around artificial intelligence, we need to either be thinking about different algorithms or different hardware, or both."

Simon continues, "Training AI tools like ChatGPT consumes enormous, unsustainable amounts of electricity. So, finding alternative computing approaches – ones that can do the same computation with less power – is an absolute must."

Publication: Sofie J. Studholme, Zachary E. Heywood, Joshua B. Mallinson, Jamie K. Steel, Philip J. Bones, Matthew D. Arnold, and Simon A. Brown, "Computation via neuron-like spiking in percolating networks of nanoparticles," Nano Lett. 23, 10594 (2023).

1. https://press.princeton.edu/ideas/is-the-human-brain-a-biological-computer
2. https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.111.136808
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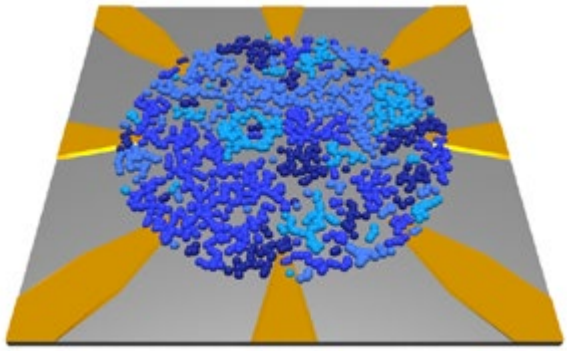
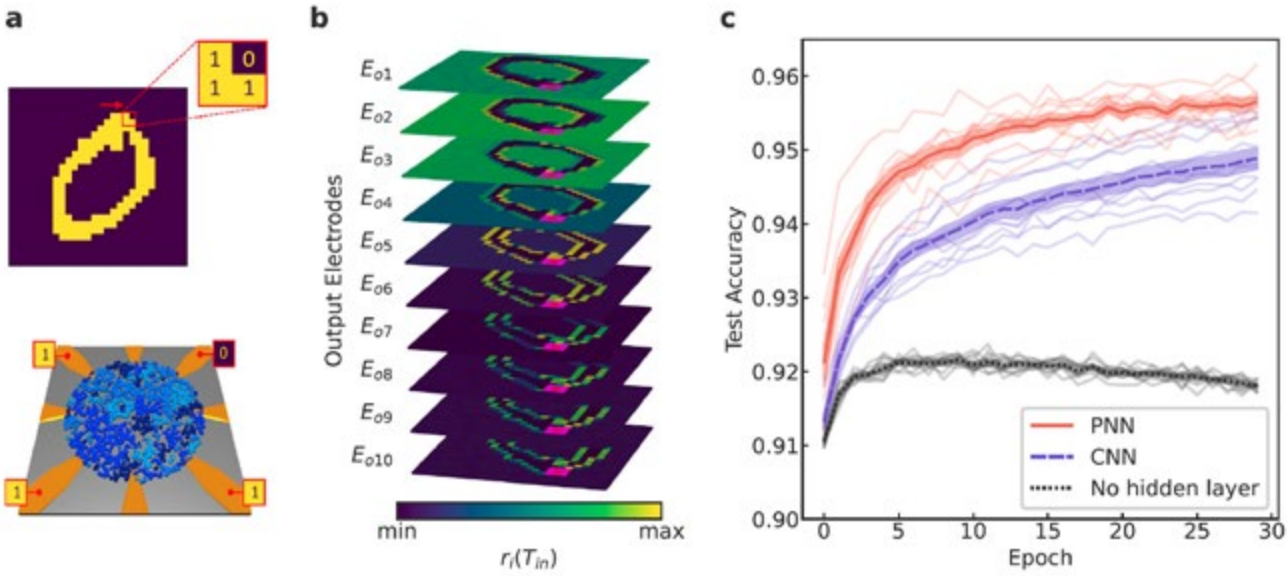
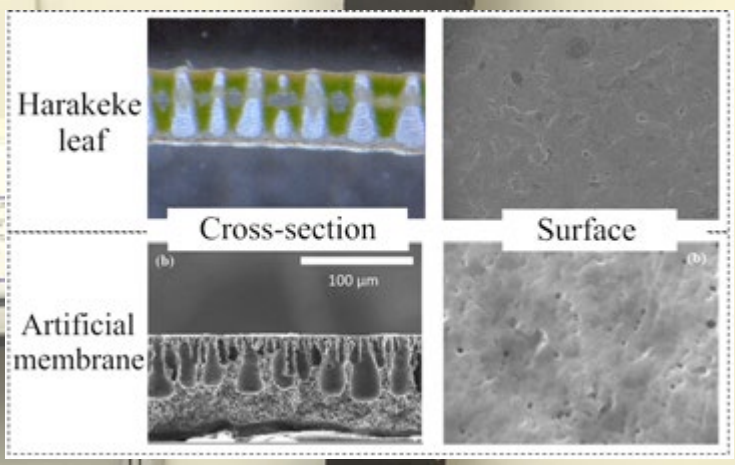


Schematic of a percolating network of nanoparticles





Cross section and surfaces of the harakeke leaf versus that of polymeric membranes

Jaye Barclay (they/them, he/him), PhD student, holding a harakeke leaf

Weaving Mātauranga Māori with contemporary science to create sustainable materials for water purification

Harakeke (New Zealand flax) is a plant synonymous with Aotearoa's unique landscapes. From the stretches of coastal regions to the contours of mountainous terrains, harakeke finds its footing. Its resilient fibres root deep in wetlands, reach out on the edges of forests, and even thrive amidst urban landscapes. It adorns the shores of nearby islands, binding them to Aotearoa's rich heritage.

"Harakeke is considered a taonga (treasure) to Māori. The leaves have been traditionally woven to make a variety of items such as kete (baskets), whāriki (mats), and clothing as well as for medicinal use," says PhD student Jaye Barclay (they/them, he/him) of Ngāti Apa and Ngāti Hauiti heritage.

Studying at Te Herenga Waka Victoria University of Wellington and based at the Paihau — Robinson Research Institute in Gracefield, Jaye is working with a team to use harakeke for water purification. Their innovative approach aims to ensure environmental sustainability by working with Mātauranga Māori, a term used to describe Māori traditional knowledge and ways of knowing. This project is part of the MacDiarmid Institute's Sustainable Resource Use - Mātauranga Māori Research Programme and Towards Zero Waste - Reconfigurable Systems Research Programme.

"The team observed that the structure of harakeke, when viewed under a microscope, closely mirrors that of polymeric membranes often used in water purification. These findings suggest that harakeke leaves might possess properties comparable to these synthetic membranes," says Jaye.

Most modern water purification methods currently rely on plastic membranes. While effective, these membranes come with environmental challenges due to their non-biodegradable nature and the footprint of their production. Harakeke fibres present a potential alternative.

Under the supervision of MacDiarmid Institute Associate Investigator Dr Ben Yin and Dr Fiona Stevens McFadden of Te Herenga Waka Victoria University of Wellington, along with Dr Nancy Garrity from Manaaki Whenua and of Ngāti Makirangi alongside Ngāti Pāoa and Ngāti Hine heritage, and MacDiarmid Institute Associate Investigator Professor David Barker from Waipapa Taumata Rau University of Auckland, Jaye's PhD project aims to explore this potential further. If successful, harakeke plant fibres could usher in an environmentally friendly water purification method that would be of particular use in rural parts of the country.

Fusing Mātauranga Māori with current scientific methodologies

A cornerstone of this project is the fusion of Mātauranga Māori with current scientific methodologies, weaving together two worldviews.

"Mātauranga Māori principles emphasise the interconnectedness of all living things and the relationships between humans and the environment," says Jaye.

"By incorporating this indigenous knowledge into the development of the harakeke membrane, the project recognises the value of indigenous wisdom in addressing modern challenges."

Jaye is currently conducting experiments to adapt the harakeke plant's properties to achieve water permeation through the leaf. This optimisation aims to effectively filter out both particulates and bacteria, such as E-coli.

"I'm hoping one day we can take this out to rural marae which often don't have adequate access to clean water. If proven to be effective, we're hoping the harakeke membrane can be developed for household application," says Jaye.

Born in Japan to a Japanese-Ukrainian mother and Māori father, Jaye is no stranger to cultural diversity. They moved to Wellington when they were only one year old but had limited involvement with their Māori heritage until attending their grandfather's tangi in 2008.

Jaye's grandfather was Barry Barclay, one of Aotearoa's first Māori film makers and writers. He committed his life to documenting and preserving Māori values and ways of living.

"At his tangi I became aware of what it meant to be Māori beyond the label, feeling that community love and support was new to me," says Jaye.

"It was the first time I felt truly connected with my Māoritanga, and it started my journey to understand and embrace more of this part of myself."

Jaye went on to study te reo Māori and for their undergraduate degree at Te Herenga Waka Victoria University of Wellington, chose an eclectic combination of English literature, Māori studies and biological sciences.

Today, Jaye is the first person in their branch of the family since their great-great grandfather to be fluent in te reo. They continue their journey to reconnect with their Māori heritage.

"It's a dream of mine to be the Māori David Attenborough. I'm passionate about protecting Māori knowledge," says Jaye.

"When I heard about my current PhD project, I was thrilled to work on something that truly aligns with my values and enables me to embrace all parts of myself. What's more, I get to revive harakeke, and potentially find yet another application of this taonga (treasure)."

Understanding the spread of plant diseases to tackle some of Aotearoa's major ecological threats

Throughout human history, we have grappled with the challenges of devastating diseases. However, often overlooked is the impact of plant epidemics in influencing food security, migration patterns, and even socio-political landscapes. *Phytophthora*, meaning "plant destroyer" is a genus of oomyetes, fungus-like microorganisms that can cause significant disease in many plant species. Today, there are 30 species of *Phytophthora* known to be present in New Zealand with significant impacts on agriculture, forests and natural ecosystems.

Dr Ayelen Tayagui is a MacDiarmid Institute postdoctoral research fellow based at Te Whare Wānanga o Waitaha University of Canterbury. Working with Professors Volker Nock and Geoff Willmott, and Associate Professor Jenny Malmström from the MacDiarmid Institute and Associate Professor Ashley Garrill from Te Whare Wānanga o Waitaha University of Canterbury, Ayelen is working to understand the biology and the mechanisms used by *Phytophthora* species to infect their host plants and how these mechanisms adapt in response to environmental stress.

"This could shed light on why certain plant diseases are so challenging to tackle."
Ayelen Tayagui

"*Phytophthora* species have caused significant upheaval throughout history and continue to do so today. It was responsible for the blight that ravaged potato crops and contributed to the Irish Famine in the 1800s," says Ayelen.

Tackling the causes of kauri dieback

"Currently in New Zealand, *Phytophthora agathidicida* is receiving widespread media coverage for causing kauri dieback disease in kauri trees. Given that kauri trees are ancient and significant to the natural landscape of Aotearoa, their health is crucial for the country's native forests.

"Other prominent species include *Phytophthora cinnamomi*, known as the "biological bulldozer", which has the potential to affect 5,000 different plant species including avocado, chestnut, oak, peach, and pineapple."

Phytophthora have several means of spreading between plants including producing zoospores, reproductive cells that can swim independently using a flagellum to find a host.

Ayelen says the zoospores swim towards plant roots.
"Once within proximity of the new plant host, they shed their flagellum and form a thick-walled cyst, an encysted zoospore, that is ready to infect."

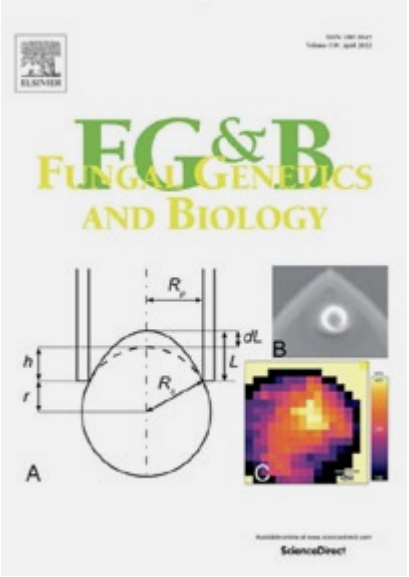
Advanced materials analysis

Ayelen and her colleagues are investigating how encysted zoospores manage their internal pressure, a process known as turgor regulation, while undergoing environmental stress. They are measuring the biomechanical and biophysical properties of zoospores, possible largely though advanced materials analysis methods developed through the MacDiarmid Institute.

"Zoospores are extremely small," she says,"only 10-12 micrometres in diameter, therefore it is difficult to penetrate the cell wall directly. Instead, we are using a technique called microaspiration to expose the zoospore to varying concentrations of different solutions to measure how the cell membrane deforms.

"Our findings indicate that zoospores of Achlya bisexualis, a type of oomycete, regulate their internal hydrostatic pressure in response to environmental stress."

The team's important discovery was featured on the front cover of the April 2022 volume of the international journal Fungal Genetics and Biology.



"There's now evidence suggesting different species of *Phytophthora*, some which cause significant disease in New Zealand plants, have this ability too. This could shed light on why certain plant diseases are so challenging to tackle."

By continuing this research, Ayelen and her colleagues hope that it will provide insight into developing environmentally sustainable strategies to combat the spread of diseases caused by *Phytophthora* species, a goal that becomes increasingly pivotal as the spread of plant diseases is exacerbated by climate change.

"But as with any research you are not guaranteed any particular outcome. In the lab you never know how an experiment will perform so you must have patience."

Raised in Argentina as the youngest of four by a hardworking single mother, Ayelen credits the circumstances of her upbringing as the primary source of her resilience.

They lived modestly, sharing a single room among nine family members until a move southward when Ayelen was nine enabled her mother to train as a teacher. Their circumstances improved from there.

“That was the first time I experienced what it was like to have running water and a toilet in my house. Sometimes I can’t believe the things my mom was able to do. I always thought if she can do all that, why couldn’t I achieve something that was a fraction that?” Ayelen’s interest in science blossomed in high school and led her to study genetics. After completing her degree and gaining lab experience, she embraced the challenge of moving to an English-speaking country and moved to Aotearoa New Zealand in 2011.

Despite the language barrier, she persevered and eventually pursued her PhD in Professor Garrill’s lab, where she still works today. Ayelen describes some of the challenges she faced as an early career researcher in New Zealand.

“The initial stages of my PhD were challenging as I had to also work to support myself prior to obtaining scholarship funding. Also adapting to a new culture while still learning English, not just spoken but also written, scientific English,” says Ayelen.

“Now as a more established researcher, finding funding in New Zealand is always a challenge and it can be so frustrating to see many great ideas and projects going unfounded.

“It is tough, but at the end of the day, if you’re lucky enough to do something you really love, I feel you are always successful. I am proud of where I came from and where I am today.”

Ayelen Tayagui in her University of Canterbury lab

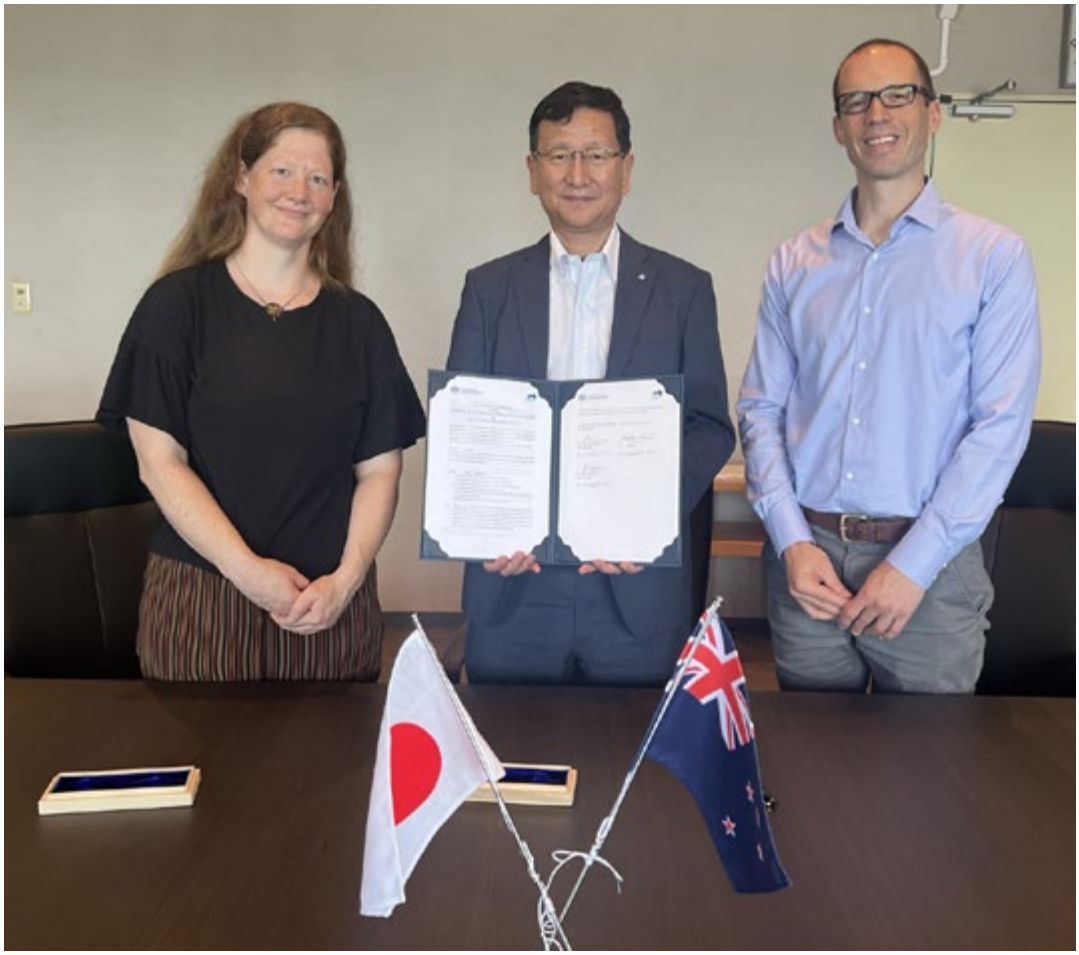
MacDiarmid Institute delegation outside NIMS

Deepening our materials science connections with Japan

A delegation from the MacDiarmid Institute visited Japan in August, holding workshops at the Institute for Integrated Cell-Material Sciences (iCeMS) at Kyoto University (with which we signed a memorandum of understanding (MOU) in 2021 and which operates an on-site lab at Te Herenga Waka Victoria University of Wellington) and at Japan's National Institute for Materials Science (NIMS, with which we signed an MOU on this visit).

The visit opened doors and opportunities for our researchers and students, and iCeMS will hold a workshop with our researchers in Wellington in February 2024 while NIMS is likely to visit for AMN11 in Ōtautahi Christchurch in 2025.

