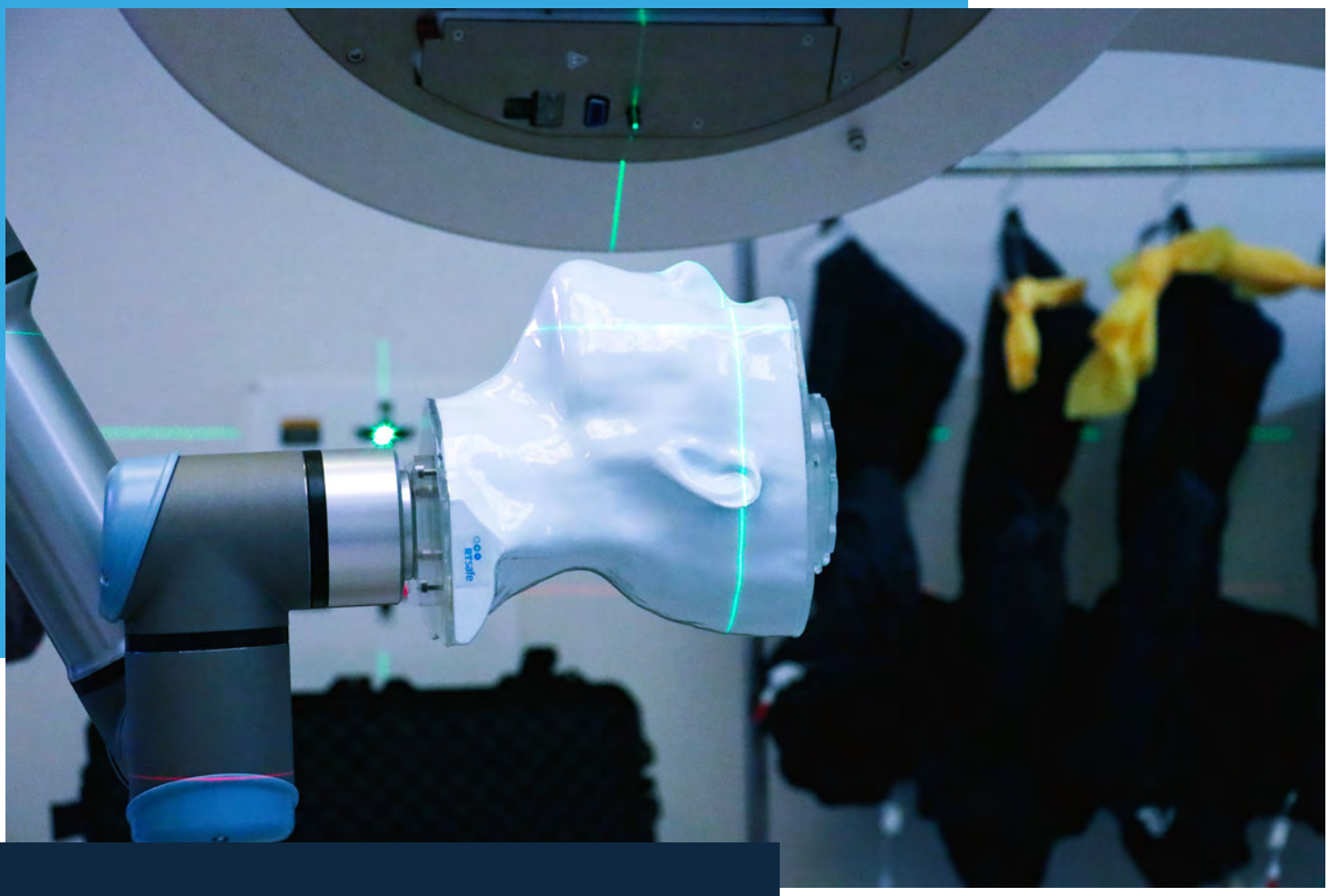

ANNUAL REPORT 2025

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IMAGE X INSTITUTE | THE UNIVERSITY OF SYDNEY

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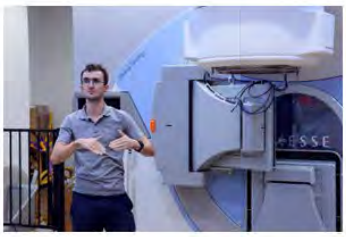
OUR MISSION

“To improve lives by inventing and advancing new ways to image and treat disease”

SNAPSHOT 2025

27 papers published



99 patients recruited to USYD-sponsored **clinical studies**

$6.3M **funding** commenced

$12.3M **funding** awarded

58 **conference presentations**

17 **invited talks**

DIRECTOR'S MESSAGE

2025 has been a year of strong progress for the Image X Institute, driven by the creativity and dedication of our researchers, students, clinical partners, and consumers. Across our MRI, interventional imaging, and radiotherapy pillars, our teams continued to advance technologies that improve access, accuracy, and equity in cancer care.

This year also brought meaningful recognition for our work. I was honoured to receive awards from Cancer Council NSW and the NSW Premier's Prizes, and these acknowledgements reflect not only individual contributions but the strength of our broader program. They highlight the vital role that Cancer Institute NSW and Cancer Council NSW have played in supporting our emerging leaders. Their funding schemes have helped launch the careers of many of our early career researchers—several of whom have now progressed to securing NHMRC Investigator and Ideas Grants and building independent research programs.

Our achievements are possible because of the contributions of many: our professional and academic staff, our university and industry partners, and the clinicians and patients who participate in our clinical studies. Their commitment ensures that our research continues to move from discovery to real-world impact.

As we look to 2026, we are energised by new funding successes, expanding collaborations, and the continued growth of our research community. We remain committed to delivering innovations that improve the lives of people with cancer and strengthen the future of medical imaging and radiation therapy.

