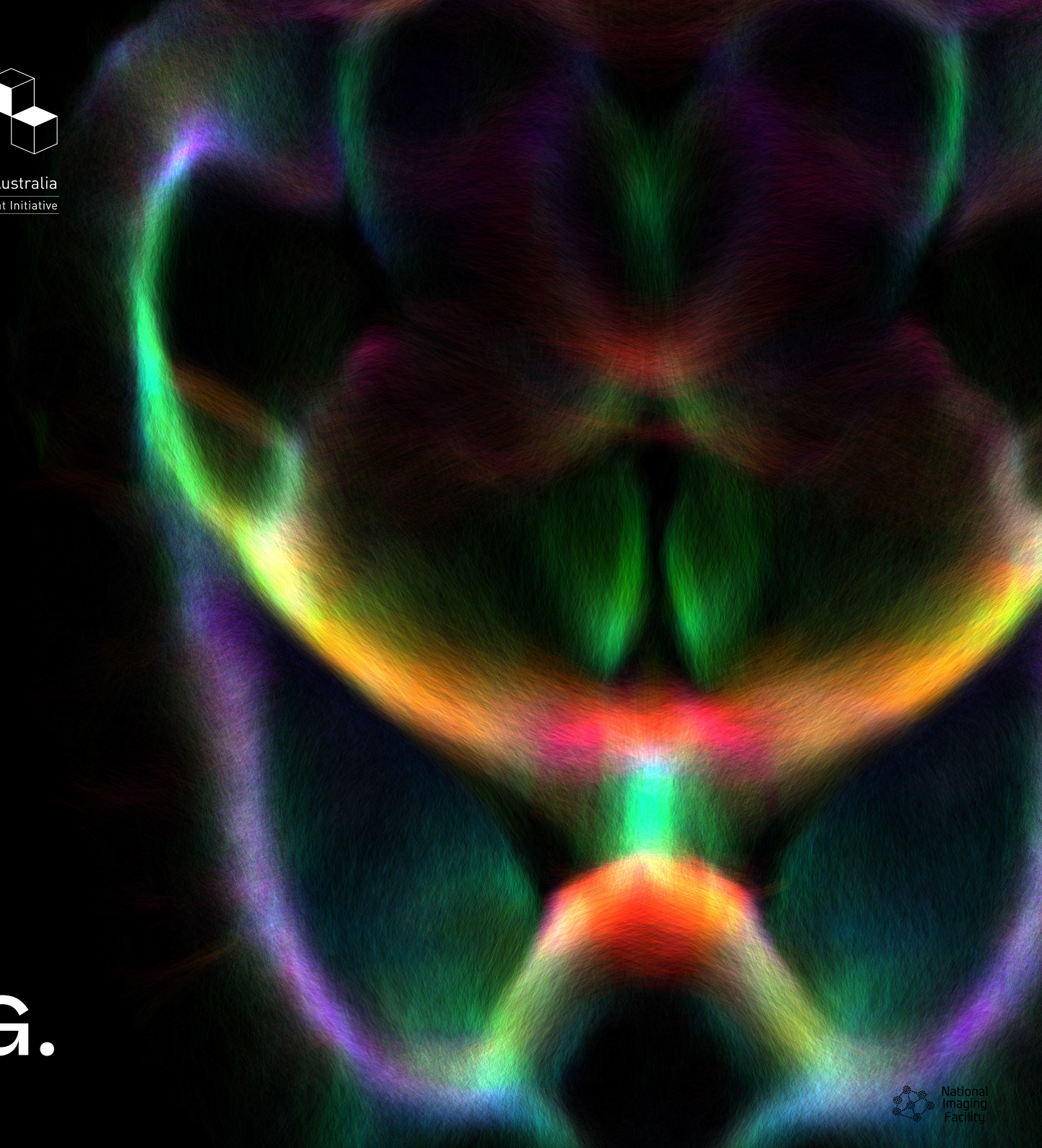
National Imaging Facility

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative



BECAUSE SEEING CHANGES EVERYTHING.

National Imaging Facility

CONTENTS

STRATEGY, IMPACT AND FUTURE

Our vision:

Enable Australian imaging science to unlock solutions to major challenges.

Our mission:

Make cutting-edge imaging capabilities accessible to Australian medical researchers, materials and agriculture scientists, enabling them to solve challenges across research and industry

This document outlines the way National Imaging Facility contributes to Australian wellbeing and outlines our future priorities.

Throughout we illustrate the way NIF addresses the challenges identified in the National Research Infrastructure Roadmap 2021. NIF focuses on Medical Products, but makes valuable contributions in Food and Beverage, Frontier Technologies and Modern Manufacturing and Resource Technology and Critical Minerals.

AUSTRALIA'S ADVANCED IMAGING NETWORK

We provide open access to flagship imaging equipment, expertise, tools, data and analysis. We address Australia's strategic science and research priorities, and this benefits Australian industry and helps keep Australians healthy.

What we do

NIF provides a full suite of advanced imaging capability including preclinical and clinical, human and animal imaging, radiochemistry, and imaging data analysis.

We focus on health and medical innovation, and also provide highly specialised capabilities for agriculture, materials science, museums and cultural applications.

We are the experts in developing new imaging technologies, processing and interpreting imaging data, and applying imaging to solve complex problems.

Our expertise, equipment and services are critical to Australia's ability to translate health discoveries, undertake clinical trials and commercialise medical products.

How we work

NIF partners with state-of-the-art imaging projects led by teams with world-class capabilities. We operate efficiently at a national level, share innovative ideas and deep expertise, and work collaboratively across the research, health, innovation and industry sectors.

We partner with people who can translate their discoveries into real-world applications.

Our impact

NIF is unlocking solutions to the world's biggest imaging challenges across commercial, clinical and research fields. We have helped Australians innovate in fields such as bioengineering, clinical science, biology, medical technology, pharmaceutical and non-pharmaceutical therapies, agriculture, materials, museums and cultural collections.

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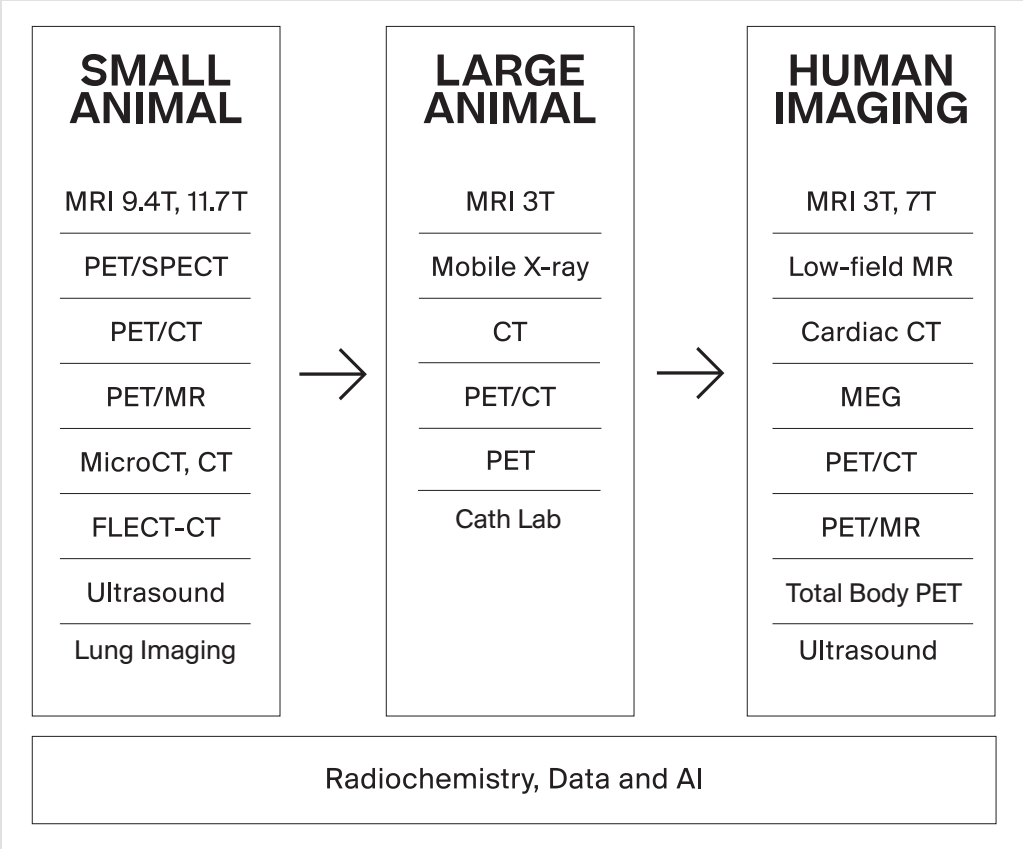
HELPING TRANSLATE DISCOVERIES TO MEDICAL BENEFITS AND PRODUCTS

Thousands of scientists, doctors, and professionals across hundreds of Australian institutions, companies and research organisations use our work to help answer their medical research questions. We also work with engaged volunteers and patients who make a valuable contribution to health and discovery by being part of research.

Our capabilities span the continuum of small and large animal imaging, to human imaging—allowing researchers to translate fundamental research to improvements in human health.

Within our themes, we offer many types of biomedical imaging, including magnetic resonance imaging (MRI), positron emission tomography (PET), X-ray computed tomography (CT), ultrasound and more.

Our work forms the basis for preclinical trials for in vivo models and large-scale, multi-site clinical human trials. Importantly, NIF is at the leading edge of developing Australia's capability, both experimentally and theoretically, to address any new challenges and applications that use biomedical imaging for medical research.



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NIF BY THE NUMBERS in 2020

2,558 researchers from **1,100** facilitated projects across **105** organisations

1,691 new users trained

146 clinical trials supported

30,060 hours of instrument time used

34 fellows providing world-class expertise across imaging, data science and radiochemistry

55 open access instruments across **13** different sites

3/3 Number of funded Medical Research Future Fund Frontiers 2020 projects that are associated with NIF facilities

NIF consists of expertise, technology, national-reach, and interdisciplinary Practices

National Imaging Facility

THE NATIONAL IMAGING FACILITY STRATEGY

Drivers: World-leading imaging technology magnifies the productivity and impact of outstanding researchers, but it is sophisticated and difficult to use, requiring human operators with deep imaging expertise.

Expertise goal: Expand Australia's world-leading community of imaging experts and users

Action E1 Coordinate expertise and infrastructure to support leading national researchers and clinicians.

Action E2 Develop expertise to make imaging applicable across disciplines, institutions and communities.