Nicola Gaston introduces iCeMS Deputy Director Aiko Fukazawa at the iCeMS/ MacDiarmid Institute workshop in Kyoto



Co-Directors Nicola Gaston and Justin Hodgkiss with National Institute for Materials Science (NIMS) President Kazuhiro Hono

Kiwi postdoc powers Japanese collaboration for computational discovery of new solar cell materials

Materials scientists are a little too blessed with all the options they have for making climate-friendly solar cells cheaper and more efficient, so they're turning to artificial intelligence (AI) to speed up the process. MacDiarmid Institute alumnus and 2023 Japan Society for the Promotion of Science (JSPS) Fellow Dr Geoffrey Weal is aiming to be part of that solution.

Solar cell research has come a long way in recent years as scientists race to develop new cost-effective and efficient solar cell materials. But the research has almost been too successful, because now that we know more about what makes a good solar cell, there are literally tens of thousands of new options for solar materials.

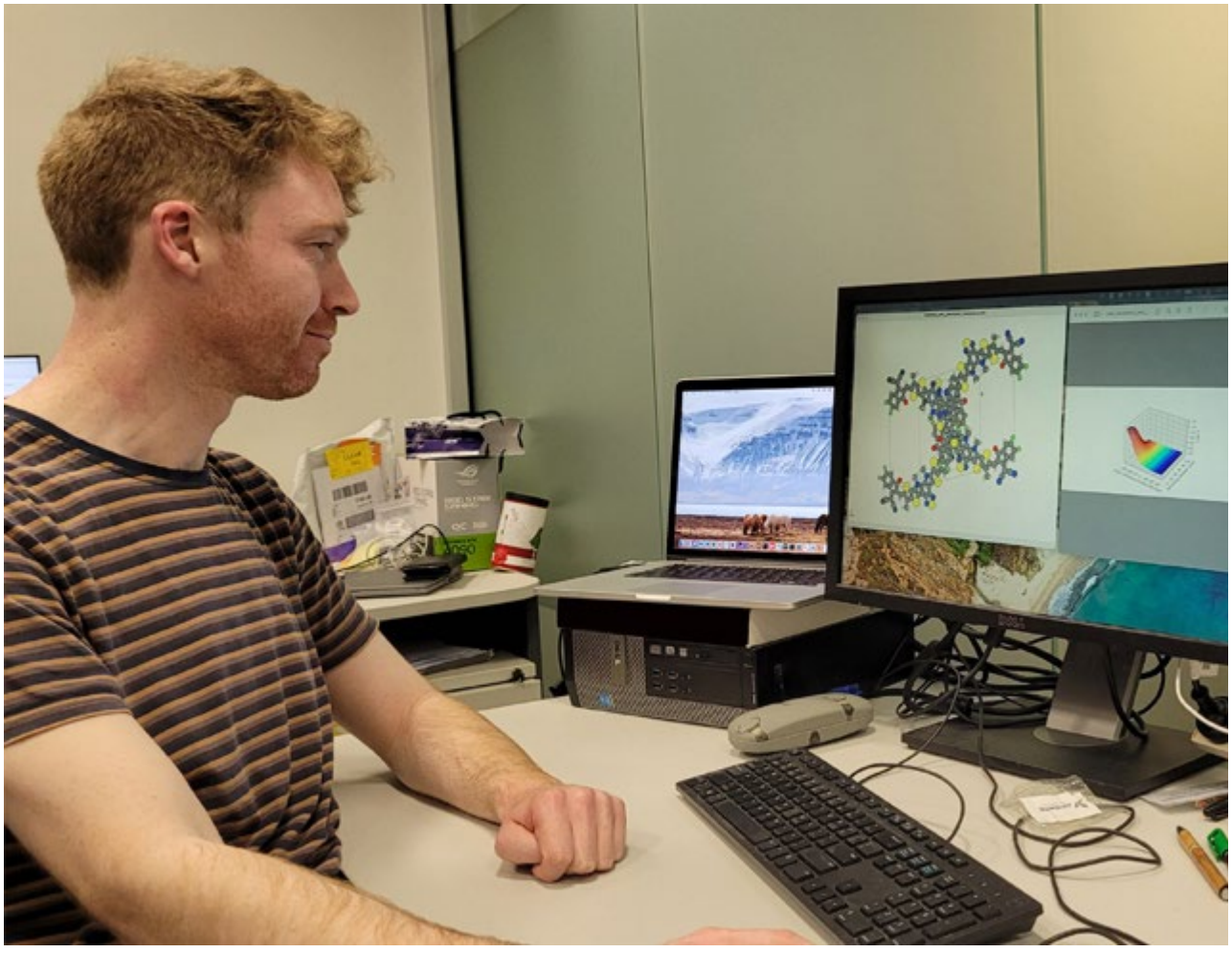
“It’s not often in science we have too many solutions,” says Geoffrey, one of only two New Zealanders selected by the Royal Society of New Zealand for a JSPS Postdoctoral Fellowship this year. “That’s the problem facing solar cell chemists around the world as they trawl through the thousands of potential candidates of new materials to find the best one for the next solar cell breakthrough. It’s just not possible for lab chemists to test each and every material.”

So, researchers are turning to computing.

The Fellowship will enable Geoffrey to be part of the solution. Over the next two years, he and his colleagues at Kyoto University’s Institute for Integrated Cell Materials Science are using computing and AI to discover which of the tens of thousands of potential new solar materials will best increase solar cell efficiency.

“It’s just not possible for lab chemists to test each and every material.”

Geoffrey Weal



Geoffrey Weal

MacDiarmid Independent Postdoctoral Fellowships

We're delighted to announce the recipients of the MacDiarmid Institute Independent Postdoctoral Fellowships. We welcome Dr Caitlin Casey-Stevens, Dr Amy Yewdall, and Dr Bicheng Zhu. Their independent projects will be in alignment with our Reconfigurable Systems and Hardware for Future Computing Research Programmes.

Fascinated by protein self-assembly, Dr Amy Yewdall organises nano-scale proteins in space and time to better understand these systems within disease contexts, and to enhance protein function and innovate new technologies. The Independent Fellowship supports her research with Te Whare Wānanga o Waitaha University of Canterbury-based Associate Investigator Professor Renwick Dobson on combining enzymes networks into droplets to capture carbon into useful precursor molecules.

Amy Yewdall

Dr Caitlin Casey-Stevens worked with Principal Investigator Associate Professor Anna Garden, using computational chemistry to understand the electrocatalytic reduction of nitrate on copper palladium nanoparticles. The Fellowship enables her to work with Principal Investigator Associate Professor Franck Natali at Te Herenga Waka Victoria University of Wellington, to investigate the formation of ammonia on rare earth species.

Caitlin Casey-Stevens

Dr Bicheng (Amy) Zhu is a research fellow at Waipapa Taumata Rau University of Auckland's School of Chemical Sciences, having received her PhD under the supervision of Principal Investigator Professor Jadranka Travas-Sejdic. Before she joined the University as a research fellow in 2019, she worked in a New Zealand start-up company for 1.5 years. She received her Postgraduate Certificate in Commercialisation and Entrepreneurship funded by one of our Alumni Business Scholarships at Waipapa Taumata Rau University of Auckland in 2020. With the support of the Fellowship, Amy aims to develop metal-free, eco-friendly and cost-effective heterogeneous graphene-based catalysts for the electroreduction of CO_2.

Bicheng (Amy) Zhu

New Deputy Directors

In July 2023 we appointed two new Deputy Directors - for Outreach and Education, and for Commercialisation and Industry Engagement.

Our new Deputy Director for Outreach and Education, Associate Professor Anna Garden, is a Principal Investigator based in the Chemistry Department at Te Whare Wānanga o Otāgo University of Otago. Anna leads a group of computational chemists studying the structure and catalytic activity of nanomaterials, with specific application to key reactions for hydrogen and ammonia production. She is a Project Leader in our Towards Zero Carbon - Catalytic Architectures Research Programme, and has previously been a Principal Investigator representative on the Science Executive and the Science Executive representative on the MacDiarmid Institute Governance Representative Board.

Our new Deputy Director for Commercialisation and Industry Engagement, Associate Professor Natalie Plank, is a Principal Investigator and physicist at the School of Chemical and Physical Sciences at Te Herenga Waka Victoria University of Wellington, where she was previously Deputy Head of School. Natalie runs the cleanroom lab with a group of physicists who make electronic devices, with specific applications to bio-sensing. She is a Project Leader in our Future Computing Research Programme, has previously been a Principal Investigator representative on the Science Executive, and was originally responsible for founding the MacDiarmid Emerging Scientists Association (MESA).

Co-Director Professor Nicola Gaston said she was delighted to be working with Anna and Natalie.
"Both are long-term members of the Institute, inveterate contributors, with expertise in their respective portfolios, who we are seriously privileged to have on board."

> "We are privileged to have such a strong team of talent."
> Co-Director Professor Nicola Gaston

As Deputy Director for Outreach and Education, Anna will lead the Institute's engagement with schools and communities, including NanoCamp and DiscoveryCamp, working to develop a scientifically literate workforce via our partnerships with Otago Museum and others.

As Deputy Director for Commercialisation and Industry Engagement, Natalie will lead our commercialisation work and develop further our soft skills training for our students and early career researchers via our Career and Relevant-to-Industry Skills Programme (CRISP).

We bid farewell from our directorship team to Professors Paul Kruger and Geoff Willmott who led the Outreach and Education and Commercialisation and Industry Engagement portfolios (respectively) for over five years. Paul and Geoff have provided strategic vision and enthusiasm to these portfolios and were integral to our successful rebid in 2020.

Associate Professor Natalie Plank

Associate Professor Anna Garden

Hon Judith Collins, then Spokesperson for Science, Innovation and Technology, with KiwiNet CEO James Hutchinson, Natalie Plank and Nicola Gaston

2023 Annual Symposium

Early December saw the Institute come together in Ōtautahi Christchurch for our annual symposium and Investigator meetings. Three CRISP workshops for students ran ahead of and following the symposium.

Deputy Director Māori Pauline Harris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2023 Awards

Margaret Brimble – University of Auckland
Davy Medal (The Royal Society, London)
Ernest Guenther Award in the Chemistry of Natural Products (American Chemical Society)
Pedler Award (Royal Society of Chemistry)
Award for Excellence in Innovative Medicines Research (Medicines New Zealand)

Renwick Dobson – University of Canterbury
Research Excellence Prize (New Zealand Society for Biochemistry and Molecular Biology)

Nicola Gaston – University of Auckland
Thomson Medal (Royal Society 2023 Research Honours Aotearoa)

Roshan Khadka – Plant & Food Research
People's Choice Award for Best Research (Plant & Food research Technology Development)
Editorial Board Member (Current Applied Polymer Science)

Kim McKelvey – Victoria University of Wellington
Emerging Innovator Award (KiwiNet)

Franck Natali – Victoria University of Wellington
Highly Commended for the INTELIA Tech For Good Innovation Award (2023 French Tech NZ Awards)

Kevin Sheehy – MacDiarmid Institute
Simpson Grierson Commercialisation Professional Award (KiwiNet Research Commercialisation Awards)

Geoff Waterhouse – University of Auckland
MacDiarmid Medal (Royal Society 2023 Research Honours Aotearoa)
Highly Cited Researcher (Clarivate Analytics)

Cameron Weber – University of Auckland
ACES-NZIC Early Career Award (New Zealand Institute of Chemistry)

2023 Funding successes

2023 Marsden Standard Grants

Kai Chen – Victoria University of Wellington
"Capturing the Fleeting: Tracking Photophysics in Organic LED and Laser Materials with Ultrafast Photoluminescence Spectroscopy"

Robin Fulton – Victoria University of Wellington
"Activating Substrates for Chemical Synthesis with Reactive Aluminium Reagents"

Keith Gordon and **James Crowley*** – University of Otago
"Hydrogen generation with sustainable resources – a combined molecular, computational and engineering approach"

Patricia Hunt – Victoria University of Wellington
"Unravelling the electronic structure of highly charged hydrogen- and halogen- bonds; rational chemical design and the creation of novel ionic liquid materials"

Geoff Jameson – Massey University
"Structural basis of viral wars: Innate immune system attack on viral genomes and the counterattack by viruses"

John Kennedy* – GNS Science
"Quest for flexible thermoelectric generators: modulation of material's crystal symmetry and anisotropy"

Erin Leitao and **Jack Chen*** – University of Auckland and Auckland University of Technology
"Applying safe-by-design approaches to develop alternatives to harmful 'forever chemicals'"

Daniel Sando and **Simon Granville*** – University of Canterbury and Victoria University of Wellington
"Multiferroic solitons at room temperature: A new topological material system for low energy computation"

Jadranka Travas-Sejdic* – University of Auckland
"Shedding light on the present and the past; a novel environmental/ancient DNA capture system"

Cameron Weber – University of Auckland
"The development of effective, easily separable liquid catalysts"

* Contributing as an AI

2023 Marsden Fast Start Grants

Prasanth Gupta – GNS Science
"Harnessing the power of thermal spikes - A new pathway to fabricate size-controlled transition metal carbide nanoparticles for energy conversion and storage"

Steven Matthews* – University of Auckland
"Merging ancient Roman knowledge and Te Ao Māori to create self-healing and sustainable concrete using natural materials"

Joseph Nelson – Lincoln Agritech
"Lithium sponges: in search of new battery electrode materials"

Charlie Ruffman and **Krista Steenbergen*** – Victoria University of Wellington
"Structural control of liquid metals using solid support"

Jami Shepherd – University of Auckland
"Using light and ultrasound for quantification of hemodynamics in bone"

Amy Yewdall – University of Canterbury
"Coming together for better or worse? How biomolecular interactions impact the self-assembly and properties of nucleoli-like condensates"

* Contributing as an AI

2023 Fellowships

Jadranka Travas-Sejdic – University of Auckland
Clare Hall Fellowship, University of Cambridge, United Kingdom – "Ultra-conformable electrodes for the enhanced recordings from brain"

2023 MBIE Endeavour Funding

Jack Chen* – Auckland University of Technology
"Waste to treasure: using novel chemistry to valorise residual plant materials"
Endeavour Research Programme

Robin Fulton* and **Aaron Marshall*** – Victoria University of Wellington and University of Canterbury
"Long-lived, high-performance organic batteries for a greener rechargeable world"
Smart Ideas Grant

John Kennedy – GNS Science
"Safe, solid-state hydrogen storage technology – Enabling New Zealand's zero-carbon emissions target"
Smart Ideas Grant

Volker Nock – University of Canterbury
"Developing platforms for biological research in microgravity"
Endeavour Research Programme

Cather Simpson and **Michel Nieuwoudt*** – University of Auckland
"Photonic device for Varroa control in NZ beehives and beyond"
Smart Ideas Grant

Geoff Willmott and **Volker Nock*** – University of Auckland and University of Canterbury
"Ion Pipette Aspiration Chips for Soft Colloidal Micromechanics"
Smart Ideas Grant

Geoff Willmott* – University of Auckland
"Next generation condensing heat exchanger technology: design, development and demonstration"
Smart Ideas Grant

* Contributing as an AI

2023 MBIE Catalyst Funding

Simon Brown – University of Canterbury
"Brain-like computing with networks of molecules"

Jadranka Travas-Sejdic – University of Auckland
"Ultra-Conformable 3D Electrode Arrays for Enhanced Brain and Gut Recordings"

2023 Callaghan Innovation Funding

Michel Nieuwoudt – University of Auckland
Callaghan New to R&D grant

2023 Domestic Funding – Other

David Barker – University of Auckland
"Development of New Lipophilic Bcl-2 Inhibitors for Pediatric Glioblastoma Multiforme Treatment" Maurice and Phyllis Paykel Trust Project Grant

Kai Chen – Victoria University of Wellington
"Proposal for the Development of a Novel Ultrafast Optical Paramertic Amplifier Using Multi-Plate Continuum (MPC) Technique" Dodd Walls New Idea

Matthew Cowan – University of Canterbury
"Empowering Tomorrow's Innovators: High School Science Integrating Mātauranga Māori and Chemical Engineering" Curious Minds

Laura Domigan – University of Auckland
"New 5th quarter products" Agmardt (commercial funding)

Vladimir Golovko – University of Canterbury
"Enabling green hydrogen future of New Zealand: Medium Energy X-ray Absorption Spectroscopy studies of novel catalysts for H2 production and utilisation and NZ rock samples from potential H2 storage reservoirs" New Zealand Synchrotron Group

Simon Granville and **Ben Ruck** – Victoria University of Wellington
"Quantum Technologies Aotearoa" Catalyst Strategic investment in quantum technologies research

Roshan Khadka – Plant & Food Research
"Bioelectronics from winery and brewery co-products" Food Transition 2050

Ben Mallett – Victoria University of Wellington
"JxB space systems" KiwiNet Tier 2

Aaron Marshall – University of Canterbury
- "On board electrolysis of a Liquid Organic Hydrogen Carrier (LOHC)t" MacDiarmid Institute Commercial Seed Funding Round
- "Liquid Organic Hydrogen Carrier - Prototype Development" External Company Grant
- "Unveiling the Structure of Heterogeneous Catalysts using Advanced Diffraction and Scattering methods" New Zealand Synchrotron Group

Steve Matthews – University of Auckland
"Novel wear resistant, non-leaching, marine anti-fouling coating system"

Joseph Nelson – Lincoln Agritech
"Medical Scanner Project" KiwiNet Tier 1 PreSeed funding
"Li-ion Batteries Project" KiwiNet Tier 1 PreSeed funding

Volker Nock – University of Canterbury
"LOC devices to study the effect of natural kānuka and mānuka oils against pathogenic oomycetes" BIC Seed Fund

Geoff Waterhouse – University of Auckland
"Metal single atom catalysts for low-cost proton-exchange membrane fuel cells (PEMFCs)" Research Energy Education Trust of New Zealand

Cameron Weber – University of Auckland
"Biodegradable Elastomer" NZPA Contract (fee-for-service)

2023 International Funding

Kai Chen – Victoria University of Wellington
"Photo-responsive thrombin inhibitors enable precise control of localised antithrombotic therapy" HRI (Heart Research Institute) Internal Grant, Australia

Petrik Galvosas – Victoria University of Wellington
"NMR Based Mass Flowmeter" Research collaboration

Roshan Khadka – Plant & Food Research
"Nature derived functional organic material" Korean Government

Jenny Malmström – University of Auckland
"Composite GelMA hydrogels as cardiac scar tissue models" ANSTO beamtime for SANS and USANS

Franck Natali – Victoria University of Wellington
"Spectroscopic understanding of the facile dissociation of molecular nitrogen at room temperature on crystalline lanthanide surfaces" Australian Synchrotron Grant Access

Tilo Söhnel – University of Auckland
- "Probing the magnetic features of the helimagnet Cu2OSeO3 using long wavelength high intensity neutron powder diffraction" ANSTO Beamtime Award

- “Manipulation of the skyrmion phase in Cu2OSeO3 single crystals by light” ANSTO Beamtime Award
- “Investigating the Magnetic Structure of Magnetic Doping in the Skyrmion Host Material Cu2OSeO3 of Single Crystal” ANSTO Beamtime Award
- “Investigating the magnetic and structural effects of magnetic Doping in the Skyrmion Host Material Cu2OSeO3” ANSTO Beamtime Award

2023 University Internal Funding

Catherine Bishop – University of Canterbury
- “Symmetry Engineering Novel Domain Structures in Barium Titanate Thin Films” PhD Scholarship
- “Production of Critical Metals for Zero Carbon Energy by Green All-Oxide Electroreduction” Sustainable Development Goals PhD Scholarship

Peng Cao – University of Auckland
“Investigating Cheverel Phase material as cathodes in magnesium ion batteries” Staff Research Fund

Vladimir Golovko – University of Canterbury
“X-Ray photoelectron spectroscopy system” Strategic Capex

Jon Kitchen – Massey University
“Using Lanthanide Supramolecular Frameworks as new Hydrogen Storage Media – towards a Green Hydrogen Economy in Aotearoa NZ” Massey University Research Fund

Luke Liu – Victoria University of Wellington
“Machine-Learning Guided Discovery of Covalent Organic Frameworks for Hydrogen Storage” Cross-Disciplinary Fund

Steve Matthews – University of Auckland
“Novel wear resistant, non-leaching, marine anti-fouling coating system” UniServices

Kim McKelvey – Victoria University of Wellington
“A New Method for Making Green Hydrogen” Faculty Strategic Research Grant

Michel Nieuwoudt – University of Auckland
UniServices RoS Funding

Volker Nock – University of Canterbury
“RootChip meets Zoospore Compartmentalization – A new Approach to shed Light on Root-Pathogen Interactions” Faculty of Engineering Strategic Research Grant

Daniel Sando – University of Canterbury
“Using crackling noise in ferroelectrics to gain insight into earthquake dynamics” Early Career Researcher Accelerator Fund

Tilo Söhnel – University of Auckland
“Investigating Cheverel phase material as cathodes in magnesium ion batteries” Faculty Research Development Fund

Into the market-place

In 2023, our researchers focused on transformative sustainability research with commercial potential. We participated in the New Zealand Cleantech Mission, showcasing our companies along with others. We supported researchers with seed funding, workshops and events, emphasising the strength of our connections and opportunities for growth. Our network is ever-expanding, and a growing cohort of research entrepreneurs and engaged alumni and investigators make for a thriving ecosystem.