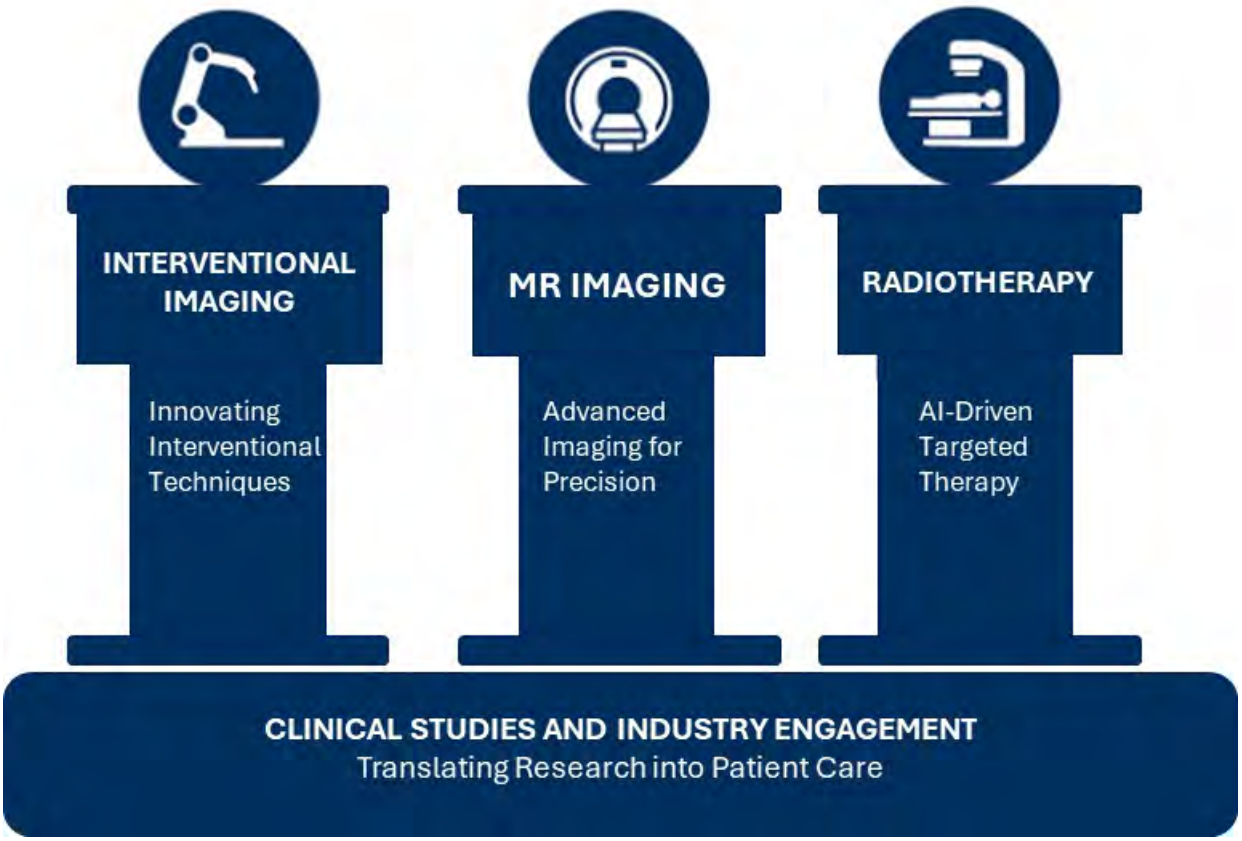
Sincerely

Professor Paul Keall

Director, Image X Institute

Faculty of Medicine and Health, University of Sydney

RESEARCH PILLARS 2025



HIGHLIGHTS – INTERVENTIONAL PILLAR

Bronchoscopy in the interventional suite

With the commencement of the National Lung Cancer Screening program the number of diagnostic biopsies is likely to increase. A new collaboration with Dr Tess Reynolds and Dr Nicholas Hindley with pulmonologists from Royal Prince Alfred Hospital and other Australian hospitals aims to extend the capabilities of CBCT platforms to improve diagnostic yield for CBCT-guided procedures. Innovations such as providing clinicians with a 3D image of the moving anatomy via an augmented reality headset and embedding optical imaging technology in the biopsy needle tip have the potential to increase diagnostic accuracy and reduce side effects. Alen Biju has been developing realistic lung imaging phantoms to assist with testing.

Picture: Testing an augmented reality headset in the interventional suite.

Extension of Research Partnership with Siemens Healthineers

Dr Tess Reynolds leads the interventional radiology program at Image X, which spans the Hybrid Theatre and the Siemens robotic ARTIS Pheno imaging system. The research partnership with Siemens, that we have had since 2016, has been extended through October 2027, and will mean over a decade-long collaboration. Siemens provide us with world-unique access to the low-level robotic control that has allowed us to leverage this and other capabilities to do research no-one else is capable of, and has led to new research partnerships with top universities such as Johns Hopkin and the University of Pennsylvania. Dr Reynolds was invited for two research visits to the University of Virginnia to apply her imaging protocols to their suite of imaging systems.

Picture: Robotic imager at the University of Virginia.

HIGHLIGHTS – MRI PILLAR

Australian MRI-Linac Program Completion

The Australian MRI-Linac is one of only four unique designs globally, developed through successive NHMRC Program grants, with additional support from the ACRF and other funding bodies. The program's research and development efforts united national and international collaborators. With clinical MRI-Linacs becoming available, the research prototype MRI-Linac device was decommissioned. Its legacy continues through several ongoing initiatives, including Dr David Waddington's low- and high-field MRI-guided radiation therapy research, collaborator Dr Trang Pham's NHMRC-funded project, and the open clinical trial, MR-STAR.

Picture: Liverpool Hospital hosted the Australian MRI-Linac Program Completion celebration.