Action E3 Nurture Australia's next generation of world leaders in imaging research.

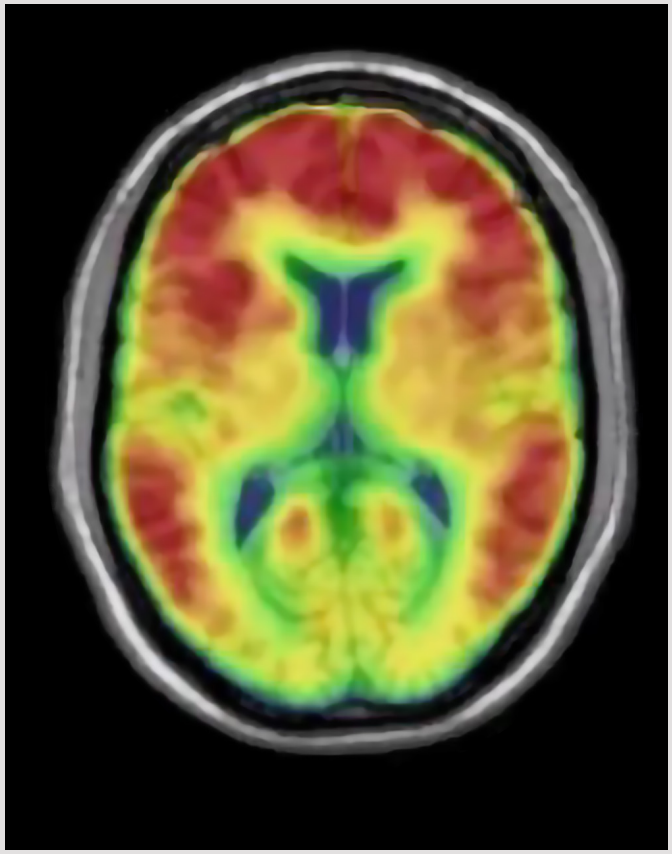
Drivers: Breakthrough hardware and advances in machine learning are transforming imaging technology globally. This is accelerating scientific discovery and its translation to impact.

Technology Goal: Keep Australia at the forefront of imaging technology and imaging data analytics

Action T1 Scope, map and develop transformative imaging technologies.

Action T2 Ensure Australia is at the cutting edge in applying data science to imaging.

Action T3 Prioritise investments for innovation and international comparative advantage.



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Drivers: Imaging has become a core technology for research translation at a time when Australian and state governments have developed a strong policy focus on impact.

Impact Goal: Deploy imaging capabilities to support translation, clinical trials and commercialisation

Action I1 Empower impact-focused teams in imaging science, health, agriculture, and materials science.

Action I2 Increase integration between basic science, applied science and clinical research by applying imaging.

Action I3 Foster partnerships with industry and end users.

Drivers: As imaging technologies increase in scale and complexity, national coordination and distributed tools are critical for making cutting-edge capabilities affordable and accessible across the country.

Coordination Goal: Maximise NIF's impact by operating as an integrated, national-scale platform

Action C1 Increase accessibility for all Australian researchers and clinicians.

Action C2 Create single 'front door' for users and standardise practices across NIF.

Action C3 Share knowledge, expertise, data and sustainable business models among NIF's nodes.

Drivers: The power of modern imaging is precipitating rising demand for imaging capabilities across science, medicine and industry, but effectively implementing imaging technologies requires strong partnerships.

Partnership Goal: Ensure that NIF has the partnerships to deliver on its vision

Action P1 Nurture relationships with government and contribute constructively to policy.

Action P2 Build bridges to diverse communities and develop non-government funding streams.

Action P3 Enhance other parts of the Australian research ecosystem.

IMAGING FOR IMPACT

THE NATIONAL IMAGING FACILITY UNDERPINS FOUR OF AUSTRALIA'S RESEARCH INFRASTRUCTURE ROADMAP THEMES: MEDICAL PRODUCTS, FRONTIER TECHNOLOGIES AND MODERN MANUFACTURING, FOOD AND BEVERAGE AND RESOURCE TECHNOLOGY AND CRITICAL MINERALS

		Medical Products	Frontier Technologies and Modern Manufacturing	Food and Beverage	Resources Technology and Critical Minerals Processing
Better evidence for decision-making in health	Advanced imaging methods and analysis provide critical evidence for decision-making—for example, imaging facial nerves affected by melanomas—across all aspects of health and clinical science to keep Australia healthy.	●	●		
New diagnostics and therapies combined	New-generation nuclear therapies where imaging-based diagnosis and treatment is combined and delivered together (called 'theranostics') are revolutionising cancer therapy, such as high-grade brain cancer treatments.	●	●		
Better health for the young and older Australians	Imaging studies that look at conditions in younger and older Australians—such as detecting dementias or drug effects during pregnancy—are essential for understanding and promoting healthy development and ageing.	●			
Equitable regional and rural health	Crucial to societal equity and research quality, delivering a geographically distributed network of advanced imaging to support research and personalised medicine, and taking part in medical trials, is a major national challenge.	●			
Growing use of imaging in agriculture and ecology	Imaging is accelerating as an important capability for agricultural and ecological sciences; for example, imaging how roots use phosphorus in nutrient-poor soils without destroying them.		●	●	
Critical contributions to materials, engineering and culture	Many varied industrial and research problems—such as chemical processes, materials science, environmental and ecosystems research, security, palaeontology and cultural preservation—are increasingly opening up to the benefits of advanced imaging technologies.		●		●

National Imaging Facility

BETTER EVIDENCE FOR DECISION-MAKING IN HEALTH

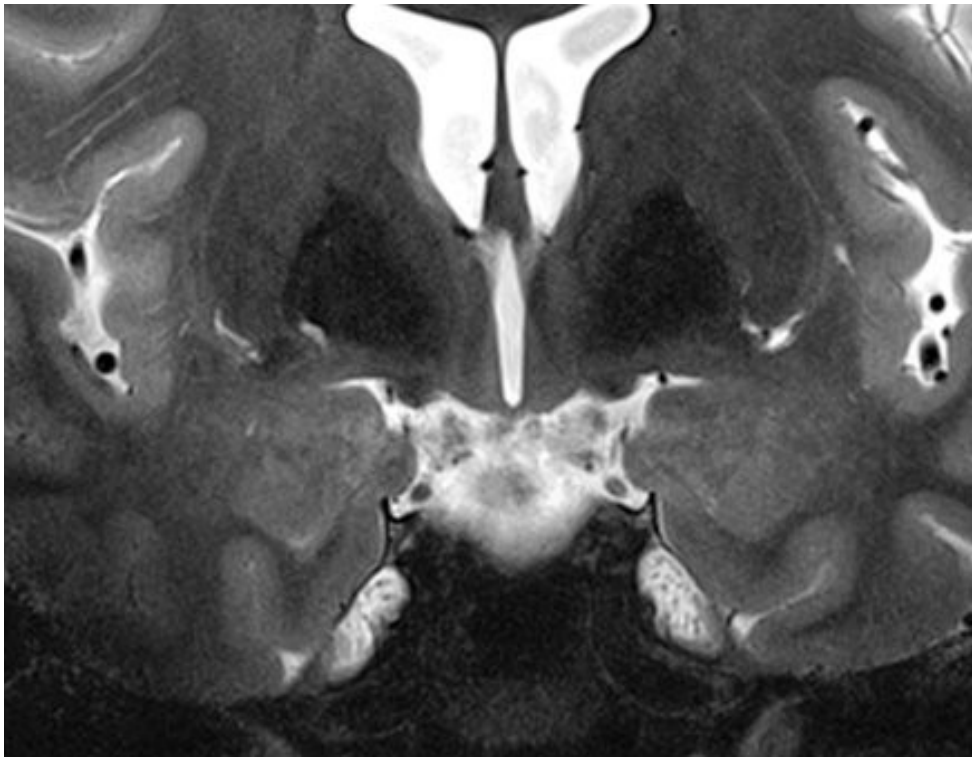
Medical Products

Frontier Technologies and Modern Manufacturing

Advanced imaging is instrumental to provide better evidence to make critical decisions across all aspects of health and medical science.

We are developing, testing and deploying next-generation imaging technologies, new image analysis techniques, and better imaging protocols that are essential for precision medicine techniques. These techniques form the backbone of advancing treatments for neurological disorders, psychiatric disorders, mental health, cardiovascular disease, and cancer. Researchers need cutting-edge imaging equipment and technologies to understand disease and its progression, and to develop novel and precise treatments.

We also know that applying new imaging technologies increases the type and amount of information that doctors can gather, directly inspiring new treatments being created.



Head and neck cancer patients will benefit from better diagnoses and treatment with improved ultra high–field MRI

Australians have one of the highest skin cancer rates globally, including melanoma in the head and neck. How these cancers progress determine a person's combination of surgery, chemotherapy and radiation treatments. Because these cancers can invade nerves of the face, and reach the brainstem via the base of the skull, imaging nerves in the area is critical.

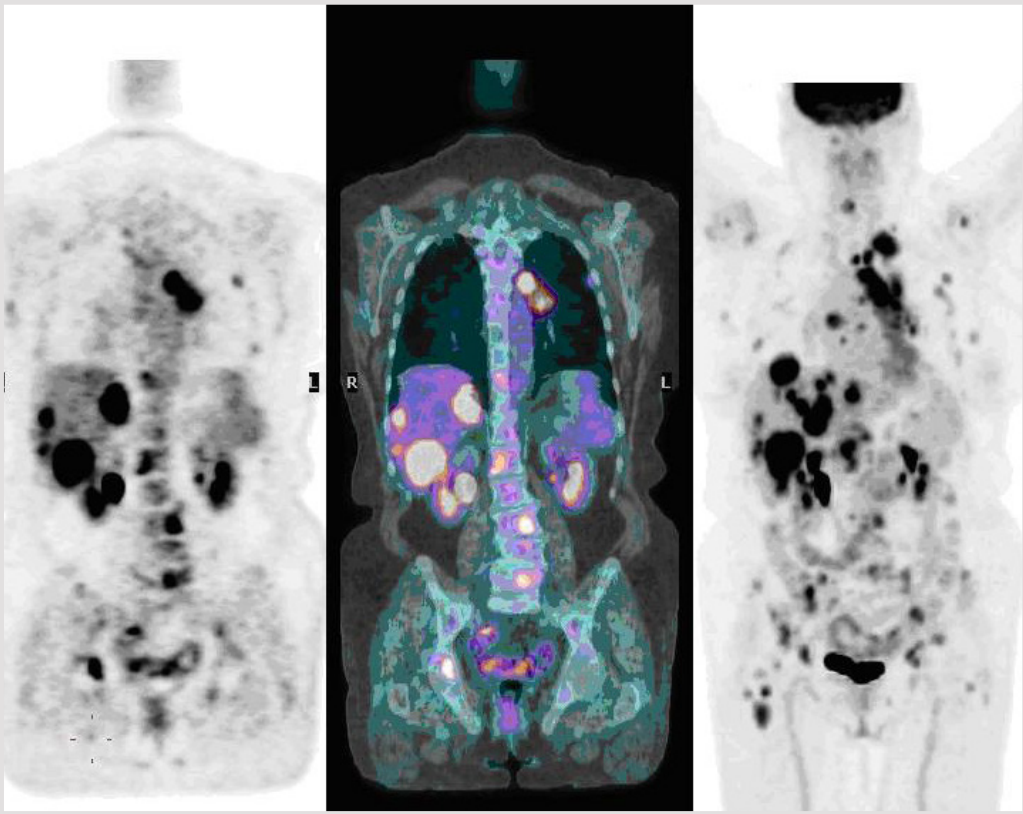
These important images strongly guide patients' and oncologists' treatment decisions and disease progression. MRI neurography is the current best practice for this kind of imaging, but standard MRIs can underestimate the extent of the cancer.