MacDiarmid Institute-affiliated start-up data

The start-up companies affiliated with us report that during the 2023 year, they:

- Raised NZ $15.9 mil (includes one company that is now registered offshore)
- Spent $8.2 mil on R&D in New Zealand
- Employed 88.8 FTE staff across 10 companies in New Zealand – includes a growth of 15.3 FTE (new employees) over the course of 2023
- Employed 29.9 FTE of PhD team members (one third of their entire workforce)
- Employed 17 MacDiarmid Institute alumni (includes founders)
- Leveraged the IP from 20 patents, including 4 new patents that were granted in 2023

Two new companies spun out and were registered in 2023:

- One that is developing a melanoma and skin diagnostic based on Raman laser
- One that is operating in stealth mode on sustainable energy, while the technology is further developed

Looking forward to 2024, our affiliated start-up companies report that:

- At least 8 existing and 6 new companies plan to go to market for capital raises
- 4 companies are looking to grow into new premises in 2024

Commercial skill-building seminars

This regular online seminar series reaches a network of over 300 research entrepreneurs. This network includes commercialisation professionals, start-up founders and staff, plus the government agencies that support the commercialisation of science. We regularly host talks by experts that help enhance our researchers' skills and awareness of the commercial dynamics that underpin success. Topics covered by local and international experts this year have included critical materials, green finance, intellectual property, scale-up of deep tech and cleantech, techno-economic analysis and more. We routinely extend the invitations to this national seminar series to our networks across KiwiNet, Return on Science, Callaghan, New Zealand Product Accelerator and each of our affiliated Technology Transfer Offices.

This year our commercial skill-building seminars have covered critical materials, green finance, intellectual property, scale up of deep tech and cleantech, techno-economic analysis and more.

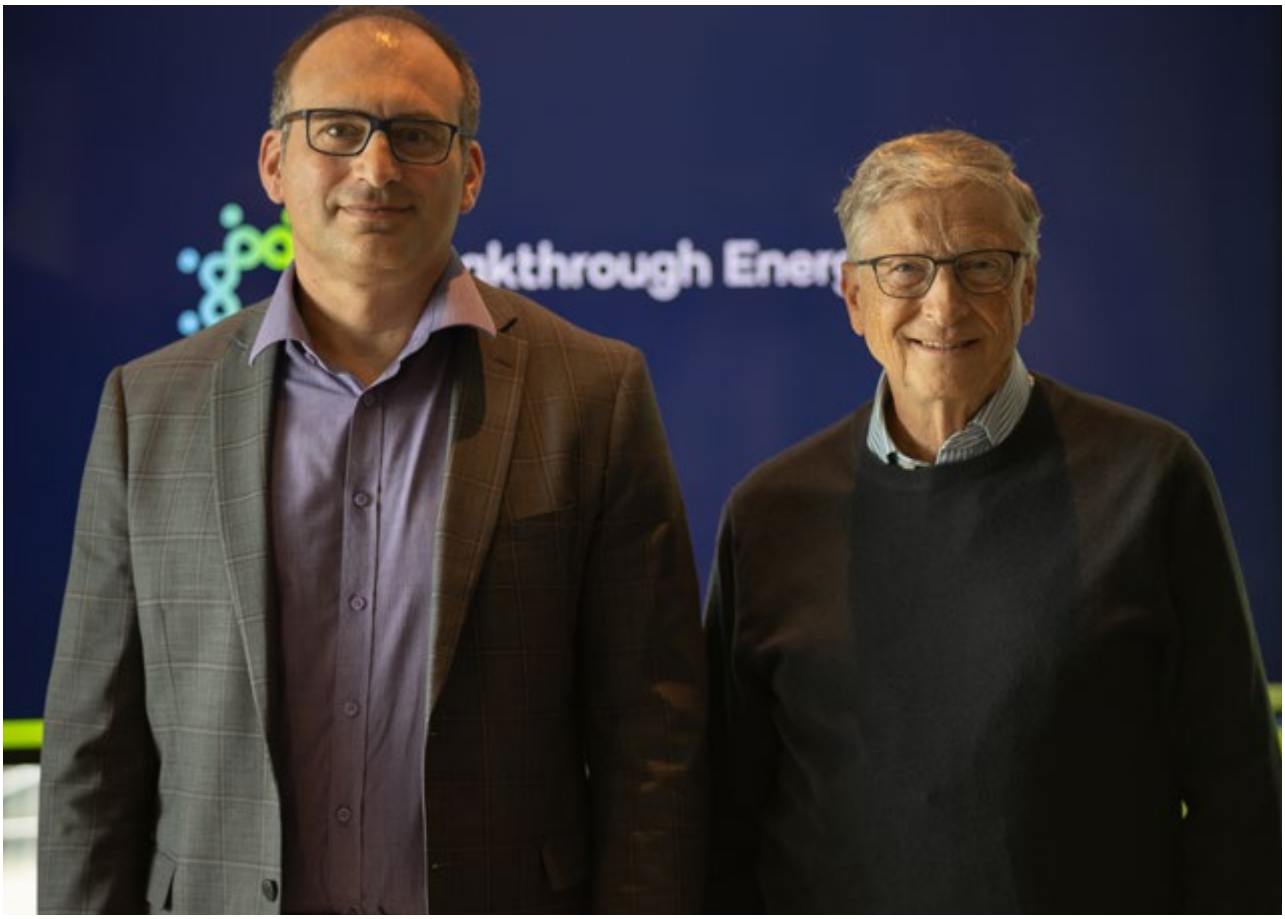
Franck Natali

Breakthrough Energy Fellowship

Principal Investigator Associate Professor Franck Natali completed his Breakthrough Energy Fellowship as one of the inaugural Fellows to participate in this global initiative. Of seven teams selected, only two, Franck included, were from outside the US - the other being from France. The Breakthrough Energy Programme, founded by Bill Gates, provides mentoring, financial and technical support as well as a global network aimed at accelerating early-stage technologies that have the potential to reduce greenhouse gasses by at least 500 million tons of carbon dioxide per year. Franck's participation is aimed at accelerating and scaling up a green ammonia production technology to enable the green export of hydrogen and a new clean ammonia liquid fuel for heavy industry. The technology is being commercialised in the spinout company Liquium, co-founded by Franck, Dr Paul Geraghty and Dr Jay Chan, and will be raising capital early in 2024.

One of the highlights of the programme for Franck was "the privilege of presenting Liquium's advances to Bill Gates and the Breakthrough Energy team as we wrapped up and graduated from the Breakthrough Energy Fellowship Programme - showing our ability to grow the team, scale up our technology through the Fellowship, and engaged with key industrial leaders committed to pioneer large-scale ammonia decarbonisation".

"It was a privilege to present Liquium's advances to Bill Gates and the Breakthrough Energy team as we wrapped up and graduated from the Breakthrough Energy Fellowship Programme."



Franck Natali with Bill Gates

Science Advisory Panels

We offer a rapid turnaround advisory panel to R&D intensive companies and deep tech start-ups to help the companies solve commercial R&D challenges. These panels are constituted by MacDiarmid Institute researchers and other scientists with capabilities directly linked to the company's area of R&D. The aims of the panels are to provide:

- Direct suggestions about how the R&D could be further developed or approached;
- Links to specific scientists who can deliver some of the R&D;
- Input about what facilities are available across our networks (specialised laboratory equipment and the capability to run it);
- Contacts with graduates with very specific skills who may be placed into company R&D projects (including for internships);
- Suggestions about funding streams that academics typically access for research projects, including consideration of joint funding applications.

Areas of R&D covered in these panels in 2023 included hydrogen containment, fog dispersal, precision fermentation, material thermodynamics, eco-jewellery, and light guides.

Our Science Advisory Panels have considered hydrogen containment, fog dispersal, precision fermentation, material thermodynamics, eco-jewellery, and light guides.

Scale-up support

New Zealand has an excellent pipeline of scientific intellectual property emerging from its research institutions. This is supported by scientific funding such as MBIE Endeavour grants which aim to generate impact from scientific research. So much so that there is a large cohort of start-up companies out-growing their university origins and needing supportive facilities to scale-up their technologies to pilot scale. Developing a pilot scale chemical or industrial process is relatively new for New Zealand. Ambitious start-up founders are aiming to follow in the footsteps of carbon capture and conversion company LanzaTech and others, to develop cleaner processes that disrupt entire industrial sectors. We have identified the need for four pillars of support to accelerate local deep tech and cleantech start-ups to address the global market. These are:

- High-quality shared facilities that can house a blend of industrial, office and engineering teams;
- Access to experienced talent from global industries which are the target customers and industrial partners across engineering, commercial and technical disciplines;
- Non-dilutive funding to enable access to the talent and facilities;
- Streamlined regulatory policy and approvals that enable new industries, and enable novel technology to be more easily deployed into established industry.

Working closely with KiwiNet and other stakeholders, we have used our insights into the deep tech and cleantech start-up sector to advocate for these pillars of enhanced support across government, economic development agencies, universities and the private sector. We are pleased to see potential clusters starting to emerge.

There is a large cohort of start-up companies outgrowing their university origins and needing supportive facilities to scale-up their technologies to pilot scale.

The Zincovery team developing a containerised pilot plant at the University of Canterbury

Cleantech Mission

We formally joined the New Zealand Cleantech Mission to contribute to a more cohesive approach to supporting emerging cleantech companies locally. With many of our MacDiarmid Institute affiliated start-up companies aiming to address cleantech opportunities in global markets, it's important they are able to scale rapidly. The collaborative efforts across the network can support this. The Cleantech Mission links companies, support agencies across government and research and the opportunities for investment, support and commercial partnerships, both locally and internationally.

Building on the work of the Cleantech Mission partners we've been able to host two further Cleantech Trek tours of research, start-up and industrial facilities in Wellington and Auckland. These Treks bring together commercial and technology leaders, researchers and the support agencies that work together to accelerate our local cleantech start-ups. The Treks included visits to start-up companies Liquium, Advemto, Bspkl, Hotlime Labs, TasmanIon, Mint Innovation, Aquafortus, Avertana, Neocrete, NZSteel (Glenbrook site) and Outset Ventures.

Cleantech Trek visiting Mint Innovation pilot plant and R&D site

Techweek: Leveraging NZ Deep Tech to Build a Sustainable Future

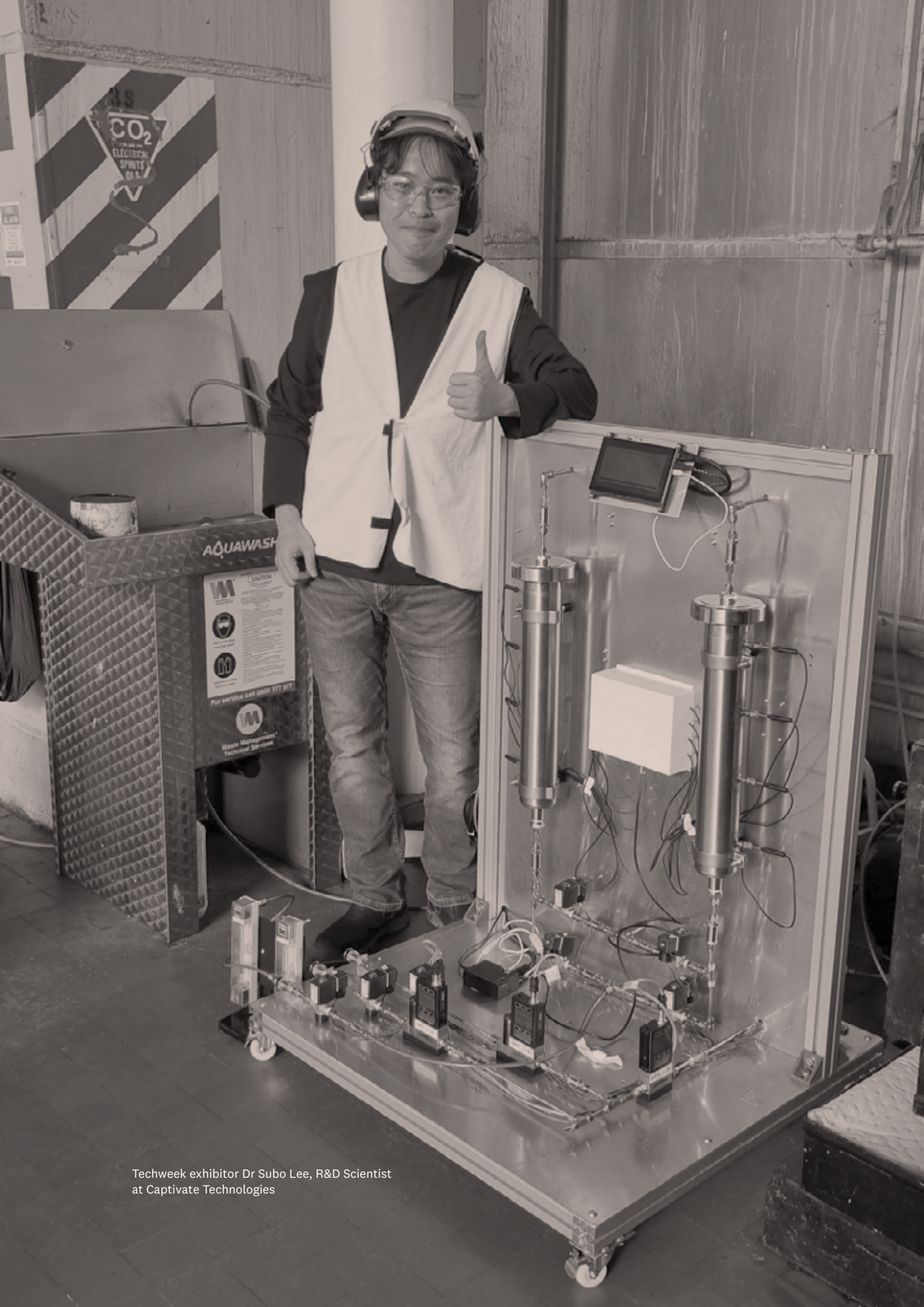
Our Techweek events this year were once again an opportunity to lead a collaboration of science commercialisation groups from across New Zealand. The events (all oversubscribed) provided an excellent showcase of deep tech and cleantech and aimed to stimulate industry partnerships, link investors and entrepreneurs and inspire the next generation of researchers to chase global ambitions.

Our Techweek speakers included Mike Lim of the Singapore-based Trirec Ventures, who shared his insights into local Cleantech start-ups from the Trirec team's recent tour of New Zealand, and Angela Ogier of EY NZ, an energy sector leader and Oceania hydrogen leader who talked about the role of technology in decarbonisation and the international incentives to help us get there. Other talks by researchers and entrepreneurs covered alternative proteins, plasma deposition applications and driving quality and value through novel analytical techniques.

Once again, we included start-up exhibitors (six at each location) to stimulate conversations about deep tech and cleantech at both of the Auckland and Palmerston North venues.

These events are run in collaboration with our event partners, the Dodd-Walls Centre, New Zealand Product Accelerator, BIC, AUT Chemistry, Momentum Committees, CHIASMA and MESA, showing the strength and connectedness of the New Zealand commercialisation sector.

Mike Lim, Partner at TRIREC. Singapore-headquartered global investor, focused on decarbonisation investments



Techweek exhibitor Dr Subo Lee, R&D Scientist
at Captivate Technologies

KiwiNet Awards

KiwiNet Awards – 28 September 2023

Congratulations to our Commercialisation and Industry Engagement Manager, Kevin Sheehy, who won the 2023 KiwiNet Simpson Grierson Commercialisation Professional Award. The award recognises a commercialisation professional working within a New Zealand research organisation who has made an outstanding contribution to the commercialisation of publicly funded research. The Institute has supported researchers and their Tech Transfer Offices (TTOs) to spin out nine start-up companies since Kevin took up his current role. Kevin has made a huge contribution, not only within the Institute but throughout New Zealand's deep tech and cleantech ecosystem. One of the key roles he has played is in pulling together key players in the wider start-up sector to identify ways that support for new deep tech and cleantech start-up companies could be enhanced. It's an exciting time in this space and exciting to see Kevin being recognised for his impact. Congratulations also to one of the Institute's newest affiliated start-up companies, Bspkl, which won the PwC Breakthrough Project Award: Activating sustainability through innovative manufacturing, including its cofounders, Dr Jérôme Leveneur (a MacDiarmid Institute alumnus) and Christina Houlihan.