Fulfilling the potential of MRI-guided radiation therapy

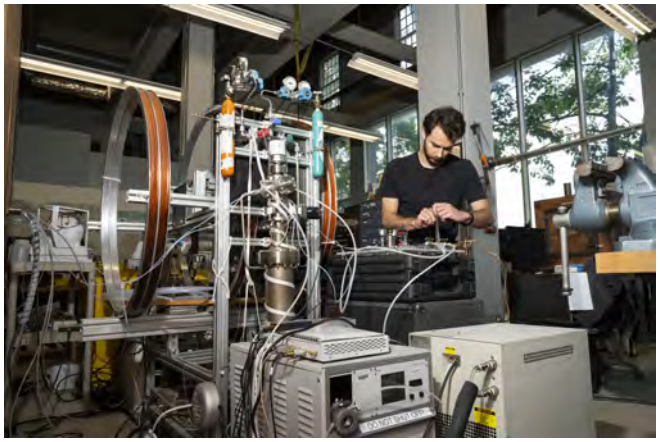
MRI-Linacs combine high quality imaging with delivery of radiation dose to tumours. Currently clinical treatment systems deliver dose guided by images acquired before treatment. This is because MRI is a slow imaging modality. To identify the tumour and normal tissues as the treatment is being delivered, new image processing and segmentation methods need to be developed. In projects funded by Tour de Cure and Cancer Council NSW, Dr David Waddington is leading the development of these methods for liver and pancreatic cancer. Dr Andrew Phair and Michale Ferraro have been recruited to the projects. Images for training models have been supplied from an MRI-Linac at GenesisCare, a partner in this research program.

Boosting the sensitivity and accessibility of MRI

Low-field MRI scanners could make MRI more accessible through lower-cost, reduced hazards and portability. The challenge is the loss of image quality at lower fields which requires new methods to process and segment the images or boosting signals through advanced imaging techniques. In 2025 a low-field Hyperfine Swoop MRI scanner was installed for teaching and research. PhD student James Grover led an entry to the Ultra-Low-Field MRI Image Enhancement Challenge to develop the AI methods to enhance ultra-low-field (64 mT) to high-field (3 T) quality. After a promising start on the international challenge data, images will be acquired on the new scanner to train the models.

Picture: Image of a brain phantom acquired on the Hyperfine Swoop scanner which is in the background.

Hyperpolarization MRI is an advanced imaging technique that boosts the MR signal from specific molecules allowing for real-time, non-invasive visualisation of metabolic pathways. It provides much greater sensitivity than conventional MRI, revealing functional and metabolic information. Dr Thomas Boele has continued his Fulbright fellowship - supported collaboration with Massachusetts General Hospital to demonstrate ultra-low field 13C MRI of hyperpolarized pyruvate.

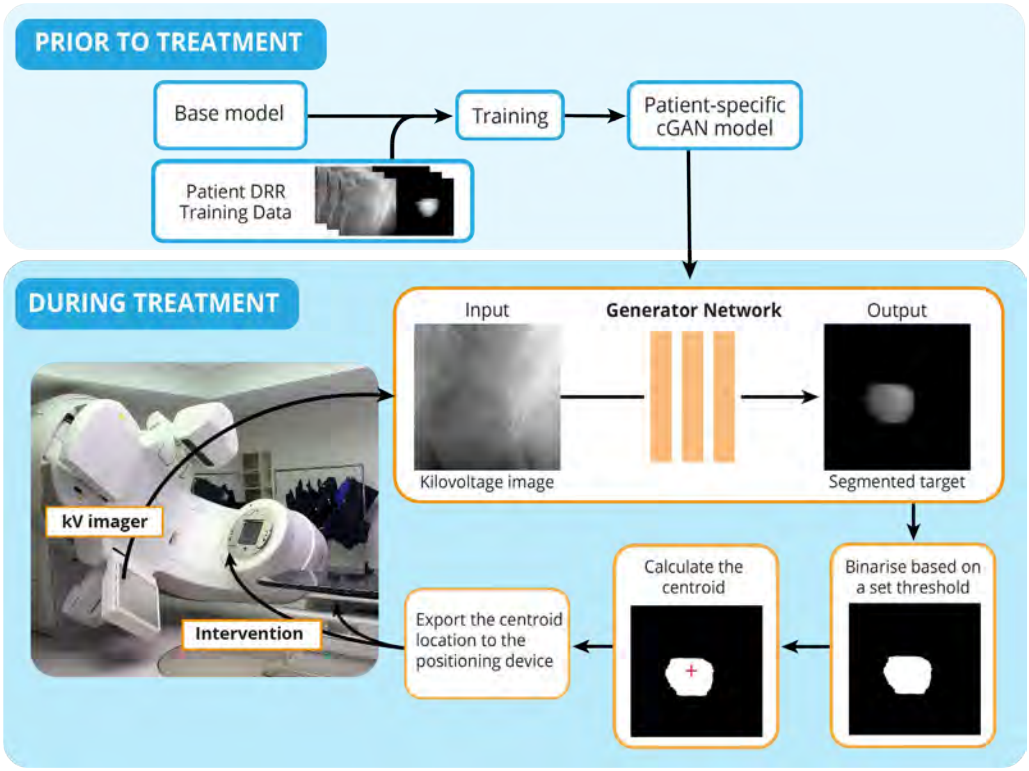


Picture: Dr Thomas Boele on a research visit to Massachusetts General Hospital.