Research conducted at the Queensland NIF Node is improving the resolution and sensitivity of these images by applying the capabilities of the 7 Tesla (7T) ultra-high field MRI scanner at The University of Queensland. Australia has an opportunity to change the leading best-practice care of skin cancer patients by successfully implementing this technology.

NEW DIAGNOSTICS AND THERAPIES COMBINED

Medical Products

Frontier Technologies and Modern Manufacturing



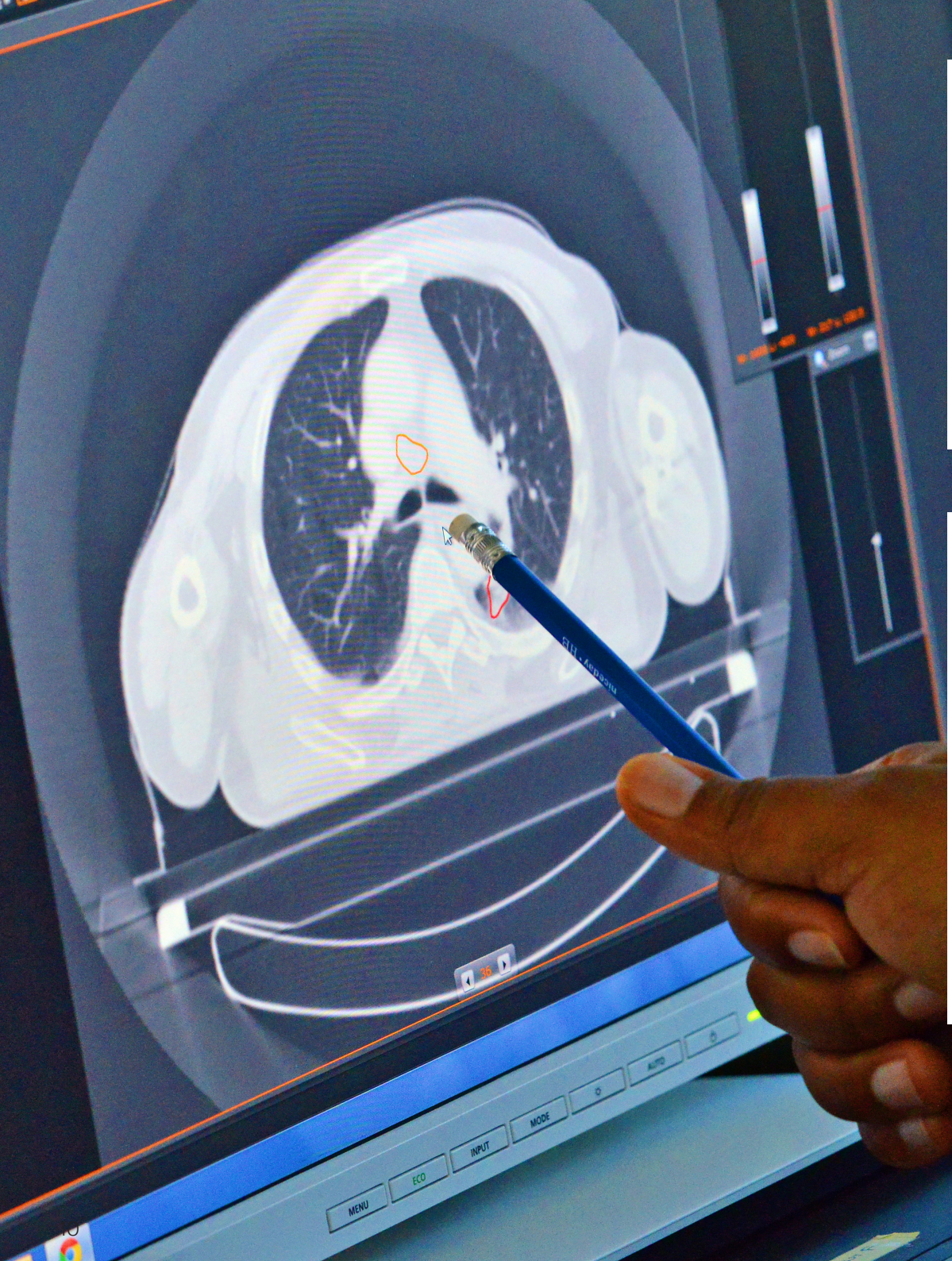
Translating new therapies into clinical practice is impossible without highly specialised imaging techniques and sophisticated image analysis. Only with superior imaging can researchers explore biological processes, visualise diseases and measure the effects of therapies. This is increasingly important for minimally invasive therapies, and treatments that are better targeted and more effective.

Imaging is increasingly a core part of therapy. This includes stereotactic surgery, MRI-guided radiotherapy, MRI-guided focused ultrasound and proton therapy, which rely on real-time, image-based guidance to steer and optimise treatment.

'Theranostics', personalised nuclear cancer treatment where diagnosis and specific drugs are given at the same time, is set to revolutionise cancer therapy in the next five years. Australia is already leading the world in how we target prostate cancer using immune-triggering prostate antigens imaged with PET/CT. These approaches ensure the right treatment, improved treatment success, more efficient care and reduced toxicity.

However, theranostics are not only limited to nuclear medicine. For example, new nanoparticle technologies can combine cancer therapy with MRI diagnostics. And microbubbles used for contrast-enhanced ultrasounds are being designed to encapsulate and monitor the delivery of anti-cancer drugs to precision places in patients' bodies. Imaging is a critical component of new generation therapeutics.

Co-locating imaging capabilities with major new Australian investments will enable us to develop individualised patient treatments that will reduce cost. Facilities such as the Australian Bragg Centre for Proton Therapy, currently under construction, offer opportunities like this.



Australia's upcoming global leadership in theranostics

Ranked ahead of Canada, Germany, UK and Japan in biotech and medtech, and #4 globally, Australia is in a highly competitive position to lead research and translation in theranostics. Australia's world-class researchers in nuclear and precision medicine and molecular imaging enable this leadership and NIF imaging infrastructure is an essential component. This leadership is also supported by Australian-based, innovative companies commercialising radiopharmaceutical products.

Developing personalised microbeam radiation therapy

Nearly half of cancer patients are treated with radiation therapy, but the doses can produce unwanted side effects and adversely affect people's quality of life. University of Wollongong researchers working at the Australian Synchrotron facility and the Monash NIF Node have investigated using personalised microbeam radiation therapy for high-grade brain cancer treatment.

Results already indicate that the microbeam techniques can significantly reduce radiation doses, and soon will be transferable to people. We are proud to be part of this first long-term preclinical study with collaborators University of Wollongong, Monash Biomedical Imaging, ANSTO, and the Prince of Wales Hospital.

BETTER HEALTH FOR THE YOUNG AND OLDER AUSTRALIANS

Medical Products

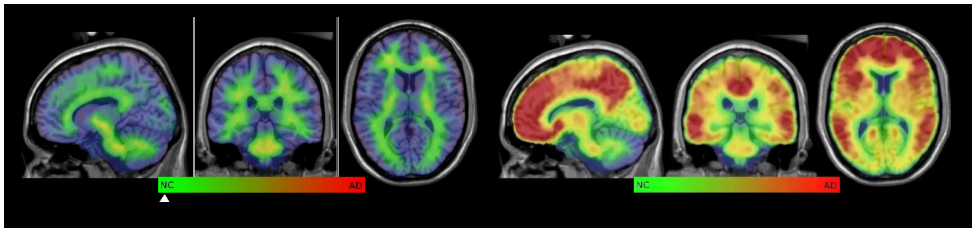
Sophisticated imaging techniques can support Australia's research into healthy babies and healthy older Australians. The first 2000 days from conception to early childhood, plus nutrition and lifestyle factors, are among the most important determinants of our children's future health.

Researchers need to track changes in babies and children to understand and promote healthy development and ageing. We know that this knowledge can advance the world's knowledge of areas such as how drugs affect babies during pregnancy, developmental disorders such as Attention Deficit Hyperactivity Disorder (ADHD), identifying early biomarkers for depression during adolescence, and how lifestyle and environmental factors impact our health.

Across our whole lifespan, our brain and cognition changes. In adulthood, the cortex gets thinner, white matter integrity declines, and patterns of brain function change. Screening populations by imaging our older communities is an important tool for understanding the effect of early intervention in diseases like dementia. This research will also critically inform the National Science and Research Priority of Health to improve prediction, identification, tracking, prevention and management of brain- and cognition-related changes with ageing.

Uncovering the mysteries of foetal health in utero

Combating the risks of intrauterine growth restriction, our imaging users have been investigating foetal development using novel in utero MRI techniques in sheep. By exploring imaging showing cardiac and phase contrast flow, placental perfusion and blood oxygen level dependent (BOLD) images, they hope to inform clinicians about best practices for maternal–fetal medicine. These developments are taking place at the South Australian Health and Medical Research Institute's (SAHMRI) NIF node, with the University of South Australia's Early Origins of Adult Health Research Group and international collaborators. They are also examining MRIs of newborns for the impacts of maternal nutrition on outcomes in prematurity, such as magnesium supplementation.