The MacDiarmid Institute was also well-represented by four other Institute-affiliated KiwiNet finalists: BNZ Researcher Entrepreneur Finalist, Principal Investigator Dr Laura Domigan, and Sprout Breakthrough Innovator Finalists, alumna Dr Olivia Ogilvie and Dr Jérôme Leveneur.

Congratulations to all of them. Being a finalist for these awards is a huge achievement. It's exciting to see so much success in this area.

Click here to open link.

Kevin Sheehy accepting the Simpson Grierson Commercialisation Professional Award

Alumni Business Scholarship

Our 2023 Alumni Business Scholar is Dr Emma Wrigglesworth who will study a Postgraduate Diploma in Business at Waipapa Taumata Rau University of Auckland.
Emma completed her PhD in chemistry at Te Herenga Waka Victoria University of Wellington in 2020, working under the supervision of Professor Jim Johnston, and currently works as Technical Lead at Inhibit Coatings Ltd. This scholarship will develop her core business knowledge and cultivate essential leadership and problem-solving skills, developing the confidence and expertise to take innovative science from the lab through to commercialisation.

2023 Alumni Business Scholar Dr Emma Wrigglesworth

MacDiarmid Institute-affiliated start-up companies founded between 2002 and 2023

Patenting

The following patent activity was undertaken by our researchers in partnership with their respective Technology Transfer Offices (only MacDiarmid Institute researchers named on the patents are included here).

Patent applications

Chris Bumby
- High-temperature superconducting switches and rectifiers (Publication) - AU2022211989A1

Chris Bumby, Justin Brooks, Ratu Mataira
- Superconducting diode (Publication) - WO2024013664A1

Chris Bumby, Ross Taylor
- Superconducting electromagnets and method of forming - AU2023902627A0

Jack Chen, Bryan Andres Tiban Anrango
- Janus-type spherical cellulose nanoparticles (Publication) - WO2023084383A1

Jack Chen, Bryan Andres Tiban Anrango, Mohinder Naiya
- Process for making Janus-type spherical cellulose nanoparticles - AU2023904131A0

Nathaniel Davis, Jake Hardy
- Perovskite material and uses thereof - AU2023901888A0

Ben Mallett
- Passive temperature regulation in superconducting circuits - AU2023903119A0

Aaron Marshall, Leatham Landon Lane
- Method for processing materials containing iron and zinc - WO2023209646A1

Aaron Marshall, Jerome Leveneur, Sophie McArdle
- Redox flow battery electrodes - AU2023900842A0

Michel Nieuwoudt, Marco Bonesi
- Analysis system and probe assembly - AU2023901702A0
- Oxygen saturation measurement technologies - AU2023902642A0

Volker Nock, Ren Dobson, Fabian Dolamore, Julian Menges, Robert Meffan
- Microfluidic Sealing Valve and Microfluidic Circuit (Publication) - US20230083434A1
- Microfluidic devices, systems and methods for providing an indication of rheology of a substance (Publication) - AU2022331216A1

Ben Yin
- System, method, and apparatus for enhancing a fluid - WO2023175545A1

Patents granted

Simon Brown, Edoardo Galli, Susant Kumar Acharya
- Electrical contacts for nanoparticle networks - US11856877B2

Into the community

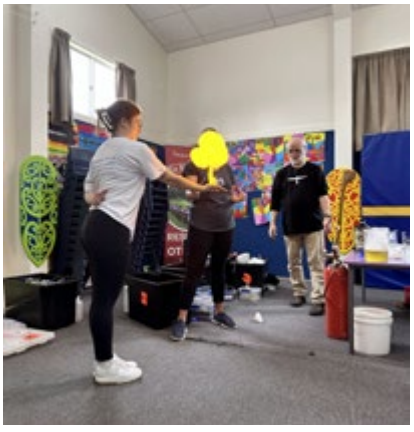
In 2023 we extended our community engagement widely, through our people and our partners. Our researchers delivered DiscoveryCamp, NanoCamp and the Regional Lecture Series. Collaborations with Tūhura Otago Museum, House of Science, GNS Science and the Robinson Research Institute brought materials science to schools and communities. A first-time engagement with a home-schooling group and ongoing outreach in Northland communities by Institute Affiliate Dave Warren deepened regional connections. We cherish our partnerships. Both we and our communities are richer for them.


Exit
Room One

Welcome to our first Institute Affiliate!

It is with great pleasure that we announce the appointment of our first Institute Affiliate (IA), Dr Dave Warren. Dave holds a PhD in Physical Chemistry, using ATR-IR techniques to characterise materials. He is currently employed as a Senior Teaching Fellow at Te Whare Wānanga o Otāgo University of Otago, where for the last decade he has run the successful Department of Chemistry Outreach Programme.

Dave has a longstanding involvement with the Institute, particularly in outreach activities but also in mentoring students. IA status recognises outreach partnerships, research collaborations and other contributions that complement and strengthen our activities.



Chemistry Outreach with Dr Dave Warren in Northland

Our new Institute Affiliate, Dr Dave Warren from Chemistry Outreach at Te Whare Wānanga o Otāgo University of Otago, travelled to Northland in July and November for two (separate) weeks of educational outreach. Dave has been building the relationship with the Northland communities over four trips to date, beginning independently in 2022 then supported by the Institute for three subsequent trips. This year, Dave was joined by our PhD student Sam McIntyre, along with several other Te Whare Wānanga o Otāgo University of Otago students.

In June, the team visited five schools (three primary schools and two secondary schools, working with around 300 children), and were hosted on a marae by Ngāti Kahu. In November the team was joined by Josh Bristowe (Ngāti Porou and Ngāpuhi) from Plant & Food Research and again visited five schools in five days; these included some of the regular schools (Pāmapūria, Oturu, Mangōnui and Taipā area school) who the team had previously partnered with, plus Kaitaia primary school. Over the week, the team worked with 430 children and were joined by three kuia from the Ngāti Kahu education portfolio.

The presence of the kuia brings great mana to the outreach visits and is a strong indication of the importance of this kaupapa to the iwi. The strengths of the relationship-building between Dave's team is evident in the invitation for one of the MSc students to collect local kānuka samples for extraction of natural products including potential anti-viral and anti-microbial compounds. The team will return the data gathered to the iwi once analysis is complete, which will also serve as another engagement opportunity to foster this growing relationship in an often-overlooked part of Aotearoa New Zealand.

DiscoveryCamp and NanoCamp

Our annual in-person science camps for Year 12 and Year 13 secondary school students ran in January, with 11 students attending our 14th annual DiscoveryCamp in Christchurch, and a further 11 students taking part in our 13th annual NanoCamp in Palmerston North.

NanoCamp

NanoCamp 2023 was led by Te Kunenga ki Pūrehuroa Massey University-based Associate Investigators Dr Ebu Avci and Dr Emilia Nowak. The NanoCampers studied microscopy imaging, microrobots and silver nanoparticles, manipulated micro-objects with lasers, took a field trip to Herb Farm in Ashurst and heard from current PhD students about science and academic pathways. The camp attendees also enjoyed a busy social programme in the evenings, including bowling, go-karting and trampolining.

The NanoCampers were looked after by a number of MacDiarmid Institute Emerging Scientists Association (MESA) students and postdoctoral researchers, including Ludwig Petters, Martin Allen, Shivangi Chourasia, Kate Andrew, Marco Pandullo and Nick Carlisle. They were also helped by local undergraduate students Joel Bezuidenhout and Yuki Yarita.

"NanoCamp has been a brilliant opportunity to explore the incredibly diverse and somewhat hidden world of nanoscience."

"My time at Massey University for the MacDiarmid NanoCamp was nothing short of highly educational and extremely fun."

"The combination of the great science activities and social events make the experience truly amazing."

"What I will treasure most as I recall the experience, will be the interactions I had with all the awesome people who were involved."

"Taking part in NanoCamp was a really inspiring experience for me. After spending five days at camp, taking part in hands-on science sessions, meeting other attendees, and talking to lecturers and postgraduate students, I know I want to follow a career in science."

"I met a great group of diverse, intelligent and creative postgrad students who were all so welcoming, supportive and willing to answer my questions about university, postgraduate study, and the science industry."

"Another part of the Nanocamp that I thoroughly enjoyed was observing university life on campus and witnessing how students at the university work towards their degrees."

"My time at NanoCamp allowed me to experience science at a much more practical level than I get to at school."

"A highlight for me was manipulating micro-objects with a laser."

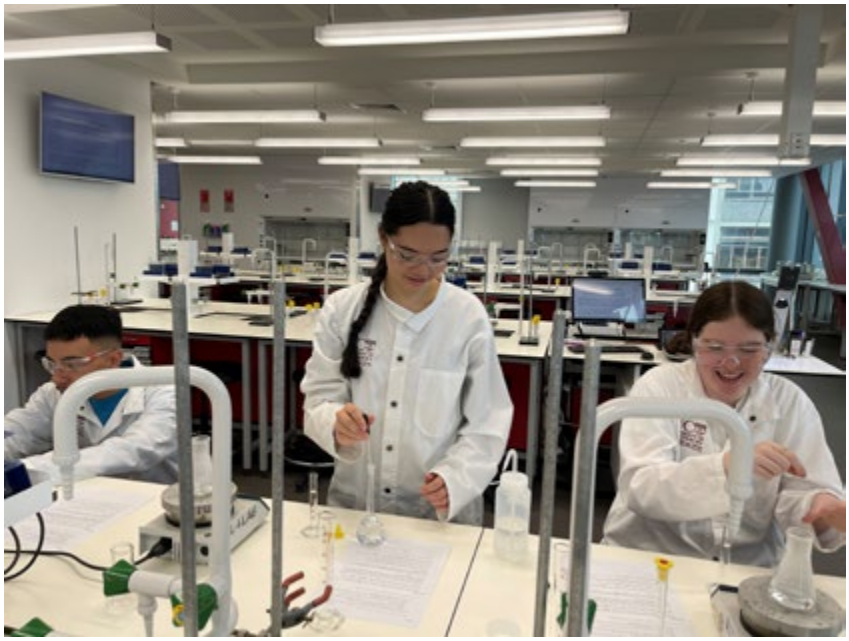
"The conversations I had outside of the main science practicals were some of the most valuable moments from NanoCamp."

"Being able to use all the techniques you learn in school to synthesise aspirin is such a cool thing."

"One of my favourite aspects was being able to be vulnerable and unapologetically make mistakes that high-achievers and perfectionists would usually be so worried about."

DiscoveryCamp

DiscoveryCamp 2023 was led by Te Whare Wānanga o Waitaha University of Canterbury-based Principal Investigator Professor Martin Allen. The DiscoveryCampers studied nanotechnology, silicon wafer photolithography, water electrolysis (green hydrogen production), dye sensitized solar cells, nano-chemistry, microbiology and microfluidics. They also met with current Māori postgraduate students, research assistants and Discovery Scholars who shared pathways to and through tertiary education. Team-building evening activities included a learn-to-surf session and escape rooms. Our Stakeholder Relations Partner Iwi Diane Bradshaw and Whakarewarewa research assistant Ringahora Huata also joined the DiscoveryCampers for the week. The DiscoveryCampers were looked after by MESA PhD students Ryan Adams, Te-Rina King-Hudson, Winter Zakaria, Kate Wislang, Sydnee Koia, Jin Ang and Hamish Trlin, as well as Discovery Scholar Zack Avery.



DiscoveryCamp students making ‘nanogold’ during a lab session, January 2023

“This camp has inspired me, and I am definitely eager to apply for the University of Canterbury after this trip!”

“It makes such a difference to be completely surrounded by people who have such a passion for science and are so knowledgeable in their fields.”

DiscoveryCamp 2023 students attend Surf School at Sumner Beach in Christchurch

DiscoveryCamp 2023 attendees with Ringahora Huata (far left) and Diane Bradshaw (far right)

Students talk about their time at DiscoveryCamp

"Before going to this camp I was contemplating getting an apprenticeship like the rest of my mates, but this camp made me change my mind and it has really made me want to work hard through my final year at high school."

"From creating our own solar cells, to imprinting our images on silicon wafers, I was able to experiment with things that were new to me."

"I was around other people of Māori or Pacific Island heritage who also enjoyed learning about science, which created a really encouraging space where there was no doubt that we belong in academic and scientific environments."

"The people on this camp were welcoming of every form of diversity and I came out of it feeling more comfortable and confident in both my heritage and cultural identity, but also my career in STEM."

"A real strength of the DiscoveryCamp was how well it catered to our age group."

"The escape room was my favourite since it gave me an opportunity to practise my teamwork skills while also mentally challenging me."

"My favourite session was the silicon wafer photolithography and learning about how we can see nanostructures using electrons instead of light."

"The balance between learning and socialising was essential to keep us engaged and made sure that we had a memorable time."

"We were all from different walks of life and different parts of the country, yet by the end of five days, we had all become a tight-knit group."

Growing the Horowhenua/Manawatū branch of the House of Science

In 2023 we continued our sponsorship of the House of Science Horowhenua/Manawatū branch. As a result of the Institute's support, the science resource kit library for the branch has now more than doubled, the branch has been able to take on more member schools and has also been able to increase the hours of the part-time branch manager to cope with the extra workload. The manager, together with a team of volunteers, delivers 25-30 science kits each fortnight.

House of Science CEO Chris Duggan says that with the Institute's support, over 2,000 students in the Horowhenua/Kāpiti region are now using the kits and taking part in science learning every two weeks.

The House of Science currently has 20 branches around the country, with 700 member schools. The science kits and teacher professional development empower teachers to deliver science lessons so that children in primary and intermediate schools develop a love for science, which will stay with them throughout their schooling and influence their career choices. The Institute was the House of Science's first national sponsor.

"2,000 students are now taking part in science learning every two weeks in this branch alone."

Chris Duggan, CEO of House of Science

Tūhura Otago Museum

Below is a breakdown of the number of people directly engaged with outreach activities related to the MacDiarmid Institute.

Through our partnership with Tūhura Otago Museum, 522 people engaged directly with our materials science based outreach content:

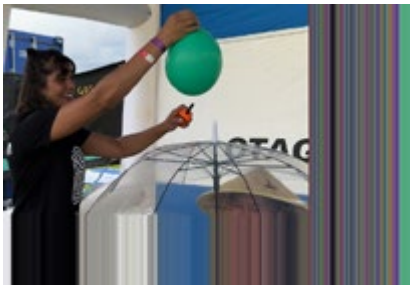
	Direct Engagement
School visits	430
NZ International Science Festival	122
Total	552

The Museum also took our outreach content to wider audiences as part of their general engagement:

ASB Polyfest	2696
Niue Science Festival	708
Total	3404

ASB Polyfest in Auckland, March 2023

Several members of Tūhura Otago Museum's outreach team travelled to Tāmaki Makaurau to deliver science engagement at ASB Polyfest. Most of the team's content focused on climate change in the Pacific for an Unlocking Curious Minds project titled Islands to Arks. Several of the activities were repurposed from an older science showcase, Far from Frozen II, on which the MacDiarmid Institute had been a partner. These activities focused on our current impact on the environment as well as greentech solutions being developed in Aotearoa New Zealand and the Pacific.



A global warming activity that uses a water balloon to demonstrate the different heat-absorption abilities of water and air, highlighting the importance of greentech solutions

Road user and CO_2 emissions interactive at ASB Polyfest, developed in partnership with Tūhura Otago Museum for their climate change showcase

The Future is Nano pop-up

'The Future is Nano' pop-up station during the NZ International Science Festival

Niue Science Festival, June 2023

The Tūhura Otago Museum outreach team travelled to Niue to conduct the first ever science festival held in the country. The material they brought covered the science of medicines, light and colour, star navigation, climate change and greentech. The students, parents and wider community were absolutely delighted and keenly engaged with all the festival content. One of the most popular demonstrations related to the MacDiarmid Institute was the hydrogen balloon explosion to show how hydrogen gas can be a clean alternative to petroleum.

Science Engagement Co-Ordinator Anna Farrelly-Rosch preparing a crowd in Niue for a hydrogen balloon explosion – a popular demonstration on using hydrogen for clean, green energy

Another hydrogen balloon demonstration at the Niue Science Festival

25 Years of Science exhibit, Meridian Mall, Dunedin

When you're spooning yoghurt on your breakfast cereal, do you ever think how the yoghurt could be related to a brain scan?

The above tag line invited viewers of the 25 Years of Science exhibit to join in the spirit of Sir Paul Callaghan and think about the world around us in ways that we perhaps haven't before. Back in the late 20th century, Sir Paul was using Magnetic Resonance Imaging (MRI) to measure the sap flow in wheat seeds, showing that you could use this technique to study living things, without having to cut up the seeds or destroy them in any way.

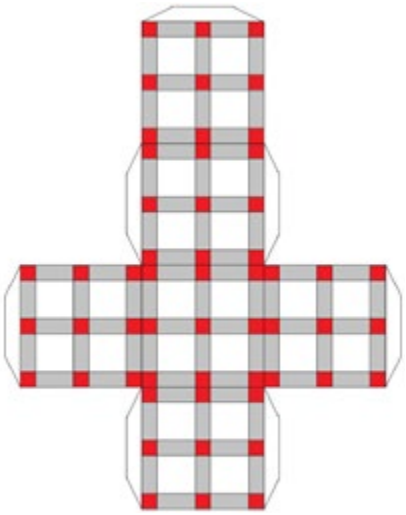
When you're spooning yoghurt on your breakfast cereal, do you ever think how the yoghurt could be related to a brain scan?

While an established tool, MRI in its current form was not suitable to study soft matter. Indeed, sometimes the current tools you have aren't quite right for the problem you're trying to solve so Sir Paul improved the Nuclear Magnetic Resonance (NMR) and MRI technologies along the way. With each experiment, he adapted the technology to the need, pushing the boundaries of NMR and MRI techniques, coming up with solutions that support the technology we know and use today.

We hope that some of this spirit rubbed off on viewers of the 25 Years of Science exhibit and we look forward to the future of technology and the innovative solutions that will be provided by the next generation.

Developing new take-home craft activities

Dr Marijn Kouwenhoven has been developing a new crafty activity, like the Buckyball sheets, focused on metal-organic frameworks (MOFs). Although this activity is still in its prototype stage, there are plans for early next year to develop the template further so it can be manufactured professionally.