HIGHLIGHTS – RADIOTHERAPY PILLAR

Targeted Radiotherapy with Artificial Intelligence Platforms

Targeted radiotherapy images the cancerous tumour in real-time, enabling the treatment beam to focus its destructive energy on the patient's cancer, not their healthy tissue. Targeted radiotherapy, on $10M devices has reduced side effects for 25% of cancer patients. However, >95% of radiotherapy is given on standard $3M devices. This clinical benefit has led to a global demand: over 70% of centres want better targeted radiotherapy but are limited by resources and capacity. To address this unmet need, we have invented an AI targeting radiotherapy platform for standard $3M devices. Our AI-targeting technology for liver cancer was deployed non-interventionally for the first time during a patient treatment at Gosford Hospital as part of the NHMRC Development Grant-funded Learning Environment for Artificial Intelligence in Radiotherapy New Technology (LEARN) study. Dr Chandrima Sengupta was central to clinically implementing the technology along with the markerless tracking team. Future work will deploy these methods prospectively in the MRFF NCRI grant-funded Real-Time IGRT clinical trial.



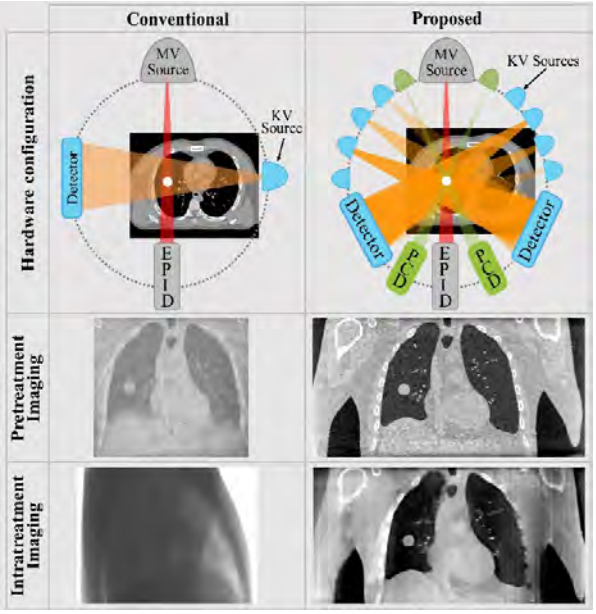
Picture: Our deep learning AI-based targeted radiotherapy approach.

Targeted Radiotherapy with Does-Guided Beam Adaptation

Adapting the shape of the beam to adjust for patient motion has been demonstrated to deliver doses to the target and normal tissues that more closely match the planned doses, compared to when no adaptation occurs. Dr Emily Hewson has further developed her tracking strategies based on the geometric position of the targets to include information on the dose already delivered to the targets. In 2025 she implemented her methodology experimentally with a research visit to UMC Utrecht. Here she had access to an MRI-Linac where she could integrate her beam shaping algorithms into a treatment system and measure the effects on the accuracy of dose delivery.

Targeted Radiotherapy with 3D pretreatment and intratreatment imaging

Replacing the conventional x-ray imaging source and detector on standard radiotherapy systems with an array of miniature Carbon Nano Tube (CNT) x-ray sources and Photon Counting Detectors (PCDs) has the potential to enable 3D imaging during treatment. In a Cancer Council NSW-funded project, Dr Owen Dillon has led integration of the novel hardware with a standard radiotherapy system at the Nelune Comprehensive Cancer Centre.



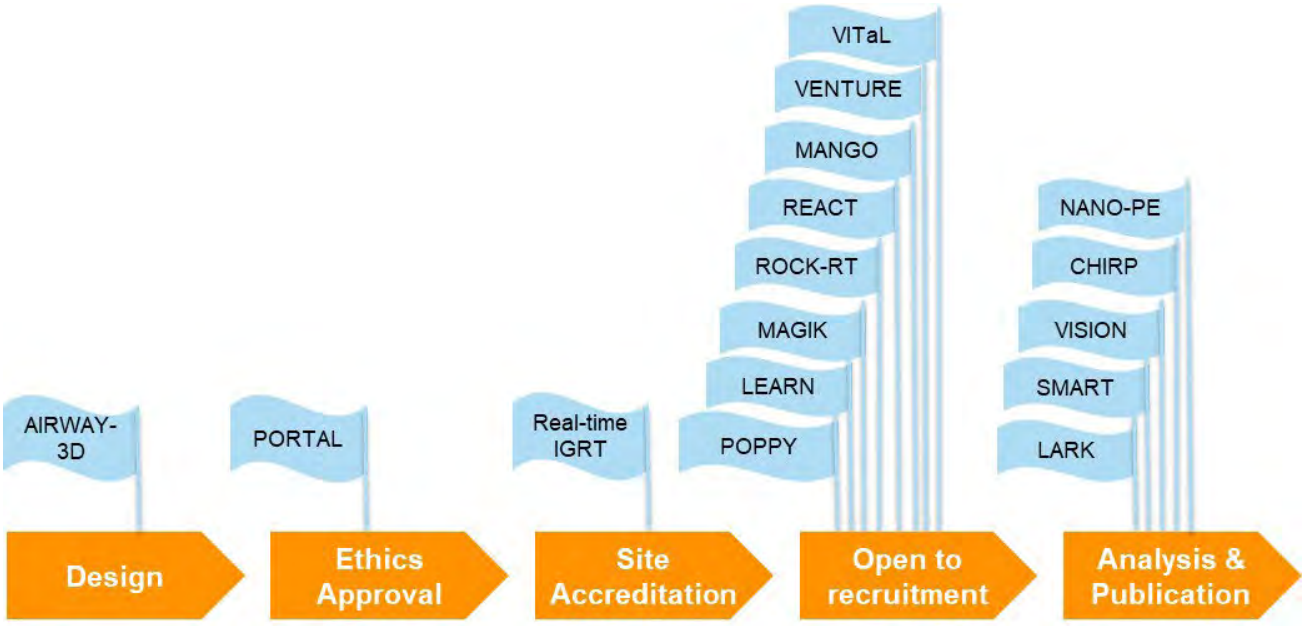
Picture: Novel imaging hardware producing 3D treatment images for targeted radiotherapy.