Identifying dementia earlier for faster treatment

In 30 years' time, nearly 1 million Australians will be living with Alzheimer's disease—about 70% of people with dementia. But early detection is possible: degeneration within the brain begins 20–30 years before obvious symptoms. We have already taken a major role in ensuring Australia maintains its leadership in dementia imaging, particularly for Alzheimer's. NIF's University of Melbourne and University of Queensland Nodes, and the Hunter Medical Research Institute have undertaken several trials to find early biomarkers, evaluate novel radiotracers as a diagnostic tool, and develop a national radiotracer network for dementia screening. We proudly collaborate with Q-TRaCE and the Australia Dementia Network for this work.

NIF supports treatments for Alzheimer's disease

NIF has supported several phase 1-3 clinical trials of disease-modifying therapies for Alzheimer's and PET tracers for diagnosing and managing the impact of Alzheimer's therapies. Our instruments were used to screen potentially suitable participants with amyloid PET scans at the University of Melbourne, Herston Imaging Research Facility, and the Hunter Medical Research Institute as well as other Australian sites. In addition to screening, the University of Melbourne provided longitudinal data used to develop tracers and methodologies to influence the effectiveness of therapies for follow-up trials. This work has been done in close partnership with the Australian Imaging Biomarkers and Lifestyle Study, Australian Dementia Network, Austin Health, the Florey Institute of Neuroscience and Mental Health and CSIRO.

Imaging will be crucial to prescribe treatment for early signs of disease—researchers need PET and MRI imaging, and cerebrospinal fluid and blood biomarkers to confirm the Alzheimer's-affected patients, and to manage side effects from Alzheimer's therapies.

EQUITABLE REGIONAL AND RURAL HEALTH

Medical Products

Australians living in regional and rural areas unduly suffer lower life expectancy and a higher burden of diseases because of reduced screening, late detection and barriers to treatment. The Australian Government has prioritised improved regional health treatment, tele-oncology and access to clinical trials for rural communities.

Advanced imaging capability is currently out of reach, even though research conducted in regional and rural health areas is addressing important gaps in our knowledge about remote and rural health risk factors. However, our network is uniquely positioned to provide a hub-and-spoke model for advanced imaging to translate research methods into approaches ready and suitable for conducting regional clinical trials. We are already planning how we will harmonise imaging protocols between centres, support acquisition through remote cockpits, train local staff and provide data-analysis services.

Delivering a geographically distributed network of advanced imaging to support research and forming the foundation for personalised medicine is a major national challenge, is crucial to societal equity and research quality, and we are ready to continue our vital contributions in this space.

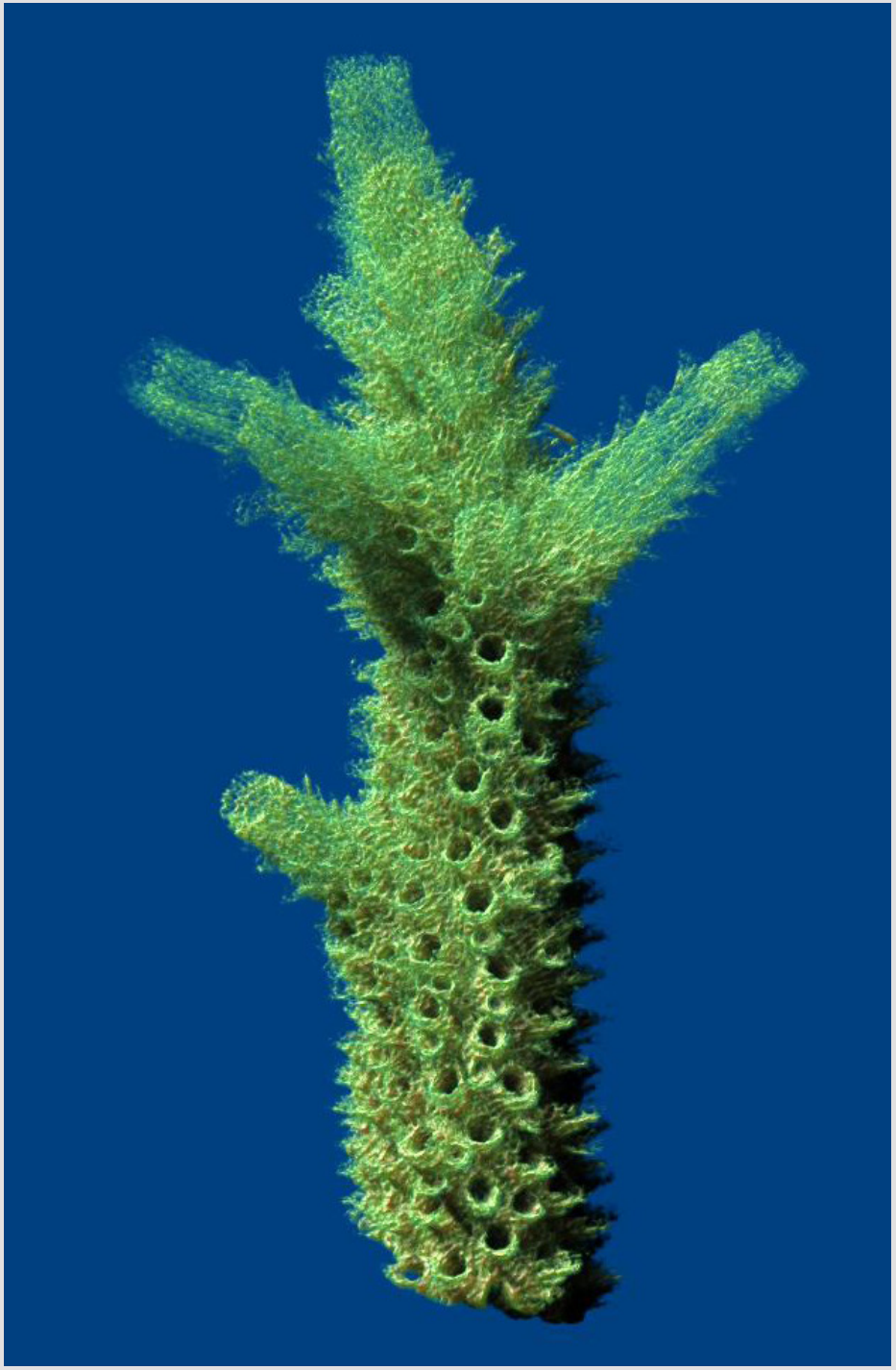
NIF is already deploying regional and rural imaging

In 2022, we will deploy four low-field MRI scanners to remote and regional sites to help researchers apply this affordable imaging technology in regional areas. We envision using these scanners to diagnose stroke, traumatic brain injury, and other conditions after testing in research laboratories at NIF nodes.

In 2021, we welcomed our first regional node—the University of Newcastle, with unique links to regional, rural and remote communities through the Hunter and New England districts of NSW. The node encompasses the Imaging Centre of the Hunter Medical Research Institute, the University of Newcastle and the Hunter New England Health District. The University of Newcastle, through the unique Wollotuka Institute and other partners, possesses a renowned reputation for Indigenous engagement, education, training and advocacy. We are excited at the opportunity to engage with Aboriginal communities and their health needs to build a national capability in this space through these links.

In 2021, we expanded our human imaging capabilities to include South Australia and Western Australia, significantly ability to undertake large-cohort imaging projects and ensuring that our network can provide imaging across a representative sample of the Australian population.

NIF's increased national human imaging reach will enable health research in remote and vulnerable populations to mitigate bias introduced by sampling patients within metropolitan areas. This will also increase access to better healthcare, professional training and socio-economic equity.



IMAGING FOR IMPACT

GROWING USE OF IMAGING IN AGRICULTURE AND ECOLOGY

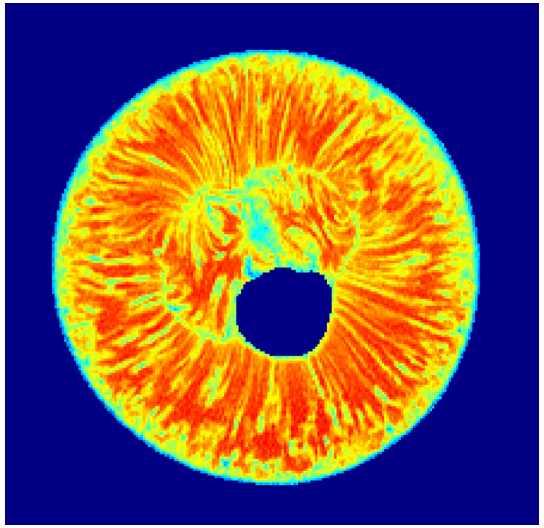
Frontier Technologies and Modern Manufacturing

Food and Beverage

Imaging is opening new horizons for agricultural and ecological science—we are seeing fascinating new applications that will help agriculture become more climate-resilient, optimise when we harvest fruit, check quality, reduce our need for fertiliser, and much more.

MRI can non-invasively probe water and nutrient movement in plants to find out how they deal with arid or freezing environments. Below-ground imaging can support us to find new ways to grow crops in poor soils.

NIF supports Australian producers so they can reduce their use of the finite, non-renewable resource phosphorus.



MRI at our University of Western Australia node is being used to study how plants and soil interact at different availabilities of water and phosphorus, in sandy soils. This advantageous technique lets us see high-resolution images of plant roots over time without destroying or damaging them. Researchers can then analyse the genetics of the most nutrient-efficient plants. This work stems from agriculture's increasing interest in management strategies to improve crop phosphorus nutrition, such as placing fertiliser deep in poorer subsoils.

NIF is looking ahead. A future molecular imaging scanner customised for imaging of plants will be a world-first, that will allow researchers to understand the chemical functionality of plant systems rather than just their physical structure.