Initial mock-ups of templates for paper MOF model

First attempt at assembling paper template

2023 Regional Lecture Series Good news for a change: Sustainability Tech in Aotearoa New Zealand and the science behind it

Sustainability has been a theme throughout our Regional Lectures Series over the past several years. This year we focused on tangible sustainability tech happening right now in Aotearoa New Zealand: 'Good news for a change: Sustainability tech in Aotearoa New Zealand and the science behind it'. We reached out to our partners and further into the wider deep tech start-up ecosystem to bring stories of sustainability tech, and looked at the science behind these discoveries, in particular the science that relates to the Institute's research.

The talks covered:

- The work of our partner GNS Science creating hydrogen micro grids in remote communities (Ngāhina Marae) and the science of green hydrogen fuel;
- Aotearoa New Zealand's biggest solar installation, being developed on 400 hectares of land alongside Christchurch International Airport runways, and the science of solar power;
- The science of converting waste to value, using the example of start-ups Geo40 and Zincovery; and
- The science of carbon capture by porous materials, using start-up Captivate Technologies as an example.

Dr Michelle Cook (GNS Science-based MacDiarmid Institute alumna) was part of the Tauranga lecture, along with Dr Charlie Ruffman (Waipapa Taumata Rau University of Auckland postdoc and MacDiarmid Institute alumnus) and Te Herenga Waka Victoria University of Wellington PhD graduate Calum Gordon.

The Tauranga lecture was held in association with Café Scientifique and attended by approximately 120 people. The team visited two schools and helped students make their own solar cells out of berries. At Matua Primary School they met with about 30 students from years five and six. They then ran a workshop for 15 home school students. It was great to engage with a group of students who have in the past missed out on visits from our scientists.

> "Impressed by the enthusiasm and knowledge of the three young speakers. Our future is in good hands."
>
> Attendee feedback from the Tauranga lecture

> "Clear, concise, informative, and makes people think."
>
> "Fascinating work – your visit is a highlight of our year"
>
> Jenny Dee, Hawke's Bay Branch of the Royal Society Te Apārangi

For the Hawke's Bay lecture, Principal Investigator Professor Chris Bumby (Paihau - Robinson Research Institute) and Associate Investigator Dr Nate Davis (Te Herenga Waka Victoria University of Wellington) were joined by Robinson Research Institute (RRI) outreach coordinator Tahlia Crabtree. The three combined their visit to the Hawke's Bay with two school visits, to Napier Boys' High School and Karamu High School. The focus of the school sessions was on microscopy, with Tahlia bringing RRI's tabletop scanning electron microscope to the schools, as well as some light microscopes.

Our Wanaka lecture was delivered by Te Kunenga ki Pūrehuroa Massey University-based Associate Investigator Dr Emilia Nowak and Te Whare Wānanga o Otāgo University of Otago-based Principal Investigator and Deputy Director for Outreach and Education Associate Professor Anna Garden. Emilia also visited Mt Aspiring College while she was there and met with senior physics students to look at experimental fluid dynamics using a chocolate fountain, and to discuss the physics behind it based on simulation of non-Newtonian liquids with heat transfer.

Te Whare Wānanga o Otāgo University of Otago-based Associate Investigator Dr Courtney Ennis and Te Whare Wānanga o Waitaha University of Canterbury-based Principal Investigator Professor Paul Kruger travelled to Nelson to speak at Cawthron INSPIRE, an annual festival held in Nelson for primary and intermediate age children (approximate ages 8-13). Courtney and Paul presented the Regional Lecture Series talk for the festival's community lecture and ran two workshop sessions for students aged between 8 and 13 titled 'What's open framework chemistry?!' with hands-on activities for the students to create their own frameworks for greenhouse gas capture.

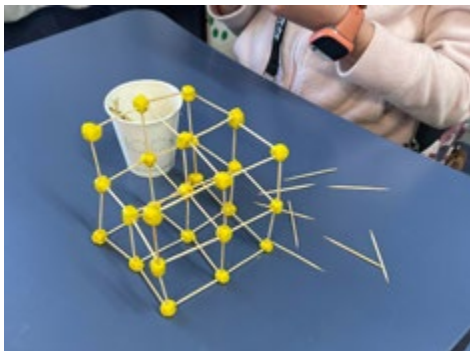
Tahlia Crabtree, Napier

Calum Gordon (top), Michelle Cook (bottom right) and Charlie Ruffman (bottom left) speaking at the RLS event in Tauranga

“MacDiarmid Institute presentations are always enlightening, topical and professionally presented (plus enjoyable). Well done!”

“It was all excellent, relevant and interesting – no need to improve!”

“Fascinating. Leaves TV for dead.”



Calum Gordon and Charlie Ruffman (top and left) delivering their solar cells workshop with home school students in Tauranga; and Paul Kruger and Courtney Ennis (bottom) in their first of two Nelson workshops where students created their own frameworks for greenhouse gas capture


1050
1400
1700
2027
CB

Sci Fi/Sci Fact podcast takes off

A further six episodes of our Sci Fi/Sci Fact podcast have gone to air. The podcast, which was a collaboration between the MacDiarmid Institute and RNZ Nights, is a series of light-hearted episodes recorded with then host of Nights Bryan Crump.

And the podcast has literally taken off. As of 2023 you can now listen to Sci Fi/ Sci Fact on Air New Zealand's international Inflight entertainment.

Waipapa Taumata Rau University of Auckland-based Emeritus Investigator Professor Cather Simpson discussed Zero Point Energy from The Incredibles.

Professor Jan Eldridge from Waipapa Taumata Rau University of Auckland gave us her scientific take on Neutronium, a material widely written about in fiction.

Principal Investigator based at Te Kunenga ki Pūrehuroa Massey University, Professor Bill Williams, talked about Axonite from Dr Who, a 'thinking' material that can replicate any substance and spread itself.

Emeritus Investigator and Waipapa Taumata Rau University of Auckland Professor Penny Brothers spoke about Nth Metal from DC Comics.

Dr Krista Steenbergen, Associate Investigator and Senior Lecturer at Te Herenga Waka Victoria University of Wellington, talked about Philote from the Ender's Game.

MacDiarmid Institute alumnus and former Rutherford Discovery Fellow at Te Herenga Victoria University of Wellington, Dr Mike Price, discussed Antman’s suit.

Into the future

We are incredibly proud of our alumni. The growing deep tech sector here in New Zealand is dependent on a tech-savvy, scientifically trained workforce. Not only do our graduates take with them into the workforce the experience of working with leading researchers, but they bring along a whole host of broader skills, essential to success in the workplace. Our CRISP training programme helps our students and early career researchers develop their wider expertise, including interpersonal skills, IP and product development know-how, preparation for the job market and more. And our internship programme for PhD graduates gives them real life work experience in the deep tech sector, in the wider commercial sphere and in government.

Career and Relevant-to-Industry Skills Programme (CRISP)

Preparing our graduates for their careers after their time as postgraduate students is one of the key drivers for CRISP. Throughout the year, events are organised and designed together with the central MacDiarmid Institute, investigators and a team from MESA to provide training beyond the PhD. This year we had several events which included:

- How to Budget and Spend for Research Success
- Building your Personal Effectiveness
- Deep Tech Hackathon
- The Product Development Lifecycle
- Landing Your First High-Impact Job
- Technology-Market Fit
- Tiriti o Waitangi Training

We aim to provide a range of topics for students to select from that align with their potential career choices. All our events are run by external facilitators and relevant experts making for an exciting and insightful learning experience for our graduates. These events allow us to make stronger ties with external partners, benefiting both students and the partners, who make connections with our future alumni and see first-hand the skills of employees with PhD and research-intensive experience.

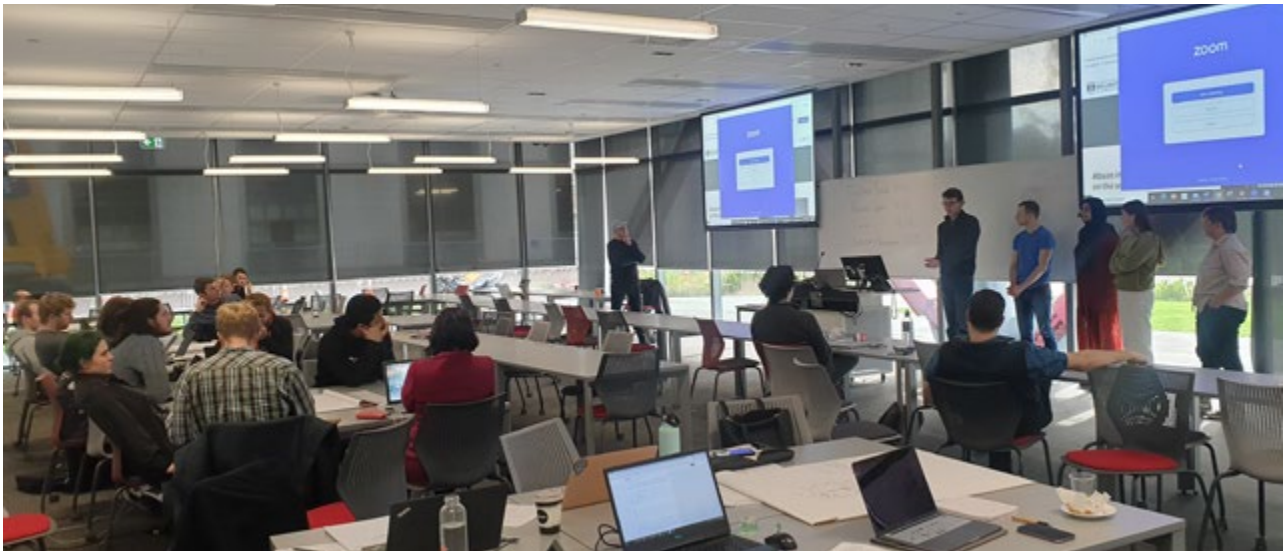
From our Product Development Lifecycle workshop - one set of insights about why a company needs PhD graduates (Resene presenter):

- They can carry out projects, independently.
- They usually have faster business uptake.
- They already know how to conduct a project.
- They usually have better scientific perception (than other science and technical graduates).
- They are more likely to develop long-life products (commercial life in-market).

These insights reflect the opinions of managers who have previously employed at least one PhD graduate.

"Congratulations to the Institute on your amazing engagement, hard work, intelligence and problem-solving skills - I was hugely impressed at your effort and the results in such a short timeframe."

Ben Reid, facilitator of CRISP Deep Tech Hackathon



PhD graduate internships in government and industry in 2023

Nisansala Bandara
Ministry of Business, Innovation and Employment
January to April 2023
Te Ara Paerangi review

Keemi Lim
Captivate Technologies
July to September 2023
Life cycle analysis of a carbon capture adsorbent

Kun Woo Park
Ministry for the Environment
August to November 2023
Automated approaches to assessing solid waste composition in Aotearoa New Zealand

MESA Co-Chairs' report

It has been a productive year for the MacDiarmid Emerging Scientists Association (MESA), with the running of our usual scheduled events including welcome events, workshops, coffee catch-ups, industry visits and the annual bootcamp. Workshops this year included the Blender software workshop in Auckland, presentation skills in Otago, writing and graphics workshop in Wellington, and a pitching workshop in Palmerston North.

The annual bootcamp this year was hosted in Raglan at the Institute of Awesome, the theme of which was 'Simulating Reality - computational techniques for your research and career'. We were fortunate this year to have the largest amount of participants at a bootcamp to date.

Aside from our regular event schedule, MESA also ran a T-shirt design competition this year. Thank you to Discovery Scholarship alumna Sydnee Koia – whose winning design has been printed on t-shirts for our members to purchase.

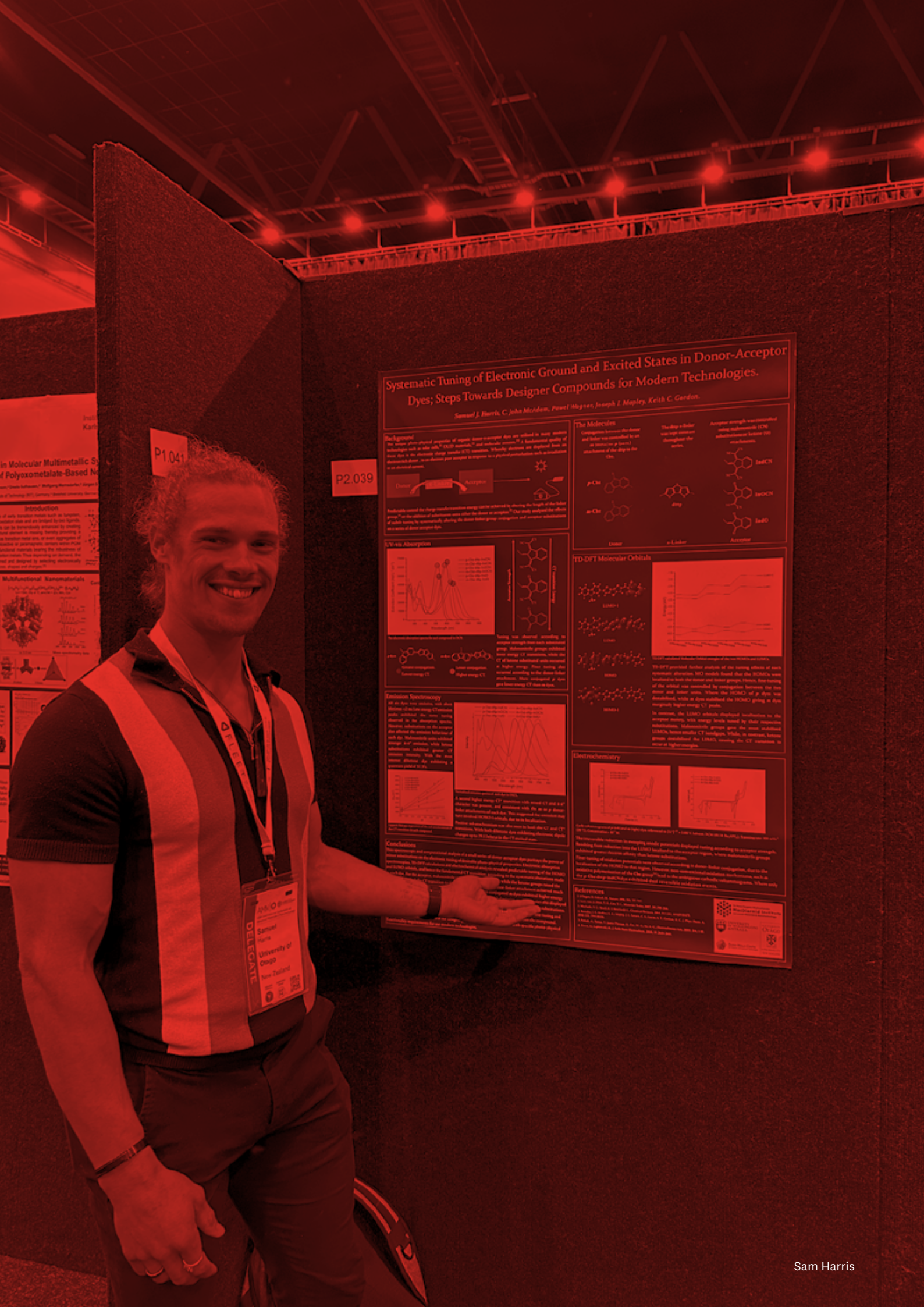
This year was also the inaugural year for a new MESA position (Diversity, Equity and Inclusion Representative) and nation-wide Slack channel.

A big thank you to Nicholas Smith for taking up the new position and developing it, notably by organising the Introduction to Diversity, Equity and Inclusion workshop alongside Diversity Works NZ. Thank you also to those MESA members who have engaged with the Slack channel – moving forward, we hope to continue it as a new form of communication among MESA members.

Lastly, a sincere thank you to all MESA members for actively engaging in MESA events. It's truly fantastic to see familiar and new faces actively connecting and advancing their skills together!

Photos taken at the MESA annual bootcamp in 2023 (above and right)


A snapshot of NeSI Data Services:
Secure, high-speed transfer & share capabilities for large research datasets.
939 TB
Shared Datasets
24 PB
Virtual labs and portals. Support of FAIR principles.
genomics aotearoa
Co-designing longer-term data management solutions.
Aotearoa Genomic Data Repository
Rakeiora project
Endpoints in Aotearoa NZ:
NeSI
Data storage resources for proj
using NeSI's HPC platform


Systematic Tuning of Electronic Ground and Excited States in Donor-Acceptor Dyes; Steps Towards Designer Compounds for Modern Technologies.
P1.041
P2.039
DELEGATE

Sam Harris

MESA commercialisation portfolio

We've begun deploying two MESA commercialisation representatives for two years each, and this year Daniel Mak (Te Whare Wānanga o Waitaha University of Canterbury) and Sam Harris (Te Whare Wānanga o Otāgo University of Otago) have provided excellent Commercialisation and Industry Engagement (CIE) support for MacDiarmid Institute students. The large volume of activities undertaken benefitted from their combined organisational and management skills. They have been instrumental in supporting the development and delivery of our CRISP workshops (with help from Brooke Matthews on the MESA committee) and a series of industry site visits. Site visits were hosted at Christchurch start-ups Dawn Aerospace, Precision Chroma, and Zincovery. These visits helped MacDiarmid Institute students see the potential career paths in deep tech and meet some of the entrepreneurs chasing global ambitions from New Zealand. Daniel, Sam and the MESA Committee arranged the annual MESA bootcamp with invited speaker Jonathan Good, CEO of Scentian Bio, who gave a talk on his career path and the lessons he learnt. Daniel and Sam also represented the MacDiarmid Institute student group at our TechWeek events in Auckland and Palmerston North and the annual KiwiNet Awards in Auckland. Daniel and Sam would like to thank everyone who gave up their time to make 2023 an outstanding year for MESA's CIE efforts. For 2024, we welcome Aston Pearcy to the junior CIE representative role, as Sam moves to the senior role and Daniel steps down to complete his studies and work on a start-up he is founding.