The goal is to produce MRI-quality images from robust, reliable, and relatively cheap x-ray scans with our dedicated research radiation therapy system and verify where radiation accumulates using a dose recording phantom. Additional funding from the Department of Industry, Science and Resources will support development of a prototype Quantum Computed Tomography (QCT) scanner. This technology uses CNT x-ray sources arranged in arrays, eliminating the need for mechanical movement. As a result, QCT scanners can be smaller, more efficient, and better suited for mobile clinics. The device aims to replace 2D x-ray systems in rural areas, supporting the $1B National Lung Cancer Screening Program, which requires 3D imaging for at-risk Australians who often lack access to conventional CT systems.

HIGHLIGHTS – CLINICAL STUDIES

Clinical Study Overview

Clinical studies are critical for translating discoveries into clinical practice. This report we celebrate a record number of 99 participants in our clinical studies and several important milestones in the clinical study life-cycle, from protocol approval, to recruitment of the first and last patients on a study. Successful completion of studies relies on the efforts of our researchers, clinical partners, patients and the guidance of our Clinical Trials Lead, Shona Silvester.



Picture: Status of our clinical studies.

Firsts in our clinical studies in 2025

- First patient recruited in the **POPPY** (Post-Operative Prediction of PulmonarY function) trial, a pilot study to assess the benefit of incorporating regional ventilation information in the prediction of post-operative lung function for lung cancer surgery. The treatment centre was Royal North Shore Hospital (RNSH)
- First patient treated in the **VENTURE** trial, a study evaluating the benefits of CT ventilation imaging outside of lung cancer radiation therapy. Fifteen patients will undergo SPECT/CT V/Q scans in the trial conducted at RNSH.

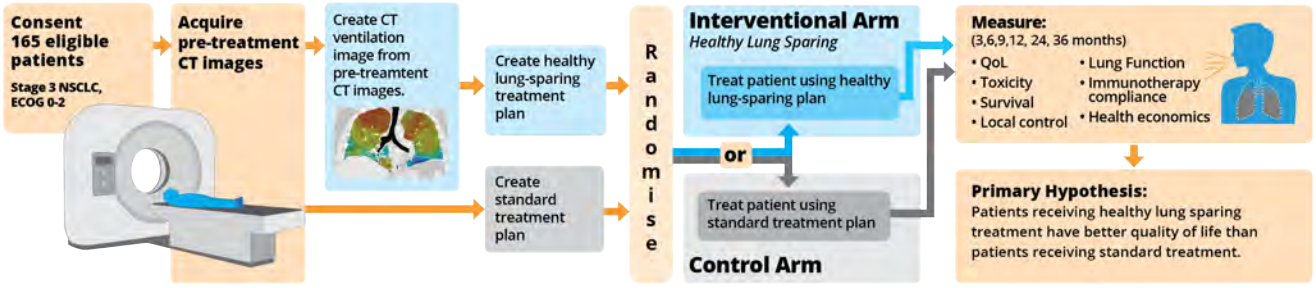
- First non-interventional deployment of our AI-targeting technology for liver cancer during a patient treatment at Gosford Hospital as part of the Learning Environment for Artificial Intelligence in Radiotherapy New Technology (**LEARN**) study.

Patient recruitment at a regional NSW treatment centre

Patients and clinical staff in regional areas often do not have the opportunity to participate in clinical trials. At the suggestion of one of our consumers, we have opened the **LEARN** study at treatment centres in Orange and Dubbo as well as metropolitan centres. In our largest clinical study to date, LEARN aims to develop and implement a whole-of-body markerless tracking method for measuring the motion of the tumour and surrounding organs during radiation therapy, enabling real-time image guidance. We've already reached a key milestone, with the successful recruitment of the first 10 out of 300 patients at the Orange Health Service Radiotherapy Treatment Service thanks to the efforts of Dr Chandrima Sengupta and our clinical partners in Orange.

NHMRC Clinical Trial and Cohort Scheme funding for the VITaL trial

The Ventilation Imaging to reduce Toxicity for Lung cancer RT patients (VITaL) trial will test the consumer-driven primary hypothesis that patients receiving healthy lung sparing treatment have better quality of life than patients receiving standard treatment. This randomised controlled trial will recruit 165 patients at treatment centres across Australia and will include a health economics analysis to provide evidence to support clinical adoption. We were delighted to receive a grant for nearly $2M from the NHMRC Clinical Trial and Cohort Scheme to support the trial. The protocol has been approved by the SWSLHD HREC and sites are being accredited to open for trial recruitment.



Picture: The double masked randomised controlled VITaL phase 3 trial schema.

HIGHLIGHTS – INDUSTRY ENGAGEMENT

Image X has strengthened partnerships with industry through applying for funding to test and translate our technologies. Companies we have partnered with on successful grant applications include:

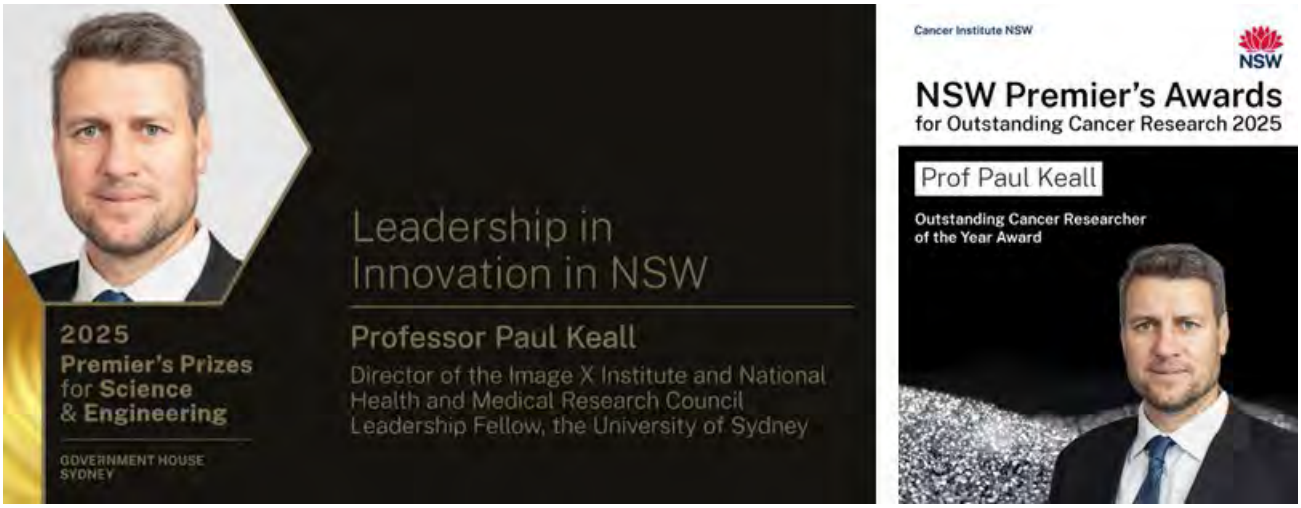
- 4D Medical who licensed our invention to develop their ventilation imaging product which will be used in the NHMRC CTCS-funded VITaL trial.
- MICRO-X; building the prototype CNT array devices for Cancer Council NSW- and DISR Critical Technologies Challenge Program-funded projects.
- SeeTreat; developing the AI-platforms for targeted radiotherapy into commercial products in MRFF NCRI-, Cancer Institute NSW TPG- and Australian Economic Accelerator (AEA) Ignite- funded projects.

Although not initially successful in 2025, an application to the NHMRC Development scheme received support from Siemens Healthineers and an application to the AEA Ignite scheme involved Deteqt and these projects will be further developed in 2026.

Dr Tess Reynolds extended her industry partnership with Siemens Healthcare to maintain unique access to the control system of a robotic C-arm imager and include her international collaborators in the agreement.

RECOGNITION

Prof Paul Keall received several awards in 2025. The Sally Crossing AM Award from the Cancer Council NSW is for achieving a significant outcome in the field of cancer research that benefits the community and involves consumers in Cancer Council NSW-funded research. The NSW Premier's Prizes in Science and Engineering awarded him the Leadership in Innovation prize. Prof Keall also received the NSW Premier's Outstanding Cancer Researcher of the year 2025 award.



Picture: A rewarding year for Prof Paul Keall.

Dr Thomas Boele was awarded the judges' prize for his presentation at the Sydney Clinical Imaging summit.

Dr Vicky Chin was awarded the Frank Ellis Medal, presented to the first author of the paper considered to have made the best contribution to advancing the cause of science in cancer treatment or in the use of radiation in the management of benign disease published in Clinical Oncology in a given year. She received the award from the Royal College of Radiologists at a ceremony in London.

Dr Nicholas Hindley was honoured with the Catalyst for Change Award at the NSW Cancer Summit and the award for the Best ECR presentation at the UNSW Optimisation Workshop. He was promoted to Level B commencing in 2026

Dr Tess Reynolds received the award for mentoring from the Sydney Early and Mid-Career Academic Network (SEMCAN). This is a competitive, University-wide scheme that recognises and rewards outstanding mentors. Dr Reynolds was promoted to Level D commencing in 2026.

Gregory Willson received the best PhD student presentation award at MedPhys25.

Picture: Image X researchers receiving their awards.

ENGAGEMENT

Image X Institute strives to connect with a diverse and dynamic community. This includes undergraduates and postgraduates, researchers within the Faculty of Medicine and Health, healthcare professionals, cancer survivors, consumer advocates, and the general public. In 2025 our researchers shared their work and their personal career journeys through a range of platforms, from panel discussions to videos, and created opportunities for engagement through symposium and seminar series.

PhD students, Chen Cheng and Alicja Kaczynska, were on the organising committee for two HDR student events, the 2025 Cancer Research Network Higher Degree by Research (HDR) Symposium and the Higher Degree by Research Careers Symposium. Dr David Waddington was a speaker at the career symposium.

Picture: The organising committee for the Cancer Research Network HDR Symposium including Chen and Alicja.

World Radiotherapy Awareness Day

The European Society for Radiotherapy and Oncology (ESTRO) promoted Dr Chandrima Sengupta as a future leader with the quote *Invest in science, innovate with purpose, and translate discoveries into practice to create a future where radiotherapy is personalised, effective and accessible to all*. Julia Johnson created a short video on what Image X researchers wished people know about radiotherapy https://youtu.be/1B-g9W0pzo8

Picture: Excerpts from the video for World Radiotherapy Awareness Day.

Cancer Education and Advocacy

The Remove the Mask project is championed, by our consumer Julie McCrossin. She created this video for a review of the project and the broader improvements in technology for head and neck cancer patients. It features Dr Youssef Ben Bouchta who led the development of surface guidance technology. https://www.youtube.com/watch?v=QHUQ7M7CSGk.

Dr Owen Dillon was interviewed for a video to promote the Cancer Council Box Car rally.

Picture: Dr Own Dillon interviewed for a Cancer Council NSW video and the flyer for the seminar series.

Emerging Women in Medical Physics and Radiology Seminar Series

In November the institute held its Emerging Women in Medical Physics and Radiology Seminar Series, initiated and curated by Tess Reynolds. The series was publicly accessible online, with the goal of providing a platform to share the amazing work being done by emerging researchers across a range of areas, with a post-talk Q&A with each speaker.