CRITICAL CONTRIBUTIONS TO MATERIALS, ENGINEERING AND CULTURE

Frontier Technologies and Modern Manufacturing

Resources Technology and Critical Minerals Processing

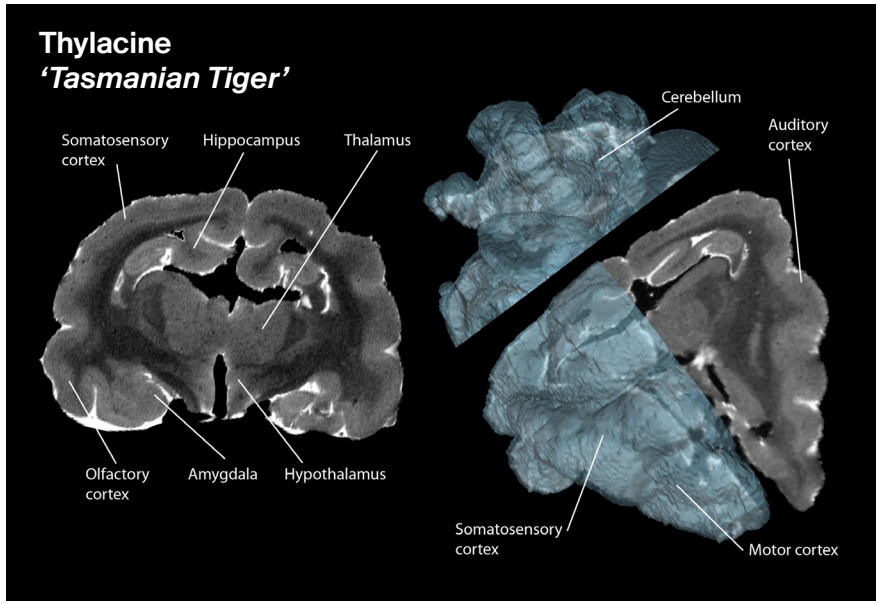
Imaging is critical to a broad variety of industrial and research problems—including chemical processes, materials science, environmental and ecosystems research, security, palaeontology and cultural preservation.

As we further develop low-field MRI technology to provide 3D images, many industrial and engineering fields will benefit, especially in mining and chemical processing.

Imaging is crucial for museum researchers to non-destructively explore and preserve the interior of rare, high-value or fragile specimens. Individually, these commercially and culturally important fields would not be able to support advanced imaging capabilities on their own. However, our unique capabilities are positioned to provide infrastructure to address important questions of enormous significance for Australia's future.

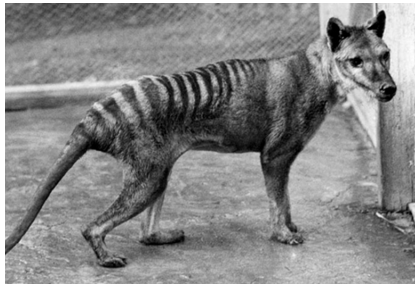
Peering into pipelines: a world-first for oil and gas industries

Believed to be a world-first, researchers are using the medical MRI facility at the WA NIF Node to look inside oil and gas pipelines. Checking how oil, gas and other chemicals flow in pipes is extremely important to the oil and gas industry. Researchers at the University of Western Australia collaborated with industry partner Woodside Energy to improve deepwater oil and gas production by better understanding and controlling the flow of particles called hydrates that are transported in water and oil.



Understanding the brain of the extinct Tasmanian tiger

The Tasmanian tiger ('thylacine') was once common across Australia, vanishing from the mainland several thousand years ago. Most reports say the last thylacine died in captivity in 1936. To capture clues about their behaviour, scientists have turned to the anatomy of museum specimens because limited data was collected from living animals.

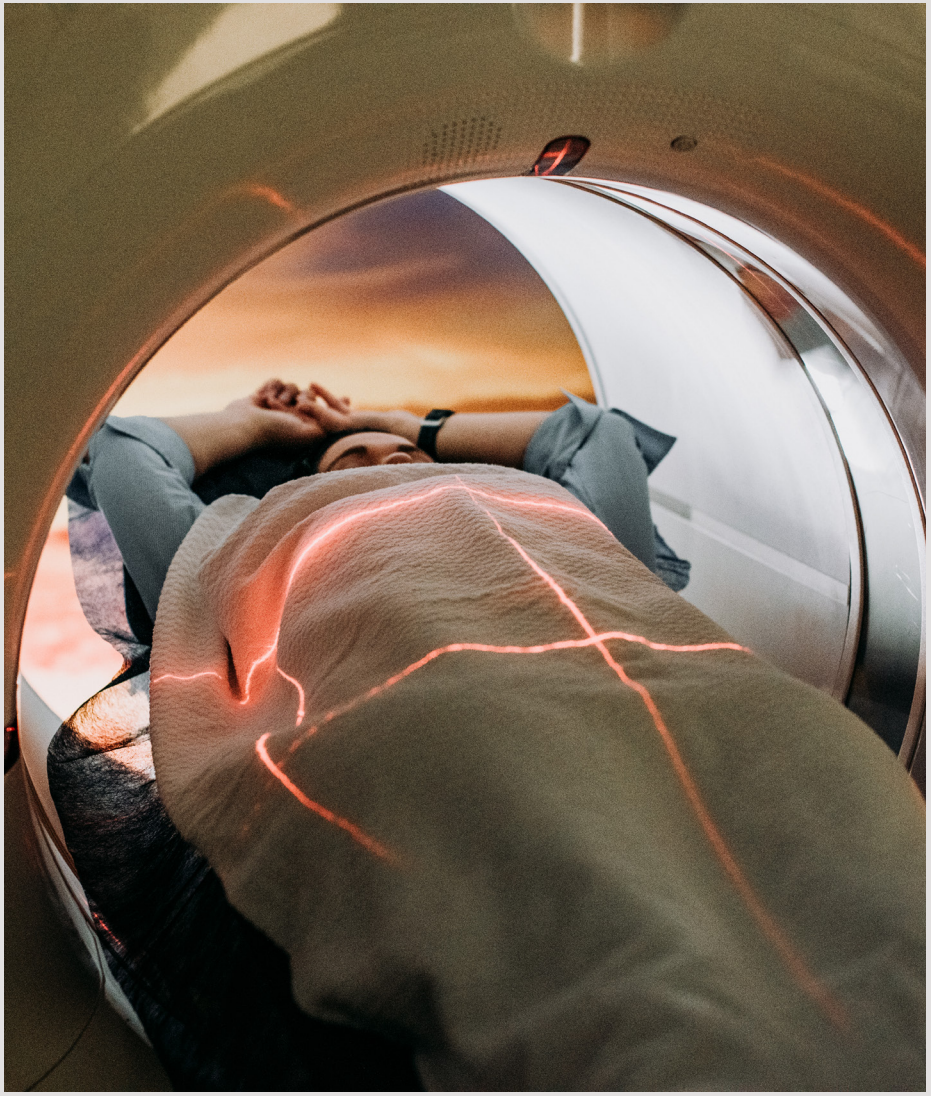


For instance, though the thylacine had a stronger bite than the dingo, the anatomy of its head and neck may have meant it was less suited to taking large prey. Its elbow joint suggests it was more of an 'ambush' than 'pursuit' predator, and analysis of its teeth hints that it hunted prey in the 1 kg to 5 kg range in 'pounce-pursuit' style.

To better understand what the thylacine was capable of, a research team including our University of New South Wales node scanned two century-old brains. Although MR images of museum samples are challenging to generate because of long preservation times, the team successfully collected precious brain images of this extinct species. The high-resolution MRI and Diffusion Tensor Imaging (DTI) studies revealed complex brain regions devoted to planning and decision-making, contributing to evidence that thylacines were capable predators.

NATIONAL-SCALE COORDINATION

NIF WILL IMPLEMENT THREE NATIONAL-SCALE COORDINATION NETWORKS.



These networks will make it easier, cheaper and simpler for researchers to access key imaging technology in Australia. We will simplify processes, harmonise instruments for multi-site studies (calibrate instruments to appropriate standards and with each other), standardise practices, share innovations and continue to increase the quality of the data we produce. Researchers will be able to use a single 'front door' to access any part of the NIF network. Standardisation will reduce the costs of using imaging for research, for researchers and for NIF.

Our three networks:

Applying machine learning to revolutionise imaging

Machine-learning techniques can transform how images are made and interpreted. Our plans will accelerate adoption, promote best practice, and increase research reproducibility (to ensure that research studies can be easily proven or disproven).

Harmonising a national Magnetic Resonance Imaging network

A new generation of preclinical and clinical trials conducted at multiple centres will require the underpinning support of our nationally coordinated MRI network.

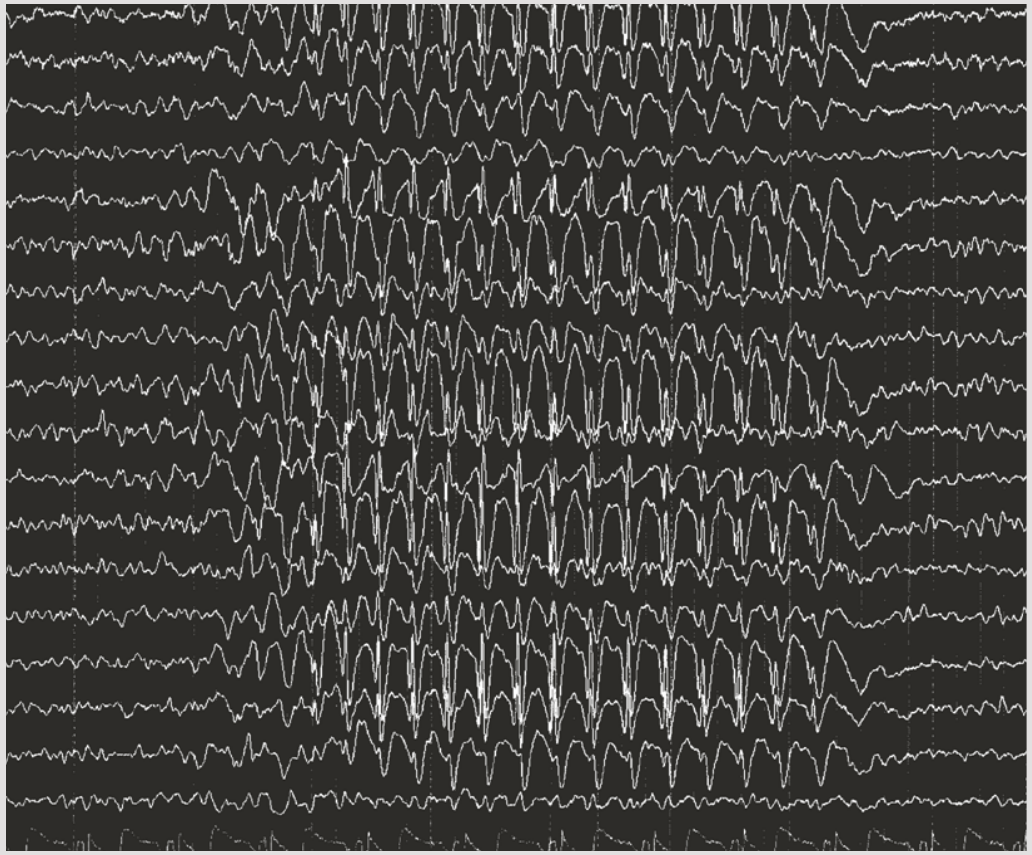
Coordinating a radiochemistry and molecular imaging network

National-scale coordination of radioisotope and radiochemistry for imaging will strongly support the clinical translation of new radiotracers, and support Australian clinical trials in dementia, cancer, and cardiac and metabolic diseases.