Daniel Mak

Into the metrics

Financials

	2022	2023
Income		
CoRE Funding	$6,400,000.00	$6,400,000.00
Surplus Carried forward	$2,160,868.54	$2,888,688.94
Total Income	$8,560,868.54	**$9,288,688.94**
Salaries and salary related costs		
Directors and Principal Investigators	$733,610.16	$746,753.80
Associate Investigators	$—	$—
Post-Doctoral fellows	$346,154.48	$1,066,925.65
Research/Technical assistants	$401,088.05	$280,955.99
Others	$457,797.14	$525,829.50
Total Salaries & Salary-related costs	$1,938,649.83	**$2,620,464.94**
Other Costs		
Overheads	$756,544.54	$935,071.53
Project Costs	$1,389,905.63	$1,476,764.02
Travel	$81,303.18	$175,870.33
Postgraduate students	$1,459,226.68	$1,988,722.90
Equipment depreciation/rental	$46,549.74	$24,897.21
Subcontractors	$—	$—
Extraordinary expenditure	$—	$—
Total Other Costs	$3,733,529.77	**$4,601,325.98**
late partner invoices to be paid out in following financial year	$820,364.92	$1,135,117.10
Total CoRE Expenditure		
Total Expenses	$5,672,179.60	**$7,221,790.92**
with late invoices	*$6,492,544.52*	*$8,356,908.02*
Net Surplus/(Deficit)	$2,888,688.94	$2,066,898.02
with late invoices	*$2,068,324.02*	*$931,780.92*

At a glance

Headcounts by category	
Emeritus Investigators	21
Principal Investigators	34
Stakeholder Relations Partner Iwi	1
Associate Investigators	50
Postdoctoral Researchers	126
Students	344
Total	**576**

Peer reviewed research outputs by type	
Journal articles	342
Book chapters	6
Conference papers	20
Books	1
Total	**369**

Board, executive, staff and students

Governance Representative Board

Professor Richard Blaikie
Deputy Vice-Chancellor, Research & Enterprise
University of Otago

Mr Will Charles
Executive Director, Technology Development, UniServices
University of Auckland

Professor Ray Geor
Pro Vice-Chancellor College of Sciences
Massey University

Professor Margaret Hyland
Deputy Vice-Chancellor Research
Victoria University of Wellington

Mr Joe Manning
Head of Department – Materials and Air
GNS Science

Mr Hēmi Rolleston
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General Manager Te Ao Māori and Science Services
Scion

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Chief Sustainability and Risk Officer
Callaghan Innovation

Professor Ian Wright
Deputy Vice-Chancellor Research and Innovation,
University of Canterbury

Ex-Officio

Associate Professor Anna Garden
Science Executive Representative, MacDiarmid Institute / Deputy Director Outreach and Education, MacDiarmid Institute
University of Otago

Professor Nicola Gaston
Co-Director, MacDiarmid Institute
University of Auckland

Professor Justin Hodgkiss
Co-Director, MacDiarmid Institute
Victoria University of Wellington

Professor Paul Kruger*
Deputy Director Outreach and Education, MacDiarmid Institute
University of Canterbury

Associate Professor Natalie Plank*
Deputy Director Commercialisation and Industry Engagement, MacDiarmid Institute
Victoria University of Wellington

Associate Professor Charles Unsworth*
Science Executive Representative, MacDiarmid Institute
University of Auckland

Associate Professor Geoff Willmott*
Deputy Director Commercialisation and Industry Engagement, MacDiarmid Institute
University of Auckland

Rosie Wayte
Institute Manager, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

*Partial year

International Science Advisory Board

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University of Cambridge, United Kingdom
Physics of energy materials, condensed matter

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Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Porous materials

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Professor of Chemistry, Institute for Molecules and Materials
Radboud University, Netherlands
Artificial cells

Professor Tomonobu Nakayama
Deputy Director, Administrative Director, Group Leader of WPI-MANA
Deputy Director of International Center for Young Scientists (ICYS)
Professor at the University of Tsukuba
National Institute for Materials Science (NIMS)
International Center for Materials Nanoarchitectonics (MANA)
University of Tsukuba, Japan
Surface physics and chemistry, nanotechnology, nanobioscience

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Patterson Rockwood Professor of Energy
Harvard University, United States of America
Chemistry of renewal energy

Professor Ivan Parkin
Dean of Mathematical and Physical Sciences Faculty
University College London, United Kingdom
Nanomaterials

Professor Annie Powell
Professor of Inorganic Chemistry, Institute of Inorganic Chemistry and Institute of Nanotechnology
Karlsruhe Institute of Technology, Germany
Molecular materials

Dr Charles Royal
Independent researcher and consultant
New Zealand
Mātauranga Māori

Professor Michelle Simmons
Director, Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology
Laureate Fellow
Scientia Professor of Physics
University of New South Wales, Australia
Quantum computing, condensed matter physics

Professor Matt Trau
Professor of Chemistry, University of Queensland
Deputy Director and co-founder, Australian Institute for Bioengineering and Nanotechnology
University of Queensland, Australia
Nanoscience, nanotechnology, and molecular diagnostics

Dr David Williams
Chief Research Scientist and Laboratory Manager, Hitachi Cambridge Laboratory
University of Cambridge, United Kingdom
Materials for computing

Science Executive

Professor Nicola Gaston
Co-Director, MacDiarmid Institute
University of Auckland

Professor Justin Hodgkiss
Co-Director, MacDiarmid Institute
Victoria University of Wellington

Associate Professor Anna Garden
PI Representative/Deputy Director Outreach and Education, MacDiarmid Institute
University of Otago

Associate Professor Pauline Harris
Deputy Director Māori/Māori Research Representative/Research Programme Leader: Mātauranga Māori
Massey University

Professor Paul Kruger*
Deputy Director Outreach and Education, MacDiarmid Institute
University of Canterbury

Associate Professor Natalie Plank*
Deputy Director Commercialisation and Industry Engagement, MacDiarmid Institute
Victoria University of Wellington

Professor Geoff Willmott*
Deputy Director Commercialisation and Industry Engagement, MacDiarmid Institute
University of Auckland

Professor Simon Brown
Research Programme Leader: Future Computing
University of Canterbury

Dr Jack Chen*
Associate Investigator Representative
Auckland University of Technology

Dr Laura Domigan*
Principal Investigator Representative
University of Auckland

Associate Professor Chris Fitchett*
Associate Investigator Representative
University of Canterbury

Professor Derek Kawiti
Principal Investigator Representative
Victoria University of Wellington

Professor Volker Nock*
Research Programme Leader: Reconfigurable Systems
University of Canterbury

Professor Shane Telfer
Research Programme Leader: Catalytic Architectures
Massey University

Professor Jadranka Travas-Sejdic*
Research Programme Leader: Reconfigurable Systems
University of Auckland

Associate Professor Charles Unsworth*
Principal Investigator Representative
University of Auckland

Calum Gordon
MESA Co-Chair
Victoria University of Wellington

Brianna Nally
MESA Co-Chair
University of Otago

Ex-Officio

Kirsty Doyle*
Strategic Manager Māori, MacDiarmid Institute
Victoria University of Wellington

Gabrielle Holmes
Programme Manager, MacDiarmid Institute
Victoria University of Wellington

Kevin Sheehy
Commercialisation and Industry Engagement Manager, MacDiarmid Institute
Victoria University of Wellington

Rosie Wayte
Institute Manager, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

Vanessa Young
Strategic Engagement and Communications Manager, MacDiarmid Institute
Victoria University of Wellington

* Partial year.

MacDiarmid Emerging Scientist Association (MESA) 2023

Calum Gordon
Co-Chair
PhD Student
Victoria University of Wellington

Brianna Nally
Co-Chair
PhD Student
University of Otago

Issy Cowlishaw
Co-Secretary
PhD Student
University of Auckland

Georgia Richardson
Co-Secretary
PhD Student
Victoria University of Wellington

Lara Browne
Co-Treasurer
PhD Student
Victoria University of Wellington

Sarah Sale
Co-Treasurer
PhD Student
University of Canterbury

Roisin (Rosie) Mooney
Social Media Representative
PhD Student
Auckland University of Technology

Daniel Mak
Commercialisation and Industry Representative
PhD Student
University of Auckland

Ben Westberry
Commercialisation and Industry Representative
Postdoctoral Fellow
Massey University

Nicholas Smith
Diversity, Equity and Inclusion Representative
PhD Student
University of Otago

Samuel Harris
Centre Representative/Commercialisation and Industry Representative
PhD Student
University of Otago

Bushra Anam Khalil
Centre Representative
Postdoc
University of Canterbury

Aditi Kumar
Centre Representative
PhD Student
Victoria University of Wellington

Anmol Mahendra
Centre Representative
PhD Student
Robinson Research Institute

Olivia Matich
Centre Representative
PhD Student
Auckland University of Technology

Andrea O'Reilly
Centre Representative
PhD Student
Victoria University of Wellington

Ludwig Petters
Centre Representative
PhD Student
Massey University

Marco Vas
Centre Representative
PhD Student
University of Auckland

Winter Zakaria
Centre Representative
PhD Student
University of Canterbury

Principal Investigators (34)

Martin Allen
Sally Brooker
Simon Brown
Chris Bumby
Laura Domigan
Anna Garden
Nicola Gaston
Keith Gordon
Michele Governale
Simon Granville
Pauline Harris
Justin Hodgkiss
Derek Kawiti
John Kennedy
Paul Kruger
Eric Le Ru
Nigel Lucas
Jenny Malmström
Aaron Marshall
Duncan McGillivray
Franck Natali**
Volker Nock
Natalie Plank
Ben Ruck
James Storey
Shane Telfer
Jadranka Travas-Sejdic
Charles Unsworth
Geoff Waterhouse
Catherine Whitby
Grant Williams
Martin (Bill) Williams*
Geoff Willmott
Ulrich Zuelicke

* Indicates resigned as PI
** Indicates changed status from AI to PI

Stakeholder Relations Partner Iwi (1)

Diane Bradshaw

Associate Investigators (50)

Mathew Anker
Baptiste Auguie
Ebubekir (Ebu) Avci
David Barker
Catherine Bishop
Margaret Brimble
Philip Brydon
Peng Cao
Jack Chen
Kai Chen
Shen Chong
Martyn Coles
Matthew Cowan
James Crowley
Nathaniel Davis
Renwick Dobson
Courtney Ennis
Christopher Fitchett
Robin Fulton
Petrik Galvosas
Vladimir Golovko
Prasanth Gupta
Muhammad Hanif
Patricia Hunt
Geoff Jameson
Marcus Jones
Vedran Jovic

Roshan Khadka*
Jon Kitchen
Erin Leitao
Jérôme Leveneur***
Luke Liu
Taniela Lolohea
Ben Mallett
Steven Matthews
Kim McKelvey
Franck Natali**
Michel Nieuwoudt
Emilia Nowak
Elke Pahl
Kannan Ridings
Daniel Sando*
Viji Sarojini
Jami Shepherd
Tilo Söhnel
Krista Steenbergen
Mark Waterland
Cameron Weber
Ben Yin
Alex Yip*

* Indicates appointed as AI
** Indicates change of status from AI to PI
*** Indicates pause in status as AI

Emeritus Investigators (21)

Maan Alkaisi
Richard Blaikie
Penny Brothers
Ian Brown
Bob Buckley
Sally Davenport
Juliet Gerrard
Simon Hall
Shaun Hendy
Jim Johnston
Tim Kemmitt
Ken MacKenzie
Andreas Markwitz
Jim Metson
Roger Reeves
Mike Reid
Craig Rofe
Cather Simpson
Jeff Tallon
Richard Tilley
David Williams

Professional Staff

Kirsty Doyle*
Strategic Manager Māori, MacDiarmid Institute
Victoria University of Wellington

Genevieve Fitzjames*
Project Coordinator, MacDiarmid Institute
University of Auckland

Gabrielle Holmes
Programme Manager, MacDiarmid Institute
Victoria University of Wellington

Kevin Sheehy
Commercialisation and Industry Engagement Manager, MacDiarmid Institute
Victoria University of Wellington

Rosie Wayte
Institute Manager, MacDiarmid Institute
Victoria University of Wellington

Vanessa Young
Strategic Engagement and Communications Manager, MacDiarmid Institute
Victoria University of Wellington

* Indicates partial year

MacDiarmid Institute students in 2023

Masters (47)

Allen	Martin	Massey University
Baiju	Sajith	University of Canterbury
Chaudry	Muhammad (Musa)	Victoria University of Wellington
Clague	Lily	University of Otago
Devane	Harrison	Victoria University of Wellington
Evans	Logan	Victoria University of Wellington
Faulkner	Logan	University of Otago
Filatov	Yuri	University of Canterbury
Fowler	Jackson	Victoria University of Wellington
Gao	Hetian (Henry)	University of Auckland
Hackner	Nico	University of Otago
Halliday	Joshua	Victoria University of Wellington
He	Jing	Massey University
Kuang	Ze	University of Auckland
Mare	Alaigne	Victoria University of Wellington
McClea	Glen	University of Canterbury
Monkman	Aleece	University of Auckland
Moree	Lana	University of Otago
Pearcy	Aston	University of Otago
Plummer	Sam	University of Canterbury
Poata	Joseph	Victoria University of Wellington
Rex	Angelique	Massey University
Rowe	Cameron	Victoria University of Wellington
Scott	Jacob	Massey University
Sergent	Madison	University of Canterbury
Shi	Ji	University of Auckland
Siesicki	Jessica	Victoria University of Wellington
Stephens	Emily	Victoria University of Wellington
Summers	Hannah	Victoria University of Wellington
Tamorite	Hajie	University of Otago
Thatcher	Kathryn	University of Canterbury
Tong	Marco	University of Auckland
Unsworth	Sophie	Victoria University of Wellington
Venkatesh	Siddharth	Massey University
Wang	Keer	Auckland University of Technology
Wang	Liying	University of Auckland
Wang	Runzhong (Derek)	University of Auckland
Watson	Hosea	University of Canterbury
Watt	Carlie	University of Auckland
Whiting	John	University of Otago
Wiley	Richard	University of Canterbury
Wong	Emily	Victoria University of Wellington
Wung	Alexander	University of Auckland
Xie	Haotian	University of Auckland
Yuan	Kun (Peter)	University of Auckland
Yue	Grace	University of Otago
Zhang	Hongliang (Ryan)	University of Auckland

PhDs (297)

Abeysekera	Gayan	University of Canterbury
Acheson	Chris	Victoria University of Wellington
Adams	Ryan	University of Canterbury
Aguilar	Clouie Justin	University of Auckland
Ahangarpour	Marzieh	University of Auckland
Ahmmed	Fatema	University of Otago
Alidoust Ghatar	Azizeh	Victoria University of Wellington
Allan	Claudia	University of Canterbury
Ambadiyil Soman	Arya	Victoria University of Wellington
Anand	Aljo	University of Auckland
Andarini	Rizki Putri	Victoria University of Wellington
Andriani	Cynthia	University of Auckland
Antony	Irene	University of Canterbury
Anvari	Rezvan	University of Canterbury
Appletree	Lun	University of Auckland
Arul	Mohana	Massey University
Ashraf	Jesna	University of Auckland
Auer	Bernhard Stephan	Massey University
Baiju	Sajith	University of Canterbury
Bandi	Bhanumathi	Auckland University of Technology
Barclay	Jaye	Victoria University of Wellington
Barrera Morelli	Josefina	University of Auckland
Baserisalehi	Farzaneh	Massey University
Basharat	Sumaira	University of Auckland
Battley	Andrew	University of Auckland
Bayat	Afrooz	University of Canterbury
Begzaad	Sangar	Victoria University of Wellington
Bell-Tyler	Joseph	University of Auckland
Bernach	Michal	University of Canterbury
Birchall	Finn	University of Canterbury
Board	Amanda	University of Canterbury
Booth	Tony	Victoria University of Wellington
Browne	Lara	Victoria University of Wellington
Bryant	Devon	University of Auckland
Burling	Sophie	Massey University
Buzas Stowers-Hull	André	Massey University
Cahyanto	Harry	University of Canterbury
Cai	Yichao	Massey University
Carleton	Daniel	Auckland University of Technology
Carlisle	Nicholas	Massey University
Cassie	Erica	Victoria University of Wellington
Chahal	Harpreet Kaur	University of Auckland
Chan	Sanutep	Victoria University of Wellington
Chen	Qun (Queenie)	University of Auckland
Chen	Xize	University of Auckland
Choudhury	Minati	University of Otago
Chourasia	Shivangi	Massey University
Chung	Stephen	University of Auckland
Cleland	Josiah	Massey University
Clyde	Daniel	University of Auckland
Coombes	David	University of Canterbury
Cowlishaw	Isabel	University of Auckland
Dahalan	Ghadir	Massey University
Data	Shailja	University of Auckland
Deas	Robert Ian	University of Auckland
DeMonte	Kieran	University of Otago
Dierkes	Marissa	Victoria University of Wellington
Dinachandran	Lekshmi	University of Otago
Donaldson	Marryllyn	Massey University
Dong	Yusong	University of Auckland