RESEARCH ACTIVITY

Research Funding and Scholarships

Commenced in 2025 (Image X researcher)

- Prof Paul Keall, Prof Shalini Vinod, A/Prof Sashendra Senthi, Prof Val Gebski, Prof Ricky O'Brien, A/Prof Nicholas Hardcastle, Dr Mbathio Dieng, Dr Rebecca Mercieca-Bebber, Prof Amit Sawant, Dr Surein Arulananda. *A randomised controlled trial investigating Ventilation Imaging To improve the quality of life for Lung cancer radiation therapy patients (VITaL).* NHMRC Clinical Trials and Cohort Scheme $1,861,324
- Dr David Waddington, Prof Paul Keall, Dr Emily Hewson, Prof Lois Holloway, Dr Trang Pham, Dr Michael Jameson, Dr Jeremiah de Leon, Prof Yves De Deene. *Improved MRI-guided radiotherapy for pancreatic cancer enabled by robust artificial intelligence.* Cancer Council NSW Project Grant $450,000
- Prof Ricky O'Brien, Dr Doan Trang Nguyen, Prof Paul Keall, Dr Pierre Qian. *New devices to treat arrhythmias with radiation.* NHMRC Development Grant $942,703
- Dr Thomas Boele. *Translating quantum physics to clinical benefit for cancer patients: Accessible metabolic MRI for biology-guided radiotherapy.* Sydney Cancer Partners Seed Grant $20,000 project costs and $29,910 for services at Sydney Imaging Core Facility.
- Dr Chandrima Sengupta. *The next generation of tumour targeting technology: Halving toxicity and treatment time with real-time adaptive liver cancer radiation therapy*. Cancer Institute NSW Early Career Fellowship $515,715
- Dr Nicholas Hindley. *Doubling access while halving toxicity with adaptive lung cancer radiation therapy.* Cancer Institute NSW Early Career Fellowship $518,766
- Dr Nicholas Hindley, Honorary Postdoctoral Fellowship, Heart Foundation
- Alicja Kaczynska. *Developing a novel image-guided radiotherapy technology to improve liver cancer patient outcomes.* Tour de Cure PhD Student Grant $10,000
- Chen Cheng. *Real-Time Volumetric Imaging of the Head and Neck on a Standard Linac Using a Kalman Filter*. Tour de Cure PhD Student Grant $10,000
- Prof Shankar Siva, Prof Ben Solomon, Prof Paul Keall, Dr Marliese Alexander, Prof Ken O'Byrne, Prof David Palma, Prof Jarushka Naidoo, Prof Richard De Abreu Lourenç, Prof Haryana Dhillon, Chris Brown, Dr Rebecca Mercieca-Bebber, A/Prof Nicholas Hardcastle, Dr Tracy Leong. *Primary Radiotherapy In MEtastatic Lung Cancer: PRIME-Lung*. MRFF NCRI - Innovative Trials scheme $1,496,596
- Dr Thomas Boele. FMH Bright Ideas $20,000
- Dr David Waddington. FMH Publication Scheme $4,000
- Prof Paul Keall. FMH Big Grant Accelerator $50,000
- Dr Tess Reynolds. FMH Near Miss 2025 $15,000
- Dr Nicholas Hindley. FMH Near Miss 2025 $15,000

- Jad Boutros. Australian Government RTP PhD stipend
- Alicja Kaczynska. Australian Government Research Training Stipend
- Gregory Willson. Australian Government Research Training Stipend

Awarded in 2025 and commencing in 2026 (Image X researcher)

- Prof Paul Keall, Dr Tess Reynolds, Dr David Waddington, Prof Annette Haworth, Prof Lois Holloway, Prof Jeremy Booth, Prof Shalini Vinod, Dr Emily Hewson, Dr Chandrima Sengupta, Dr Doan Trang Nguyen. *Bridging the Divide: Scalable Radiotherapy Innovations for People with Cancer*. Cancer Institute NSW Translational Program Grant $3,750,000
- Dr Tess Reynolds. *Delivering the future of 3D image guidance*. NHMRC Investigator Grant EL2 $1,623,700
- Prof Paul Keall. *Image Guided Radiation Therapy: From Discovery to Clinical Practice*. NHMRC Investigator Grant L3 $3,014,025
- Dr Owen Dillon, Mr Anthony Skeats, A/Prof Michael Jackson, Dr Saree Alnaghy, Prof Ricky O'Brien. *Quantum CT for Cancer Diagnosis in All Australian Clinics*. Critical Technologies Challenge Program Stage 2 $1,492,000
- Dr Saree Alnaghy, Mr Rui Lopes, A/Prof Michael Jackson, Dr Owen Dillon, Prof Paul Keall. *A Quantum Photon Counting Linac for Advanced Image Guided Radiotherapy*. Critical Technologies Challenge Program Stage 2
- Dr Chandrima Sengupta, Dr Zhuang Xiong, Mr Liubo Jin, Prof Paul Keall, Dr Doan Trang Nguyen, A/Prof Jeremy Booth, A/Prof Michael Jameson, Dr Benjamin Zwan, Dr Ryan Brown. *An AI enabled medical device to halve toxicity, reduce hospital visits and expand access to prostate cancer radiotherapy*. Australian Economic Accelerator Ignite Grant $499,916
- Dr Chandrima Sengupta, Dr Nicholas Hindley, A/Prof Andre Kyme, Dr Laura Bear, A/Prof Saurabh Kumar, Prof Oliver Blanck, Prof Geoffrey Hugo, Dr Michael Jameson, Prof Phillip Cuculich. *Tracking the beating heart: Enabling safe and effective radiotherapy for cardiac arrhythmias*. NHMRC Ideas grant $1,259,220
- Dr Nicholas Hindley, Dr Chun-Chien Shieh, A/Prof Dan Ruan, A/Prof Paul Segars, A/Prof Magdalena Bazalova-Carter. *Less toxicity, fewer hospital visits and improved clinician confidence: The future of liver cancer treatment with motion-adaptive radiation therapy*. NHMRC Ideas Grant $657,798
- Dr Suzanne Lydiard, Dr Peter Kerstens, Dr Leanne Tyrie, Mrs Shelley Donnell, Mrs Varissa Sheridan, Prof Paul Keall, Dr Chandrima Sengupta, Dr Zhuang Xiong. *Harnessing AI to halve toxicities in prostate radiotherapy*. Prostate Cancer Foundation of New Zealand Research Grant $45,000
- Michael Ferraro Australian Government RTP stipend