TRANSFORMING IMAGING WITH MACHINE LEARNING

Medical Products

Frontier Technologies and Modern Manufacturing



Impact areas:
All fields of imaging, precision medicine

Machine-learning techniques are revolutionising how images are interpreted. This type of analysis can take huge amounts of high-quality study data, and increasingly extract more information from the data using less human work. The impact of imaging in scientific research is only increasing, because researchers can now extract quantifiable information from ever-larger data collections by applying machine-learning methods such as deep learning and convolutional neural networks.

Imaging instrument vendors are increasingly investing in machine-learning technology and algorithms, and Australian researchers have much to contribute—already, we collaborate with vendors in this space. By growing these collaborations, we can contribute to impactful translation and commercialisation.

Over the foreseeable future, the size of research studies will continue to increase, in response to the demand for larger studies to ensure research quality and to increase reproducibility. Therefore, NIF is focused on a range of activities to increase uptake of machine learning in imaging, including data infrastructure and imaging quality.

The growth of machine learning means that high quality trustworthy data collections are a valuable asset in industrial collaborations, which NIF is well positioned to leverage.

NIF priority:

We will invest in producing quality-controlled and harmonised data that can be used in studies using machine-learning techniques. We will invest in data infrastructure to underpin and grow these projects. NIF will increase our expertise in machine learning to apply to imaging problems and make this capability available to our users. We will partner to create unique data collections that are valuable Australian assets. We will undertake these activities in partnership with national centres of excellence and expertise, and NCRIS.

NATIONAL-SCALE COORDINATION

A HARMONISED NATIONAL MAGNETIC RESONANCE IMAGING NETWORK

Medical Products

Food and Beverage

Impact areas:
Health, life sciences, clinical research

Large-scale imaging studies are critical to understanding complicated diseases, developing the next generation of medical innovations, and translating these innovations into treatments applied in clinical practice.

For representative and equitable research studies, and detecting rare and 'orphan' diseases, it is critically important that researchers can undertake imaging studies across a representative selection of the Australian population, including regional, rural and metro populations—a uniquely challenging prospect for Australia in scale, coordination and geographic equity.

Collecting data across multiple locations and scanners is challenging. Scanners require harmonisation (calibration to appropriate standards and with each other) using dummy scans, quality assurance checks, and careful protocol setup.

Our National Magnetic Resonance Imaging Network will ensure this harmonisation by embedding experts to develop and apply standardised scientific processes, and who can support accuracy from multicentre studies through all stages of preclinical and clinical development. The network will work with selected remote clinical sites to much better represent Australia and its diverse regions. In this way, Australia will remain an attractive destination for the next generation of biomarker-enabled trials (MTPConnect, 2021, *Australia's Clinical Trials Sector Report*).

NIF priority:

NIF will harmonise its existing 3T scanners, invest in new scanning capacity in under-represented population centres (or partner with clinics which can), upgrade ageing equipment and align imaging protocols and data-capture standards to ensure reproducible results. NIF will offer research imaging in places that have traditionally been beyond the reach of medical research programs, to ensure equity and quality, by using a coordinated hub-and-spoke approach.

The Australian Epilepsy Project

A quarter of a million Australians live with epilepsy—and one third can't control it with medication. The Australian Epilepsy Project (AEP) will change the lives of people living with epilepsy—it will reduce uncertainty about people's diagnosis and fast-track optimal treatment by combining advanced imaging, genetics, cognition, and artificial intelligence.

People living with epilepsy can look forward to better understanding their prognosis, experiencing fewer seizures, reducing the cost burden of the disease and taking part in more of life's activities.

NIF is critical to AEP's ambition. Our National Human MR Network will enable scanning of hundreds of people across Australia. We will coordinate and harmonise our scanners to ensure consistent data quality from every location.

The healthcare costs of epilepsy over someone's life are enormous—second only to dementia. Australia has the potential to save billions of dollars in direct healthcare through the AEP, enabled by NIF. Our infrastructure helps the AEP to deliver life-changing benefits to all Australians living with epilepsy.

COORDINATING MOLECULAR IMAGING AND RADIOCHEMISTRY

Medical Products

Frontier Technologies and Modern Manufacturing

People facing dementia, cancer, or cardiac and metabolic diseases look to benefit from clinical trials and treatment with new radiopharmaceuticals—the foundation of which rests on Australian molecular imaging research scanners, and accessible radioisotopes and radiochemistry.

Applying innovations in nuclear medicine for patients depends on how Australia expands, develops and deploys radioisotopes and radiopharmaceutical research infrastructure. Coordinated access to radiochemistry for imaging also facilitates innovative research into human disease, allows translation of discoveries into the clinic, and supports exploration of new approaches to accurately diagnose and treat patients. We are already well-positioned to coordinate this work through our network of experts in key radiotracer and radiochemistry facilities throughout Australia.

National coordination will optimise how NIF uses resources at the NIF nodes with radiochemistry capability by sharing operational knowledge and jointly developing new capabilities aligned to the current and future needs of our users. Sharing this knowledge and expertise will elevate the existing radiochemistry workforce, and improve training for the next generation of radiochemists that Australia needs to support its escalating demand. The national approach will promote easier access to new and existing radiopharmaceutical and radioisotope technologies with efficient distribution of products to capital and regional centres, resulting in better outcomes for the users of the network.

NIF priority:

We will contribute to national coordination of radiopharmaceuticals and radioisotopes in collaboration with industry, ANSTO and aligned programs such as the Australian Radiopharmaceuticals Trial Network (ARTnet). NIF will invest in necessary research into cyclotron beam line capacity and Good Manufacturing Practice (GMP) supply facilities for next-generation molecular targets and radiometals. We will partner with clinical trials networks to deliver best-practice environments to test radiotherapies. NIF will harmonise data generated by human and preclinical molecular imaging instruments.

FUTURE CAPABILITIES

TO ENSURE A WORLD-CLASS RESEARCH IMAGING CAPABILITY NIF PRODUCES, AND DELIVERS TO, A NATIONAL ROADMAP FOR IMAGING RESEARCH INFRASTRUCTURE.

The NIF Imaging Roadmap shows how we will deliver on the priorities outlined in the 2021 National Research Infrastructure Roadmap for imaging.

We will support innovation and ensure Australia's international comparative advantage by prioritising these capabilities over the coming five years.

		Medical Products	Frontier Technologies and Modern Manufacturing	Food and Beverage	Resources Technology and Critical Minerals Processing
Accelerating next-generation imaging technologies	Australia is a pioneer in developing new imaging technologies and translating them to real-world applications.	●	●	●	●
Furthering critical magnetic resonance technology	Australia is a world-leader in applying and translating MRI technology—it will continue to be an important part of our imaging research infrastructure.	●	●	●	
Translating portable biomagnetic imaging	A new generation of ultra-sensitive room-temperature magnetometers promises to bring advanced, portable diagnostic biomagnetic imaging to clinics for neurological, cardiovascular and neonatal health.	●	●		
Pioneering full-colour X-ray scanners	Recent breakthrough technology promises to revolutionise the entire field of computed tomographic (CT) imaging, called photon-counting CT imaging.	●	●		●
Applying new-generation ultrasound for treatments and diagnostic techniques	Ultrasound technology is quickly evolving to provide higher quality images and innovative treatments for new therapeutic approaches—such as for diseases like Alzheimer's disease.	●	●		
Advancing molecular imaging to visualise whole-body processes	Next-generation molecular imaging and radiopharmaceuticals are revolutionising how we see biological processes at the molecular level. We can use hybrid and total-body imaging technologies to more effectively diagnose and treat people.	●	●		

FUTURE CAPABILITIES

ACCELERATING NEXT-GENERATION IMAGING TECHNOLOGIES

Medical Products | Frontier Technologies and Modern Manufacturing | Food and Beverage | Resources Technology and Critical Minerals Processing

Australia has a strong world-leadership role in imaging technology. NIF's capabilities already underpin significant commercial technology and product developments, and in the future we plan to support imaging innovation further.

We have provided the capability to develop new techniques to inspect the movement of human lungs in real time, analyse epilepsy patients' images with sophisticated algorithms, and commercialise improvements to the magnetic technology used in magnetic resonance scanners.

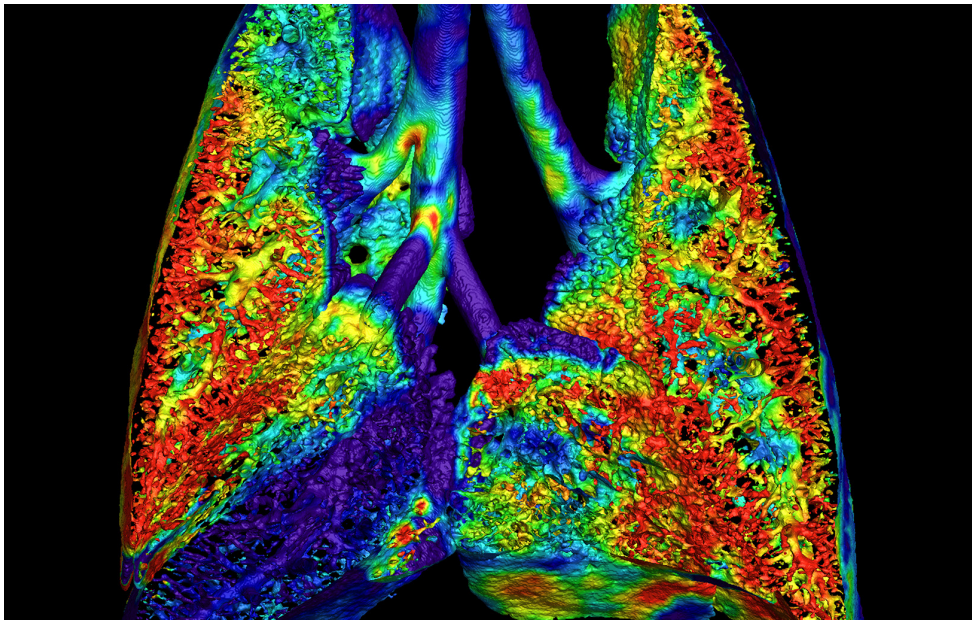
The NIF network supports an entire spectrum of imaging possibilities, and we accommodate a wide variety of experiments using highly tailored instruments. Our capabilities span the complete translational pipeline: from preclinical imaging using small animal models, large-animal imaging, human research imaging, and patient imaging in clinical research environments.