Doran	Conor	University of Auckland
Drummond	Grace	University of Auckland
Duodo	John	University of Auckland
Ebardo	Irelie	Victoria University of Wellington
Edens	Samuel	University of Canterbury
Elahi	Asrar	University of Otago
Elbashier	Elkhansa	University of Otago
Eldiven	Askin	University of Canterbury
Emeny	Chrissy	University of Canterbury
Esmaeili	Fatemeh	University of Auckland
Fellner	Daniel	University of Auckland
Fontein	Danica	Victoria Universit y of Wellington
Ford	Kathryn	University of Canterbury
Francis	Tait	University of Otago
Gater	Anastasia	University of Auckland
Gearing	Hayden	University of Auckland
George Koshy	Ben	Victoria University of Wellington
Geurts	Alisha	University of Auckland
Ghorbani Siavashani	Atusa	Massey University
Gilbert	Malachy	University of Auckland
Gilbertson	Fletcher	University of Canterbury
Gisich	Alla	Victoria University of Wellington
Gito	Donn Adam	University of Auckland
Glasson	Judith	University of Auckland
Glukhova	Stefania	Victoria University of Wellington
Gordon	Calum	Victoria University of Wellington
Gordon	Hugo	University of Auckland
Grant	Mason	University of Auckland
Grant-Mackie	Emily	University of Auckland
Green	Lewis	University of Auckland
Gunukula	Venkata	University of Auckland
Haack	Marc Alexander	University of Otago
Hamonnet	Johan	University of Canterbury
Happe	Erica	Victoria University of Wellington
Hardy	Jake	Victoria University of Wellington
Harper	Aimee	University of Canterbury
Harris	Samuel	University of Otago
Harris	Shikeale	Massey University
Harvey-Reid	Nathan	University of Canterbury
Hasannasab	Maede	University of Auckland
Hay-Fourmond	Elouan	University of Otago
He	Qishu	University of Otago
Hedley	Gavin	University of Canterbury
Heenan	Alex	University of Canterbury
Hesabirad	Maryam	Massey University
Heywood	Zachary	University of Canterbury
Hibbert	Seth	University of Canterbury
Horrocks	Matthew	University of Auckland
Hunt	Liam	University of Auckland
Hunter	Gray	University of Auckland
Ijaz	Mohsin	University of Otago
Islam	Atif	Victoria University of Wellington
Jangodaz	Elnaz	Massey University
Jena	Kumar (Debajyoti)	University of Auckland
Jia	Zong Hao (Bill)	University of Auckland
Jin	Ang	University of Canterbury
Joshy	Elma	Victoria University of Wellington
Kahlon	Navjot Kaur	University of Auckland
Kalan	Jude	University of Canterbury
Kan	Wen-Fa (Regis)	University of Auckland
Kasim	Johanes Kevin	University of Auckland
Khanal	Kritika	University of Canterbury
Kim	Alex	University of Auckland
Kim	Irene	University of Auckland
King-Hudson	Te-Rina	University of Canterbury
Kneisel	Kiersten	Victoria University of Wellington
Koia	Sydnee	University of Canterbury
Kumar	Aditi	Victoria University of Wellington
Kumar	Saawan	University of Auckland
Lamba	Saurabh	University of Auckland
Li	Sheung Yin (Tony)	University of Auckland
Li	Zoey	University of Auckland
Lim	Keemi	University of Auckland
Lin	Chao Yang (Sunny)	Victoria University of Wellington
Lin	Crystal Yongqi	University of Auckland
Lin	Rolland	University of Auckland
Liu	Tianzhao	University of Canterbury
Liu	Yuge	University of Auckland
Lopes Cavalcante	Larissa	University of Otago
Luo	Dong	Massey University
Luong	Tuan Minh	University of Auckland
Ma	Chao	University of Auckland
Mahendra	Anmol	Victoria University of Wellington
Maisuria	Bavinesh	Victoria University of Wellington
Mak	Daniel	University of Canterbury
Malone	Niall	University of Auckland
Manayath Mary Das	Dona	University of Auckland
Manners	Sarah	University of Canterbury
Mao	Yubing	University of Auckland
Markwitz	Martin	Victoria University of Wellington
Marone-Hitz	Ombéline	University of Otago
Maslin	Thomas	University of Canterbury
Mathew	Romina	Auckland University of Technology
Mathew	Sneha	Auckland University of Technology
Matich	Olivia	Auckland University of Technology
Matinong	Andrea	Massey University
Matthewman	Emma	University of Auckland
Matthews	Brooke	University of Canterbury
Mautner	Ira Nathan (Cannon)	University of Auckland
McArdle	Sophie	University of Canterbury
McIntyre	Finn	University of Canterbury
McIntyre	Sam	University of Otago
Mendoza	Shaira	Victoria University of Wellington
Miller	Gillean	University of Auckland
Mills	Chris	University of Otago
Misiiuk	Kirill	University of Otago
Molloy	Ellen Diana	Victoria University of Wellington
Montoya Mejia	Jessica	University of Canterbury
Mooney	Roisin	Auckland University of Technology
Mujuni	Viator	Victoria University of Wellington
Mulimbayan	Francis	University of Auckland
Murali	Sai	Victoria University of Wellington
Murugan	Sri Varshini	Victoria University of Wellington
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Nally	Brianna	University of Otago
Neiman	Alex	University of Canterbury
Newton-Vesty	Michael	University of Canterbury
Nguyen	Hong Phan (Jenna)	Victoria University of Wellington
Nieke	Philipp	University of Auckland

Omeje	Kingsley	Victoria University of Wellington
O'Reilly	Andrea	Victoria University of Wellington
Otter	Sam	Victoria University of Wellington
Owens	Adrian	Auckland University of Technology
Palatkin	Nikita	University of Canterbury
Palpal-latoc	Dennise	University of Auckland
Pambudi	Agung Bagus	Victoria University of Wellington
Park	Kun Woo	University of Auckland
Park	Luke Hyung-Keun	University of Auckland
Patel	Brijeshkumar	Victoria University of Wellington
Patel	Hamesh	University of Auckland
Patel	Hamza	University of Auckland
Patel	Sahil Dineshbhai	University of Auckland
Patel	Shae	Victoria University of Wellington
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Peou	Patrick	University of Auckland
Petters	Ludwig	Massey University
Porritt	Harrison	University of Auckland
Posa	Luka	University of Auckland
Pot	Catherine	Victoria University of Wellington
Poudel	Pitambar	University of Canterbury
Prendergast	Peter	University of Canterbury
Qicheng	Zhang	University of Auckland
Raghavan	Harikrishnan	University of Canterbury
Rajchakit	Urawadee	University of Auckland
Ramezani	Ghazaleh	Victoria University of Wellington
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Rasheed	Mohammad (Zarar)	Victoria University of Wellington
Remoto	Peter	University of Otago
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Richardson	Georgia Mae	Victoria University of Wellington
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Roake	Quentin	Victoria University of Wellington
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Rokni	Mahsaalsadat	University of Auckland
Rosli	Zulfitri	University of Auckland
Sale	Sarah	University of Canterbury
Sarkar	Debolina	University of Canterbury
Schuurman	Joel Chris	University of Canterbury
Sheard	William	University of Auckland
Shehzad	Qayyum	Massey University
Shepperson	Oscar	University of Auckland
Shiraz	Fathumma Rizana	University of Auckland
Shumilov	Nikita	Victoria University of Wellington
Silk	Ryan	University of Auckland
Singh	Varinder	University of Otago
Siu	Christy	University of Auckland
Smith	Caitlin	University of Auckland
Smith	Finnian	Victoria University of Wellington
Smith	George	Victoria University of Wellington
Smith	Mark	University of Auckland
Smith	Nicholas	University of Otago
Sohail	Amir Ahmed	University of Otago
Soman	Arya	Victoria University of Wellington
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Steinmetz	Kai	University of Auckland
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Sullivan	Jovarn	University of Canterbury
Sun	Xin	University of Auckland
Sweet	Tylah	Victoria University of Wellington
Tan Fui Jie	Angie	University of Canterbury
Tang	Da	University of Auckland
Taylor	Ross	Victoria University of Wellington
Tian	Chengcai	University of Otago
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Tiffin	Campbell	University of Canterbury
Titheridge	Laura	University of Canterbury
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Trewick	Edward	Victoria University of Wellington
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van Koughnet	Kiri	Victoria University of Wellington
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Vella	Joe	University of Auckland
Verleijsdonk	Andrea	Massey University
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Vyborna	Natalija	University of Auckland
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Wong	Peter	University of Auckland
Wood	David	University of Canterbury
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Yang	Kourtney	University of Auckland
Yellapurkar	Ishita	University of Auckland
Yoon	Soongseok	University of Canterbury
Young	Eilidh	University of Auckland
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Board	Amanda	University of Canterbury
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Chan	Eddie	University of Auckland
Chaouche	Naila	University of Otago
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Dang	Giang	University of Canterbury
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Ding	Xiaobo	University of Auckland
Elliott	Alexander	University of Auckland
Furkert	Daniel	University of Auckland
Gai	Sinan	University of Otago
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Holmes-Hewett	William	Victoria University of Wellington
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Martinez Gazoni	Rodrigo	University of Canterbury
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Pandullo	Marco	Massey University
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Price	Mike	Victoria University of Wellington
Pu	Yuguang	University of Auckland
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Rennison	David	University of Auckland
Rooney	Jeremy	University of Otago
Rossa	Thais	University of Auckland
Ruffman	Charlie	University of Auckland
Sharma	Shailendra	University of Canterbury
Shearer	Heather	University of Canterbury
Sheridan	Hannah	University of Auckland
Sikorska	Celina	University of Auckland
Sun	Yiling	University of Canterbury
Sun-Waterhouse	Dongxiao	University of Auckland
Takaloo	Ashkan	University of Canterbury
Tayagui	Ayelen	University of Canterbury
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Tollemache	Cherie	University of Auckland
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Weissert	Lena	University of Auckland
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Yang	Wuxin	University of Auckland
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Zhang	Yao	Victoria University of Wellington
Zhu	Bicheng (Amy)	University of Auckland

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Bennington	Michael	University of Otago
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Burnett	Brydon	University of Auckland
Case	Samuel	University of Auckland
Casey-Stevens	Caitlin	Victoria University of Wellington
Clarke	Jordan	Victoria University of Wellington
Clyde	Daniel	University of Auckland
Cosgrove-Drayton	Saskia	Victoria University of Wellington
Dissanayake	Shama	University of Auckland
Dixon	Alex	University of Auckland
Ferguson	Alexander	University of Auckland
Girdwood	Megan	Victoria University of Wellington
Hackner	Luc	Victoria University of Wellington
Hedley	Gavin	University of Canterbury
Howlett	Katie	University of Auckland
Huata	Ringahora	Whakarewarewa Living Village
Hucklesby	James	University of Auckland
Hunter-Smith	Gabrielle	Victoria University of Wellington
Itumoh	Emeka	University of Auckland
Kolathodi	Muhamed Shareef	Victoria University of Wellington
Latham	Ben	Victoria University of Wellington
Limlamthong	Mutjalin (Lin)	Victoria University of Wellington
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Loretto	Alice	University of Auckland
Mandal	Ramkrishna	University of Otago
Matthews	Hannah	University of Auckland
Monteiro	Jaimy	Victoria University of Wellington
Montgomery	Niamh	University of Auckland
Mou	Alyssa	University of Auckland
Murali	Sai	Victoria University of Wellington
Nelson	Juliet	Victoria University of Wellington
Orr	Catherine	University of Canterbury
Pearcy	Aston	Victoria University of Wellington
Phillips	Tiernan	University of Auckland
Rani	Aakanksha	University of Auckland
Robb	Matthew	University of Otago
Russell	Maisie	University of Auckland
Siow	Andrew	University of Auckland
Stephens	Emily	Victoria University of Wellington
Sun	Zhiyuan (Jerry)	Robinson Research Institute
Victor	Oskar	Victoria University of Wellington
Wagner	Isabella	Victoria University of Wellington
Ward	Ciaran	University of Otago
Weal	Geoffrey	Victoria University of Wellington
Whyte	Vivien	University of Auckland
Wilson	Eva	Victoria University of Wellington
Wu	Jiazun	Victoria University of Wellington
Zhang	Zizhong (Victor)	Victoria University of Wellington

Journal covers

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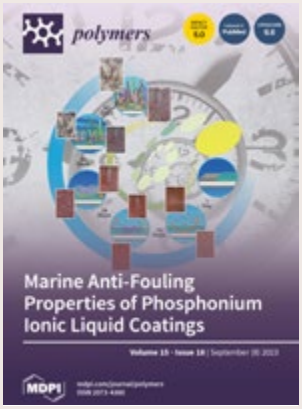

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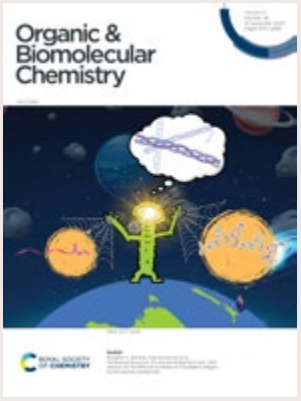

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AUTHORS	TITLE	JOURNAL
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Hagness, D.E., Yang, Y., **Tilley, R.D.** & Gooding, J.J.	The application of an applied electrical potential to generate electrical fields and forces to enhance affinity biosensors	*Biosensors and Bioelectronics* **238**, 115577 (2023)
Pearcy, A.C. & **Crowley, J.D.**	The Biologically Inspired Abilities of Metallosupramolecular Architectures	*Chemistry - A European Journal* **29**, e202203752 (2023)
Sun, X., Anema, S.G. & **Gerrard, J.A.**	The effect of dephosphorylation on the properties of αS1-casein enriched protein	*International Dairy Journal* **146**, 105744 (2023)
Siamaki, M., **Storey, J.G.**, Wiesehoefer, L. & Badcock, R.A.	The impact of magnetic field periodicity on the hysteresis loss in superconducting magnetic bearings	*Superconductivity* **5**, 100040 (2023)
Lin, B., Nair, S., Fellner, D.M.J., Nasef, N.A., Singh, H., Negron, L., Goldstone, D.C., **Brimble, M.A.**, **Gerrard, J.A.**, **Domigan, L.**, Evans, J.C., Stephens, J.M., Merry, T.L. & Loomes, K.M.	The Leptospermum scoparium (Mānuka)-Specific Nectar and Honey Compound 3,6,7-Trimethyllumazine (LepteridineTM) That Inhibits Matrix Metalloproteinase 9 (MMP-9) Activity	*Foods* **12**, 4072 (2023)
Yin, Z., Liu, X., Guo, L., Ren, M., Kang, W., Ma, C., **Waterhouse, G.I.N.** & Sun-Waterhouse, D.	The potential of dietary fiber in building immunity against gastrointestinal and respiratory disorders	*Critical Reviews in Food Science and Nutrition*, 1-19 (2023)
Mckerchar, H.J., Lento, C., Bennie, R.Z., Crowther, J.M., Dolamore, F., Dyer, J.M., Clerens, S., Mercadante, D., Wilson, D.J. & **Dobson, R.C.J.**	The protein dynamics of bovine and caprine β-lactoglobulin differ as a function of pH	*Food Chemistry* **408**, 135229 (2023)
Krieger, E.C., Nelson, W.A., Grand, J., **Le Ru, E.C.**, Bury, S.J., Cossais, A., Davy, S.K. & Cornwall, C.E.	The role of irradiance in controlling coralline algal calcification	*Limnology and Oceanography* **68**, 1269-1284 (2023)

AUTHORS	TITLE	JOURNAL
Winkler, R. & **Zülicke, U.**	Theory of electric, magnetic, and toroidal polarizations in crystalline solids with applications to hexagonal lonsdaleite and cubic diamond	*Physical Review B* **107**, 155201 (2023)
Weir, G., Trompetter, W., **Leveneur, J.**, Long, N., Turner, J. & **Kennedy, J.**	Theory of low loss minor loops in soft magnetic composites	*Journal of Magnetism and Magnetic Materials* **588**, 171411 (2023)
Tallon, J.L. & **Storey, J.G.**	Thermodynamics and the pairon model for cuprates	*Physical Review B* **107**, 054507 (2023)
Banerjee, S., Ballmann, G.M., Evans, M.J., O'Reilly, A., Kennedy, A.R., **Fulton, J.R.**, **Coles, M.P.** & Mulvey, R.E.	Three Oxidative Addition Routes of Alkali Metal Aluminyls to Dihydridoaluminates and Reactivity with CO2	*Chemistry - A European Journal* e202301849 (2023)
Chen, Y., Sun, Y., Pang, X., Wang, R., **Waterhouse, G.I.N.** & Xu, Z.	Three-dimensional dual-network magnetic conductive hydrogel for the highly sensitive electrochemical detection of ponceau 4R in foods	*Biosensors and Bioelectronics* **241**, 115698 (2023)
Governale, M. & Taddei, F.	Topological-insulator nanocylinders	*SciPost Physics Core* **6**, 32 (2023)
Kim, I.J., Pilkington, L.I. & **Barker, D.**	Total Synthesis of Linear Coumarniolignoids (+) and (−)-Sapiumin C, (−)-Moluccanin, and (−)-Hemidesminine	*Journal of Organic Chemistry* **88**, 5900-5912 (2023)
Arman, S., Gonçales, V.R., Yang, Y., **Tilley, R.D.**, Gaus, K. & Gooding, J.J.	Toward development of dual optical and electrical cell-based biosensor: An investigation on electrode geometry and transparent conductive material function	*Electroanalysis* **35**, e202300124 (2023)
Taylor, R.W., Pantoja, A.E., Hlasek, T., Plechacek, J., Weijers, H.W., Ainslie, M.D. & **Bumby, C.W.**	Transport Current Measurement of Ic(T, B,θ) and n(T, B,θ) for a Bulk REBCO Superconductor	*IEEE Transactions on Applied Superconductivity* **33**, 1-6 (2023)
Murali, S.S., Gallaher, J.K., Janiseck, C., Tay, E.J., Wagner, I., Thorn, K.E., Ilina, A., Tamming, R.R., Wang, J., Sester, C., Sutton, J.J., Price, M.B., **Gordon, K.C.**, **Chen, K.**, Zhan, X., **Hodgkiss, J.M.** & Hume, P.A.	Triplets with a Twist: Ultrafast Intersystem Crossing in a Series of Electron Acceptor Materials Driven by Conformational Disorder	*Journal of the American Chemical Society* **145**, 732-744 (2023)
Brett, M.W., Price, M.B., Gordon, C.K., Thorn, K.E., Browne, L.D., Hume, P.A., **Hodgkiss, J.M.**, Stocker, B.L., Timmer, M.S.M. & **Davis, N.J.L.K.**	Tuneable emission in single molecule dyads mediated by a charge transfer state	*Physical Chemistry Chemical Physics* **25**, 18990-18997 (2023)
Chen, Z., Wang, J., Hao, M., Xie, Y., Liu, X., Yang, H., **Waterhouse, G.I.N**., Wang, X. & Ma, S.	Tuning excited state electronic structure and charge transport in covalent organic frameworks for enhanced photocatalytic performance	*Nature Communications* **14**, 1106 (2023)
Nguyen, D.H.T., Utama, R.H., Tjandra, K.C., Suwannakot, P., Du, E.Y., Kavallaris, M., **Tilley, R.D.** & Gooding, J.J.	Tuning the Mechanical Properties of Multiarm RAFT-Based Block Copolyelectrolyte Hydrogels via Ionic Cross-Linking for 3D Cell Cultures	*Biomacromolecules* **24**, 57-68 (2023)
Heenan, A.R., Sharma, S.K. & **Marshall, A.T.**	Turning copper into gold — Tuning a gas diffusion electrode catalyst for the efficient conversion of CO2 to C2H4 or CO	*Electrochimica Acta* **467**, 143097 (2023)
Ye, J., Arul, R., **Nieuwoudt, M. K.**, Dong, J., Zhang, T., Dai, L., Greenham, N. C., Rao, A., Hoye, R. L. Z., Gao, W. & **Simpson, M. C.**	Understanding the Chemical Mechanism behind Photoinduced Enhanced Raman Spectroscopy	*The Journal Of Physical Chemistry Letters* **14**, 4607-4616
Miller, J.D., **Trodahl, H.J.**, Al Khalfioui, M., Vézian, S. & **Ruck, B.J.**	Unlocking perpendicular magnetic anisotropy with Gd substitution in SmN	*Applied Physics Letters* **122**, 092402 (2023)
Zhang, Y., Cortie, D., Lagrange, T., Lee, W., Butler, T., Ludbrook, B. & **Granville, S.**	Unraveling the sign reversal of the anomalous Hall effect in ferromagnet/heavy-metal ultrathin films	*Physical Review B* **107**, 094408 (2023)
Zhu, J., Mu, M., Liu, Y., Zhang, M., Zhang, G., Cheng, Z., Hang Yin, B., **Yip, A.C.K.**, Song, C. & Guo, X.	Unveiling the promoting effect of potassium on the structural evolution of iron catalysts during CO2 hydrogenation	*Chemical Engineering Science* **282**, 119228 (2023)
Christopher, T.D., Zhang, T., Huang, S., Zujovic, Z., Avdeev, M., **Cao, P.** & **Söhnel, T.**	Using neutron diffraction to explore lithium displacement within cubic phase stabilised Ga-doped Li6.75La3Zr1.75Ta0.25O12 lithium garnet oxides	*Journal of Alloys and Compounds* **968**, 172078 (2023)
Mallett, B., Zhang, Y., Pot, C., Van Koughnet, K., Stanley, B., **Buckley, R.G.**, Koo, A., Yin, Y., Medhekar, N.V. & **Granville, S.**	Using optical spectroscopy to probe the impact of atomic disorder on the Heusler alloy Co2MnGa	*Physical Review Materials* **7**, 094203 (2023)
Zubair, M., Kumar, P., Klingenhof, M., Subhash, B., Yuwono, J.A., Cheong, S., Yao, Y., Thomsen, L., Strasser, P., **Tilley, R.D.** & Bedford, N.M.	Vacancy Promotion in Layered Double Hydroxide Electrocatalysts for Improved Oxygen Evolution Reaction Performance	*ACS Catalysis* **13**, 4799-4810 (2023)