We are committed to working closely with other national facilities such as the to provide a seamless pipeline for technology development.

Most importantly, developing new imaging technologies requires the specialised expertise and multidisciplinary collaboration that NIF has cultivated for over a decade. Our network of Node Directors and Fellows include physicists, engineers, data scientists, chemists, medical researchers and clinicians, who work in close partnership.

NIF priority:

NIF will underpin the development of new imaging technologies through the dedicated support of its network of experts and instruments. We will invest directly to develop and deploy cutting-edge imaging technology where these innovations can be deployed as research infrastructure for Australia's benefit.



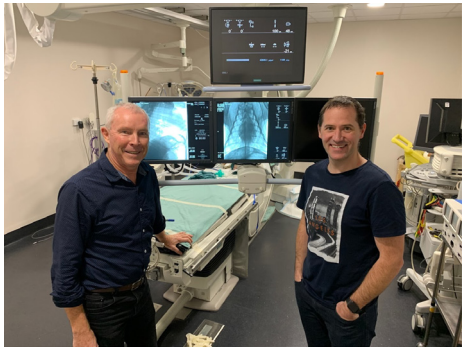
World's first dedicated lung-function scanners, but zero radiation

The Australian Lung Health Initiative (ALHI) is an Australian company that aims to develop the world's first dedicated lung function scanners, with a vision of zero radiation exposure. ALHI's goal is to deliver ground breaking advances in lung healthcare that are safe, rapid, easy to use and that provide detailed functional analysis for any patient.

ALHI—in partnership with 4DMedical, the University of Adelaide, and the NIF node at the South Australian Health and Medical Research Institute (SAHMRI)—has secured $30 million funding from the Medical Research Future Fund to develop a low-dose, non-invasive paediatric lung scanner.

Low-cost field ventilators invented during COVID-19

Based on fluoroscopy research performed at the SAHMRI NIF node, 4DMedical patented and commercialised technology into respiratory disorders and treatments. This technology was pivotal for developing a low-cost field ventilator invented and tested at the beginning of COVID-19.



Associate Professor David Parsons and Dr Martin Donnelley in NIF's SAHMRI Catheterisation suite (Cath Lab).

FURTHERING CRITICAL MAGNETIC RESONANCE TECHNOLOGY

Medical Products | Frontier Technologies and Modern Manufacturing | Food and Beverage

Australia has led the world in applying and translating MRI technology— we were one of only three countries to evaluate the first 3T MRI scanners in the world, which are now ubiquitous in hospitals world-wide. This provided Australia with unique opportunity to develop, translate and commercialise new developments ahead of the rest of the world. Australians have developed, patented and commercialised key imaging technologies that are now used in hospitals world-wide, and we have developed imaging techniques that are considered a vital part of best-practice clinical treatment. Our 3T network is an important national asset that we are expanding and harmonising.

There is also significant global research interest in developing and applying low magnetic field–strength technology due to its reduced cost and its portability. This will be a game-changer for remote and rural communities, applied in air ambulances, for instance. Correlating low-field strength results with clinical-grade 3T scanners will be an important research contribution that NIF is well placed to make.

At the other end of the scale, the next step is much higher magnetic field strength, which massively increases the resolution of the images we can create. Pioneers in related disciplines have already taken early steps to install and operate 'Extreme Field MRI'— human MRI scanners with field strengths of up to 11.7 Tesla. These scanners are currently rare, but many projects are being planned around the world. Experts suggest vision of human MRI at 20 Tesla will fill a crucial gap in our understanding of human biology, and it is important Australian researchers have access to these capabilities.

We are also part of the significant international effort to develop dedicated MRI techniques to increase spatial resolution and sensitivity in highly specific areas, such as brain fibre connections. For example, future hardware will allow researchers and clinicians to see and measure the connections at unprecedented detail—opening up new avenues to explore how brain wiring and disease are related, with the ultimate goal of providing more sensitive biomarkers.

NIF priority:

We will invest in low-field strength, portable MRI technology for research, diagnosis and treatment. NIF will partner with international institutions to provide Australian researchers access to extreme field scanners when the technology is ready, then invest in higher field scanners when they become critical to Australian research. We will invest in new scanners or upgrade existing imaging platforms for very-high detail and impactful specialised activities. We will grow our 3T network in partnership.

FUTURE CAPABILITIES

TRANSLATING PORTABLE BIOMAGNETIC IMAGING

Medical Products | Frontier Technologies and Modern Manufacturing | Food and Beverage

Mineral exploration and security applications use well established magnetometry techniques to measure magnetic fields. They are even more useful in medical research and clinical practice, and neonatal medicine, to measure the magnetic part of the electromagnetic field produced by organs such as the heart and brain. This technique has significant advantages over electrical measurements. For brain imaging, this technique is called magnetoencephalography (MEG).

Until recently, sufficiently precise magnetic field measurements required expensive and bulky cryogenic cooling systems called superconducting quantum interference devices (SQUIDS). Their size and expense has greatly limited their potential health benefits.

However, recent advances in quantum technologies have given rise to a potent new array of magnetometers ('optically pumped magnetometers') that are being adapted for health research. We are excited that these new technologies will allow greater access to magnetometry for researchers and broader applications due to reduced costs and simpler infrastructure.

NIF priority:

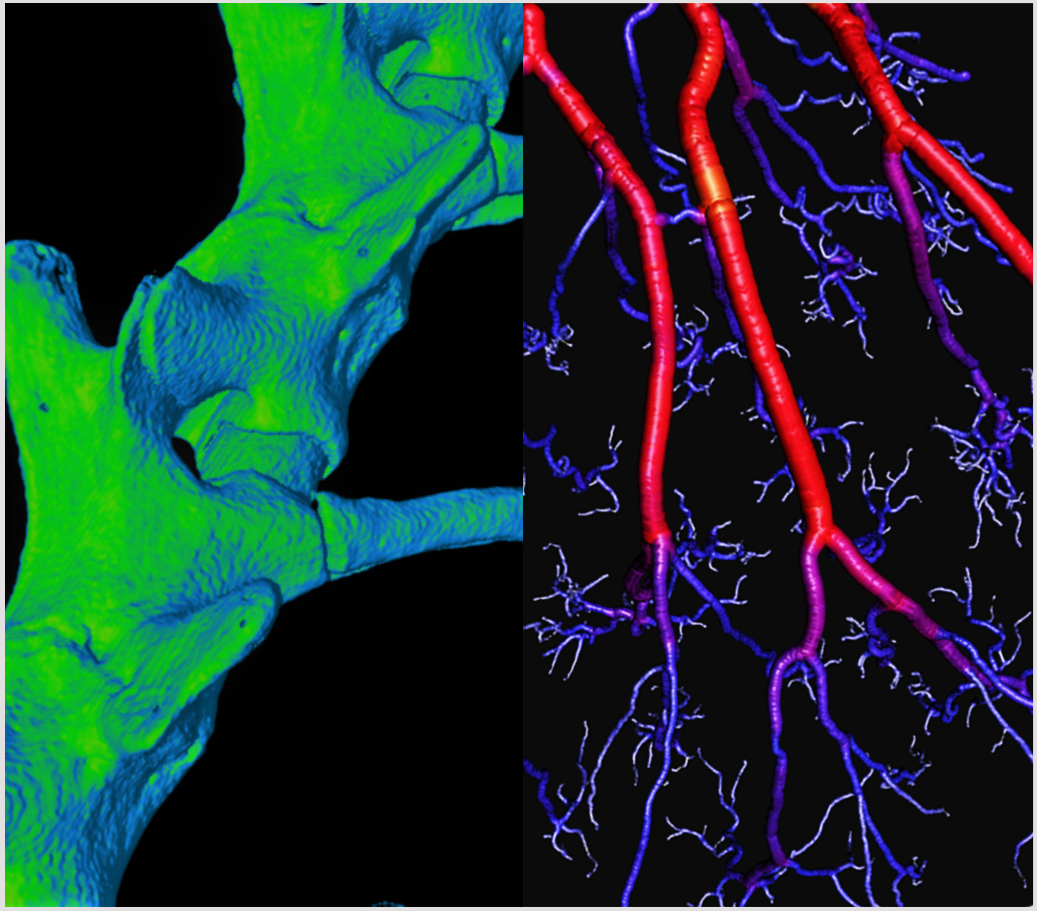
We will deploy a network of new-generation optically pumped magnetometers at key locations, and partner with clinical sites which previously could not deploy large super-conducting systems due to infrastructure costs.

Proof of concept in Melbourne gives NIF the green light for cheaper magnetometry

Recently, researchers at University of Melbourne, Swinburne University and Macquarie University have established the first Australian working proof of concept of optically pumped magnetometers. We are confident about its future applications in neurology, epilepsy presurgical evaluation, Alzheimer's disease, Parkinson's disease, traumatic brain injury, schizophrenia, multiple sclerosis, cardiovascular imaging and neonatal monitoring.

PIONEERING FULL-COLOUR X-RAY SCANNERS

Medical Products | Frontier Technologies and Modern Manufacturing | Resources Technology and Critical Minerals Processing



Set to revolutionise the entire field of CT imaging, photon-counting computed tomography (PCCT) is a recent breakthrough technology. The energy source (an X-ray tube) remains essentially the same, but PCCT detectors count the number of incoming photons and measure their energy. The effect is like moving from black and white to colour photography.

Instead of having to work out what tissue is in an x-ray from its density (is it skin, cartilage or bone?), PCCT can more easily determine what is. The scan can therefore be used in a more intelligent fashion, for example to automatically remove bone structures or perform virtual non-contrast imaging.

PCCT also gives very high resolution, which is useful for imaging heads, necks, joints, bones, lungs, coronary arteries and stents. Doctors could also image using multiple contrast agents, which will provide richer information, reduce costs and reduce scan time.

Prototype systems are currently in evaluation by the medical community internationally, and the Australian medical imaging research community will be excited to engage in this voyage of discovery of our inner world.

PCCT will also have significant applications beyond medical imaging—such as security, engineering, and culture—because it can more accurately identify materials.

NIF priority:

NIF will invest in PCCT because it is a critically important and broadly applicable next-generation imaging technology for innovations in clinical and materials science.

APPLYING NEW-GENERATION ULTRASOUND FOR TREATMENTS AND DIAGNOSTIC TECHNIQUES

Medical Products | Frontier Technologies and Modern Manufacturing

Traditional ultrasound is being re-invented to be better, cheaper, faster, and more digital—and the effect is transformative. This is especially important because getting and interpreting ultrasound image data is often subjective, which limits its use in some research studies. Importantly, ultrasound is not limited to static images of body structures but can non-invasively measure and show functional processes such as the direction and speed of blood flow in vessels and heart chambers, or the motion of heart valves.

New-generation ultrasound systems use digital solutions that speed up the work, identify anatomical structures and improve reproducibility. They can also now acquire 3D data—an advantage for some research, especially cardiac and vascular ultrasound, and endoluminal studies (studies of the inside of a tube, organ or duct). 3D ultrasound can demonstrate anatomical relationships with underlying structures, which can help plan and guide procedures.

Technical innovations have advanced to efficiently focus ultrasound waves for treatment of deep tissue structures or tumours—often a highly effective alternative treatment option for some people who are not good candidates for open surgery or to access challenging parts of the body. Focused ultrasound is an commercialised but early stage, promising technique to treat disease which minimises the invasiveness of traditional surgery. Combining focused ultrasound with imaging platforms such as MRI creates a powerful theranostic platform that is being tested for a range of applications.

NIF priority:

We will build on Australia's early-stage investment in focused ultrasound for researchers to ensure that Australian researchers have access to pre-clinical and clinical capabilities.

ADVANCING MOLECULAR IMAGING TO VISUALISE WHOLE-BODY PROCESSES

Medical Products | Frontier Technologies and Modern Manufacturing

Molecular imaging has revolutionised how we see biological processes at the cellular and molecular levels in living things.

Whilst other imaging techniques provide elements of molecular function, the field remains dominated by Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT).

PET and SPECT imaging rely on the development of radiotracers—targeted radioactive molecules that allow us to see their activity within humans and in vivo models. Developing new tracers and techniques for PET and SPECT is critically important, and NIF supports this capability. Our multifaceted 'research chain' spans from identifying potential targets and testing preclinical models, to imaging people.

Hybrid multi-modal equipment uses more than one imaging type and can therefore gain the best attributes of both. For example, we can combine the microstructural changes from MRI with PET information on how glucose is metabolised, oxygen used or neurotransmitters distributed.

Whole-body or total-body molecular imaging systems offer us the chance to capture information from all body organs simultaneously to address critical challenges in metabolic disorders and psychiatry. This could change what we know about how the brain regulates nutritional state in health and pre-diabetes, or how signalling between the gut microbiota and brain affect behaviour, cognition and mood.

NIF priority:

We will build on Australia's network of PET/CT, PET/MR and whole-body PET capabilities for both preclinical and human research. This will mean upgrades and innovations within our existing capability; targeted new purchases; and investment in technologies to improve sensitivity, spatial resolution and data integration. We will continue to invest in radiochemistry capacity and capability to support this growing demand, and will coordinate these activities at the national scale.

PET underpinning commercial success

Start-up company Inflazome is developing treatments for debilitating conditions such as cardiovascular disease; arthritis; and neurodegenerative diseases such as Parkinson's, Alzheimer's and motor neurone disease. Inflazome was acquired by Roche for about AUD $617 million, highlighting the value of translational research.

Studies undertaken at our University of Queensland node improved the understanding of Inflazome's 'inflammasome inhibitors' portfolio, enabling their drug candidates to proceed to clinical trials. Inflazome used preclinical PET/MR, PET/ CT and radiotracer production to test specific critical components of the innate immune system in animal models of Parkinson's disease and neuroinflammation.

OUR GOVERNANCE STRUCTURE AND MANAGEMENT TEAM

NIF operates as an Unincorporated Joint Venture of 14 partners and is administered by The University of Queensland.

Board

The Board is our key governing body. The Board provides NIF with oversight and strategic direction, and monitors its performance. The Board is accountable to The University of Queensland as the administering organisation.

Chair:
Emeritus Professor Margaret Harding
Members:
Dr Erol Harvey
Professor Carolyn Mountford,
Dr Thomas Barlow
Ms Sue Renkin
Professor Stephen Rose
Professor Joe Shapter

Management

Chief Executive Officer:
Professor Wojtek James Goscinski
Chief Operating Officer
Ms Saba Salehi

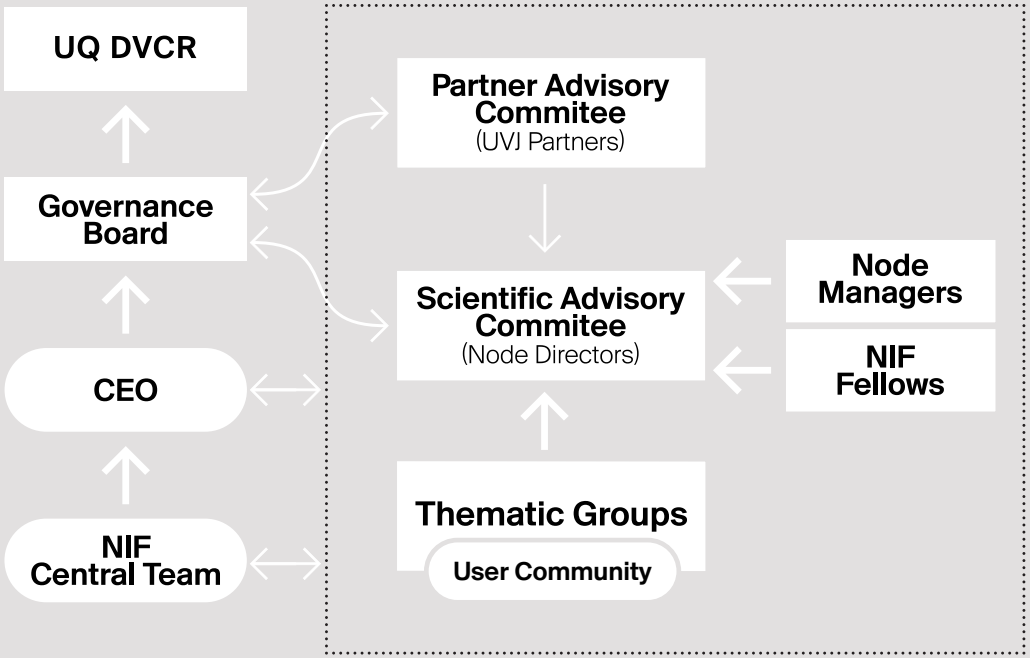
Partner Advisory Committee

The Partner Advisory Committee provides the Board with strategic advice about institutional, state and national issues that affect how we deliver national imaging capabilities that support the leading edge of international science. It comprises senior executive representatives of our partners.

Scientific Advisory Committee

The Scientific Advisory Committee is the primary scientific and technical committee for NIF, and comprises of Node Directors or co-Directors.

Governance Structure



National Imaging Facility

OUR FACILITIES

Brisbane:

- Centre for Advanced Imaging, University of Queensland
- Herston Imaging Research Facility (HIRF) and radiochemistry capability at Q-Trace

Sydney:

- Radiochemistry capability at ANSTO, Lucas Heights
- Preclinical and clinical imaging capability at Sydney Imaging, The University of Sydney
- Biological Resource Imaging Laboratory at University of New South Wales
- The 3T MRI capabilities at Neuroscience Research Australia (NeuRA) and Research Imaging NSW (RINSW)
- Biomedical Magnetic Resonance Facility at the Western Sydney University, Sydney
- Macquarie University **(new in 2021)**

Newcastle:

- University of Newcastle **(new in 2021)**

Melbourne:

- Melbourne Brain Centre Imaging Unit, University of Melbourne, Parkville
- Radiochemistry capability at Austin Health and Peter MacCallum Cancer Centre
- Monash Biomedical Imaging, Monash University, Clayton
- Preclinical Imaging Facility at Alfred Research Alliance-Monash Biomedical Imaging, Monash University, Prahran
- Swinburne Neuroimaging, Swinburne University of Technology, Hawthorn
- The Florey Institute of Neuroscience and Mental Health, Heidelberg
- Olivia Newton John Cancer Research Institute **(new in 2021)**

Adelaide:

- Small Animal Imaging Facility and Clinical Research and Imaging Centre at SAHMRI, North Terrace
- Large Animal Research Imaging Facility (LARIF), Gilles Plains

Perth:

- Centre for Microscopy, Characterisation, and Analysis, Harry Perkins Building, The University of Western Australia

OUR FUNDERS, PARTNERS AND MAJOR STAKEHOLDERS

National Imaging Facility is a $300m portfolio of imaging capabilities which have received investment from the Australian government, under National Collaborative Research Infrastructure Strategy (NCRIS), state governments, and its network of 14 university, medical research institute and government science agency partners.

NIF is administered by The University of Queensland and is independently governed. Our partners are essential to delivering our mission. We work together to address Australia's hardest imaging challenges.

NIF acknowledges and thanks our nodes and users who contributed images and stories for this document.

NIF Nodes

ANSTO

Olivia Newton-John Cancer Research Institute | LA TROBE UNIVERSITY

MACQUARIE University SYDNEY·AUSTRALIA

MONASH University

SAHMRI South Australian Health & Medical Research Institute | Large Animal Research Imaging Facility

SWINBURNE UNIVERSITY OF TECHNOLOGY

THE FLOREY INSTITUTE OF NEUROSCIENCE & MENTAL HEALTH

THE UNIVERSITY OF MELBOURNE

UNSW THE UNIVERSITY OF NEW SOUTH WALES

THE UNIVERSITY OF NEWCASTLE AUSTRALIA | HMRI

THE UNIVERSITY OF QUEENSLAND AUSTRALIA | HIRF HERSTON IMAGING RESEARCH FACILITY

THE UNIVERSITY OF SYDNEY

THE UNIVERSITY OF WESTERN AUSTRALIA

WESTERN SYDNEY UNIVERSITY

NCRIS Project Partners

Research Infrastructure Health Forum

BIOPLATFORMS AUSTRALIA

PHRN Population Health Research Network

THERAPEUTIC INNOVATION AUSTRALIA

Phenomics Australia Enabling genomic medicine

Informatics Project Partners

ARDC Australian Research Data Commons

MASSIVE

MICROSCOPY AUSTRALIA

Government funding partners

NCRIS National Research Infrastructure for Australia An Australian Government Initiative

NSW GOVERNMENT

Queensland Government

Government of South Australia

VICTORIA State Government

GOVERNMENT OF WESTERN AUSTRALIA

International Partners

EURO BIOIMAGING

GLOBAL BIOIMAGING growing collaboration

CONTACT US

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