AUTHORS	TITLE	JOURNAL
Zhang, R., Smit, A.K., Espinoza, D., **Allen, M.**, Reyes-Marcelino, G., Kimlin, M.G., Lo, S.N., Sharman, A.R., Law, M.H., Kanetsky, P.A., Mann, G.J. & Cust, A.E.	Validation of self-reported sun exposure against electronic ultraviolet radiation dosimeters	*International Journal of Epidemiology* **52**, 324-328 (2023)
Broom, M. & **Willmott, G.R.**	Water drop impacts on regular micropillar arrays: Asymmetric spreading	*Physics of Fluids* **35**, 077120 (2023)
Brett, M.W., Nass, L.C., Gordon, C.K., Browne, L.D., Stocker, B.L., Price, M.B., Timmer, M.S.M. & **Davis, N.J.L.K.**	Wavelength Dependent Photoluminescence Efficiency Enhancement in PbS/CdS Quantum Dot Hybrid Systems via Novel Tetracene-Based Chromophore Ligands	*Journal of Physical Chemistry C* **127**, 21585-21592 (2023)
O'Neil, A.T., Chalard, A., **Malmström, J.** & **Kitchen, J.A.**	White light and colour-tunable emission from a single component europium-1,8-naphthalimide thin film	*Dalton Transactions* **52**, 2255-2261 (2023)
McArdle, S. & **Marshall, A.T.**	Why electrode orientation and carbon felt heterogeneity can influence the performance of flow batteries	*Journal of Power Sources* **562**, 232755 (2023)
Sharma, S. K., Johannessen, B., **Golovko, V. B.** & **Marshall, A. T.**	X-ray Absorption Spectroscopy of Phosphine-Capped Au Clusters	*Inorganics* **11**, 191 (2023)
Schuyt, J.J. & **Williams, G.V.M.**	X-ray dose imaging using the optically stimulated luminescence of a NaMgF3:Mn/epoxy composite and CCD camera readout	*Sensors and Actuators A: Physical* **361**, 114576 (2023)
Nye, L., **Telfer, S.G.** & Turnbull, M.M.	μ-1,6-Dioxo-1,6-diphenylhexane-3,4-diolato-bis[(2,2'-bipyridine)chloridocopper(II)] dihydrate	*IUCrData* **8** (2023)

Books

AUTHORS	BOOK TITLE	PUBLISHER
Gaston, N.	*Superatoms: An Introduction*	CRC Press

Book chapters

AUTHORS	CHAPTER TITLE	BOOK TITLE	PUBLISHER
Osypenko, A. Ashraf, A. Pozhydaiev, V. Babak, M.V. & **Hanif, M.**	15.09 - Organometallic Chemistry of Anticancer Ruthenium and Osmium Complexes	*Comprehensive Organometallic Chemistry IV: Volume 1-15*	Elsevier
Coles, M.P.	Chain, ring, and cluster compounds of group 15 elements (P, As, Sb, Bi)	*Comprehensive Inorganic Chemistry III, Third Edition*	Elsevier
Lo, S., Ren, C.Z.-J., Solís-Muñana, P. & **Chen, J.L.-Y.**	Dynamic Self-assembled Supramolecular Catalysts	*Supramolecular Nanotechnology: Advanced Design of Self-Assembled Functional Materials: Volumes 1-3*	Wiley
Watkin, S.A.J., Hashemi, A., Thomson, D.R., Pearce, F.G., **Dobson, R.C.J.** & **Nock, V.M.**	Laminar flow-based microfluidic systems for molecular interaction analysis—Part 1: Chip development, system operation and measurement setup	*Methods in Enzymology*	Academic Press Inc
Watkin, S.A.J., Hashemi, A., Thomson, D.R., **Nock, V.M.**, **Dobson, R.C.J.** & Pearce, F.G.	Laminar flow-based microfluidic systems for molecular interaction analysis—Part 2: Data extraction, processing and analysis	*Methods in Enzymology*	Academic Press Inc
Bissember, A.C., Wales, S.M., Hawkins, B.C., **Chen, J.L.-Y.**, Petersen, W.F., Tague, A.J., Fleming, C.L., Cording, A.P., Bhana, A.D., Johnstone, M.D. & Shephard, J.P.	Seven-membered rings	*Progress in Heterocyclic Chemistry*	Elsevier

Conference papers

AUTHORS	TITLE OF CONFERENCE PAPER	TITLE OF PROCEEDINGS
Tayagui, A., Sun, Y., Garrill, A. & **Nock, V.**	A Microfluidic Oxygen Gradient Generator for the Study of Aerotropism in Hyphae of Oomycetes	*2023 IEEE 36th International Conference on Micro Electro Mechanical Systems (MEMS)*
Platt, I. G., Eccleston, K. W., Tan, A.E.-C., Anton, E., **Nelson, J.** & Woodhead, I. M.	Allowing for Refraction in Back Propagation	*2023 IEEE Conference on Antenna Measurements and Applications (CAMA)*
McIntyre, F., Sellier, M., Gooch, S., **Nock, V.** & Sharplin, N.	Applications of Rotational Manipulators in the Manufacture and Characterization of Highly Curved Thin Films	*Proceedings of the 24th International Conference on Engineering Design (ICED 2023)*
van Breugel, S.J., Low, I., Christie, M.L., Pokorny, M.R., Holtkamp, H.U., **Nieuwoudt, M.K.**, **Simpson, M.C.**, Zargar-Shoshtari, K. & Aguergaray, C.	Classification of clinically significant prostate cancer using Raman spectroscopy and Support Vector Machine classification	*2023 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC)*
Yin, B.H., Mendoza, S., Rumsey, B., Iwasaki, Y., Lynch, M., McCurdy, M. & **Bumby, C.W.**	Driving the transformation to hydrogen ironmaking: an experimental vertical shaft H2-DRI reactor facility in NZ	*Proceedings of the AUSIMM Iron Ore Conference 2023, (Perth, Sept 2023)*
Mak, D., Hashemi, A., Meffan, C., Menges, J., Meijer, H., Abeille, F., Blom, M.T., **Dobson, R.** & **Nock, V.**	Dual-gate and other capillary field effect transistor design improvements for increased switching speed, sealing efficacy, and liquid viscosity range	*Proceedings of the 22nd International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers 2023)*
Smith, C. , **Shepherd, J.** , Renaud, G. & van Wijk, K.	Evaluation of Photoacoustic and Ultrasound Vector Flow Imaging for Slow Flow	*IEEE International Ultrasonics Symposium, 2023*
Platt, I. G., Eccleston, K. W., Anton, E. & **Nelson, J.**	Experimental Imaging of Meat and Bone Samples Using a Negative-Refractive-Index Lens	*2023 IEEE Conference on Antenna Measurements and Applications (CAMA)*
Mesic, B. & **Johnston, J.H.**	Flexographic multilayering of conventional latex-based dispersion coatings containing small dose of silica nanoparticles: Runnability on a pilot scale and barrier performance	*TAPPICon 2023 - "Rock the Roll: Unleashing the Harmonies of the Paper Industry"*
Tan, A.E.-C., Platt, I., Hayward, A., **Nelson, J.**, Eccleston, K.W. & Anton, E.	High Gain Microstrip Patch Antenna as Illuminating Source for Near Field Imaging	*2023 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting (USNC-URSI)*
Maisuria, B., Prabowo, S., Del Puerto, D., Longbottom, R.J., Monaghan, B.J. & **Bumby, C.W.**	Hydrogen reduction of as-received and pre-oxidised NZ titanomagnetite ironsands in a small-scale high-temperature fluidised bed	*Proceedings of the AUSIMM Iron Ore Conference 2023, (Perth, Sept 2023)*
van Breugel, S.J., Low, I., Christie, M.L., Pokorny, M.R., Holtkamp, H.U., **Nieuwoudt, M.K.**, **Simpson, M.C.**, Zargar-Shoshtari, K. & Aguergaray, C.	Inclusive development of Raman-based prostate cancer diagnostic device: lessons from an ethnically-diverse clinical trial	*2023 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC)*
Carlisle, N., **Williams, M.A.K.**, **Whitby, C.P.**, **Nock, V.**, **Chen, J.L.Y.** & **Avci, E.**	Manipulation of Optical Force-Induced Micro-Assemblies at the Air-Liquid Interface	*Proceedings of the 37th IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023)*
Mendoza, S., **Yin, B.H.**, Zhang, A., Nusheh, M. & **Bumby, C.W**	Pelletisation of New Zealand titanomagnetite ironsand for hydrogen direct reduction	*Proceedings of the AUSIMM Iron Ore Conference 2023, (Perth, Sept 2023)*
Smith, C., **Shepherd, J.**, van Wijk, K. & Renaud, G.	Photoacoustic method for quantifying blood flow in bone	*Photons Plus Ultrasound: Imaging and Sensing 2023. SPIE, 2023*
Bishop, H., Tayagui, A., Sun, Y., Garrill, A. & **Nock, V.**	Pillar Centroid Tracker for the Measurement of Protrusive Forces Generated by Hyphal Microorganisms	*Proceedings of the 38th International Conference on Image and Vision Computing New Zealand (IVCNZ 2023)*
Mak, D., Meffan, R.C., Menges, J., Dolamore, F., Fee, C., **Dobson, R.C.J.** & **Nock, V.**	Self-Driven Capillaric Viscometer for Direct or Cascaded Bar Graph Read-Out of Relative Sample Viscosity	*2023 IEEE 36th International Conference on Micro Electro Mechanical Systems (MEMS)*
Jameson, G.B., Harjes, S., Kurup, H.M., Bayarjargal, M., Filitcheva, J., Su, Y., Hale, T.K., Filichev, V.V., & Harjes, E.	Structural basis of modified DNA inhibitors that competitively restrict DNA-editing activity of APOBEC3A	*Deaminet-4: International conference on base editing enzymes and applications (22-24 January 2023)*
Mallinson, J. B. & **Brown, S. A.**	Time-multiplexed Reservoir Computing with Percolating Networks of Nanoparticles	*Proceedings of the International Joint Conference on Neural Networks, Gold Coast, Australia, 18-23 June 2023*
Erkintalo, M., **Gaston, N.**, Hutchinson, D. A. W., **Plank, N. O. V.**, **Simpson, M. C.** & Vanholsbeeck, F.	What is it like to be a woman in physics in Aotearoa–New Zealand?	*AIP Conference Proceedings*

Keynote and invited speaker addresses

NAME	DETAILS
Ebu Avci	The 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2023), Detroit, USA, 1 October 2023. “Gut Microbiota and Robotic Capsules”
Diane Bradshaw	NZ Archaeological Association Annual Conference, Hamilton, New Zealand, 3-7 July 2023. “Te Puna o Korotangi - Archaeological and Heritage Perspectives on Contemporary Issues”
	ACS Congress Indianapolis, Indianapolis, USA, 26-30 March 2023. “Ernest Guenther Award in the Chemistry of Natural Products”
	Invited speaker at the 13th International Peptide Symposium, Brisbane, Australia, 15-20 October 2023. “Applications of cysteine lipidation “CLipPA” technology: drugs, vaccines and biomaterials”
Sally Brooker	Invited speaker at the 17th International Symposium on Supramolecular and Macrocyclic Chemistry, Reykjavik, Iceland, 25-29 June 2023. "Macrocyclic catalysts for hydrogen production and carbon dioxide reduction"
	Plenary speaker at the Southern Highlands Conference on Heterocyclic Chemistry, Kiama, Australia, 27-29 August 2023. "Designer heterocyclic ligands for spin crossover and catalytic production of hydrogen"
	Keynote speaker at Network 4 Sustainable Nanotechnology (N4SN) Global Summit UNSDG 7: Affordable and Clean Energy, Sydney, Australia, 27-29 November 2023. "He Honoka Hauwai / German New Zealand Green Hydrogen centre for research, networking and outreach"
Simon Brown	International Conference on Metallurgical Coatings and Thin Films (ICMCTF), San Diego, USA, 21-26 May 2023. “Computing with Percolating Networks of Nanoparticles”
	International Symposium on Small Particles and Inorganic Clusters ISSPIC XXI, Berlin, Germany, 3-8 September 2023. “Computing with Percolating Networks of Nanoparticles”
	6th International Conference on Memristive Materials, Devices & Systems, Torino, Italy, 5-9 November 2023. “Computing with Percolating Networks of Nanoparticles”
Chris Bumby	H2 2 Zero Summit 2023, Wellington, New Zealand, 7-8 September 2023. “Developing a hydrogen steelmaking process for NZ”
Martyn Coles	International Conference on Main Group Synthesis and Catalysis (ICMGSC-2023), Thiruvananthapuram, India, 9-12 February 2023. “Bond Forming Reactions Promoted by Aluminyl Anions”
	Twentieth International Conference on Biological Inorganic Chemistry (ICBIC) & Royal Australian Chemical Institute - Inorganic Chemistry IC23, Adelaide, Australia, 16-21 July 2023. “Heterometallic low-symmetry metallosupramolecular cages: Self-assembly, switching and molecular recognition”
	NZSBMB 50th Anniversary Conference, Hanmer Springs, New Zealand, 28 November-1 December 2023. “Regulation of amino-sugar metabolism in Streptococcus pneumoniae”
	10th Asia-Pacific Association of Theoretical and Computational Chemistry Conference (APATCC), Quy Nhon, Vietnam, 19-23 February 2023. “Atomistic self-assembly of nanostructure in liquid metals”
Keith Gordon	International Conference on Science and Technology of Pharmaceutical Glasses, National Institute for Materials Science, Tsukuba, Japan, 10 August 2023. “Low frequency Raman spectra to detect glass transitions”
	Invited speaker at the 9th International Discussion Meeting on Relaxations in Complex Systems (9IDMRCS), Makuhari Messe, Chiba, Japan, 12-18 August 2023. “Detecting local glass-transition temperatures in amorphous materials with low frequency Raman spectroscopy”
	12th International Conference on Advanced Vibrational Spectroscopy (ICAVS12), Krakow, Poland, 27 August – 1 September 2023. “Probing chemical speciation with low-frequency Raman spectroscopy”
	8th Asian Spectroscopy Conference (ASC2023), Nigata, Japan, 3-7 September 2023. “The tuning of ILCT and MLCT excited states in rhenium(I) complexes as probed by time-resolved spectroscopy”
	SciX 2023, Sparks, Nevada, USA, 8-13 October 2023. “A retrospect of spectroscopic studies on dipyridophenazine - from Queens University Belfast to Los Alamos to the University of Otago New Zealand”
Justin Hodgkiss	10th International Conference on Advanced Materials & Nanotechnology (AMN 10), Rotorua, New Zealand, 7-10 February 2023. “Photoprotection mechanism in the black-brown pigment eumelanin”
Patricia Hunt	MM2023 (the biannual meeting of the Association of Molecular Modellers of Australasia), Wollongong, Australia, 7-10 December. “Ionic Liquid Solvent Effects for Non-Polar Reactions”

Derek Kawiti	Keynote speaker at International Standards Organisation Annual Meeting 2023, Brisbane, Australia, 18-22 September 2023. “Preserving Paradise: Climate Adaptation for Vulnerable Islands”
Erin Leitao	106th Canadian Chemistry Conference & Exhibition (CCCE) Vancouver, Canada, 4-8 June 2023. “The synthesis and use of siloxane cross-linked polysulfide sorbents
Jenny Malmström	ASBTE2023, Christchurch, New Zealand, 16-18 April 2023. “Designing biointerfaces with spatiotemporal control over mechanical properties”
Steven Matthews	12th Asian Thermal Spray Conference, Madras, India, 2–4 November 2023. “Thermally induced transitions in thermal spray coatings produced from a commercial Cr-Ni-C atomised feedstock powder”
Charles Unsworth	Australian Brain Cancer Research Alliance (ABCARA) Scientific Research Symposium, Sydney, Australia, 8 October 2023. “Understanding how Aggressive Adult Brain Cancer Talks”
Geoff Waterhouse	Plenary speaker at the 11th International Symposium of Food Science, Nanjing, China, 6-8 August 2023. “Applications of Nanotechnology in Sensing, Separations, Agriculture and Therapies”
	Plenary speaker at the 3rd Food Chemistry Conference: Shaping a healthy and sustainable food chain through knowledge, Dresden, Germany, 10-12 October 2023. “Applications of Nanotechnology in Sensing, Separations, Agriculture and Therapies”
Catherine Whitby	Chem2023 Conference, Melbourne, Australia, 24-26 October 2023. “My journey doing colloid and surface chemistry”
Jadranka Travas-Sejdic	Invited speaker at the 10th International Conference on Advanced Materials & Nanotechnology (AMN 10), Rotorua, New Zealand, 7-10 February 2023. “Novel conducting polymers biointerfaces for bioelectronics”
	Invited speaker at the 11th International Conference on Materials for Advanced Technologies (ICMAT2023), Singapore, 26-30 June 2023. “Biomimetic Conducting Polymers for Bioelectronics”
	Invited speaker at the 35th Topical Meeting of the International Society of Electrochemistry, Gold Coast, Australia, 7 - 10 May 2023. “Electrically Addressable Biointerfaces”
	Invited speaker at the 14th International Conference on Surfaces, Coatings and Nanostructured Materials (NANOSMAT2023), Athens, Greece, 10-14 July 2023. “Novel Conducting Polymers for Bioelectronics and Isolation of Cancer Biomarkers”
	Invited speaker at the 2023 MRS Fall Meeting and Exhibit, Boston, Massachusetts, USA, November 26 – December 1 2023. “Conducting Polymers Biointerfaces for Bioelectronics”

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