Publications

Assigned an issue or published online in 2025

- Ahmed, A. M., L. Madden, M. Stewart, B. V. Y. Chow, A. Mylonas, R. Brown, G. Metz, M. Shepherd, C. Coronel, L. Ambrose, A. Turk, M. Crispin, A. Kneebone, G. Hruby, P. Keall, and J. T. Booth. "Patient-Specific Deep Learning Tracking for Real-Time 2D Pancreas Localisation in kV-Guided Radiotherapy." *Phys Imaging Radiat Oncol* 35: 100794. https://dx.doi.org/10.1016/j.phro.2025.100794.
- Brighi, C., G. Parrella, L. Morelli, S. Molinelli, G. Magro, S. Lillo, A. Iannalfi, M. Ciocca, S. Imparato, D. E. J. Waddington, P. Keall, C. Paganelli, E. Orlandi, and G. Baroni. "Evaluating the Technical Feasibility of Biology-Guided Dose Painting in Proton Therapy." *Phys Imaging Radiat Oncol* 35: 100832. https://dx.doi.org/10.1016/j.phro.2025.100832.
- Büttgen, L. E., C. Sengupta, J. R. Sykes, D. Chrystall, O. Dillon, J. T. Booth, M. Stewart, J. Hindmarsh, R. Werner, P. J. Keall, and E. A. Hewson. "Toward Real-Time Dose-Guided Radiation Therapy: Deformable Multileaf Collimator Tracking Using Motion-Model-Derived Volumetric Images in Lung and Liver Cancer Patients." *Phys Med Biol*, 70, no. 17. https://dx.doi.org/10.1088/1361-6560/ae24db.
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- Gardner, M., Y. Ben Bouchta, D. Truant, A. Mylonas, J. Sykes, P. Sundaresan, and P. J. Keall. "Deep Learning-Based Real-Time Detection of Head and Neck Tumors During Radiation Therapy." *Phys Med Biol* 70, no. 15. https://dx.doi.org/10.1088/1361-6560/adf40e.

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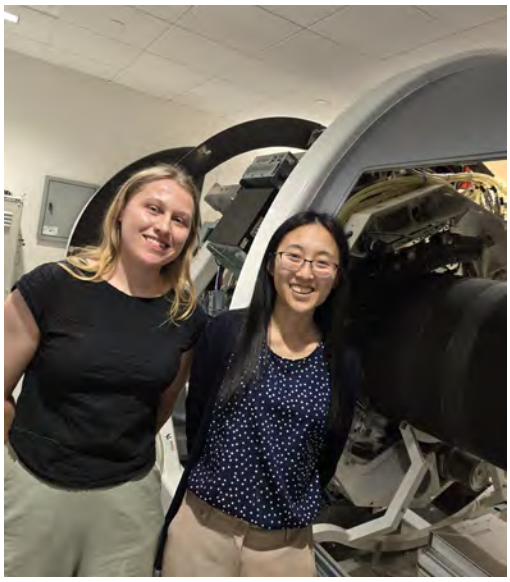
Intellectual Property

Dr Emily Hewson, Prof Paul Keall and former Image X researchers, Dr Lars Mejnertsen and Dr Trang Nguyen are inventors on the granted patent *Dose-based optimization for multi-leaf collimator ("MLC") tracking during radiation therapy methods and apparatus (US12318631)*. This method describes optimising radiotherapy in real-time using dose, the parameter most closely associated with local control for tumours and side effects for normal tissues. Previous methods of real-time optimisation relied on optimising geometry, which is a surrogate for dose in some situations, but less intuitive in more complex cases.

Other inventions proceeding to the Patent Cooperation Treaty (global phase) of the patent process were *Data-driven rapid cone-beam CT for new generation linacs* (Inventors Dr Mark Gardner, Dr Owen Dillon, Dr Hilary Byrne and Prof Paul Keall) and *X-ray motion tomography for motion compensation and ventilation imaging* (Inventors Dr Hunor Kertesz, Dr Owen Dillon, Dr Hilary Byrne, Prof Ricky O'Brien and Prof Paul Keall)

Invited Talks and other Professional Activities

- Dr Youssef Ben Bouchta presented a seminar on *Remove the Mask: A surface imaging journey* to the Institute of Medical Physics at the University of Sydney.



- Chen Cheng presented to the Medical Image Optimisation and Perception Group on *Volumetric imaging during head and neck radiation therapy using a Bayesian motion estimation approach*.
- Chen Cheng and Alicja Kaczynska visited the University of Texas Southwestern Medical Center to present on Real-time motion monitoring for radiation therapy on a standard linear accelerator. As well as an overview on Image X research they presented more specifically on their PhD work, *Volumetric Imaging During Head and Neck Radiation Therapy Using a Kalman Filter Tracking Approach* and *A Real-Time 6 Degrees-of-Freedom Image Guided Radiation Therapy Technology Using Internal-External Motion Correlation Modelling*.

Picture: Alicja Kaczynska and Chen Cheng visiting the University of Texas South-Western Medical Center.

- Chen Cheng and Alicja Kaczynska, were on the organising committee for two HDR student events, the 2025 Cancer Research Network Higher Degree by Research (HDR) Symposium and the Higher Degree by Research Careers Symposium.

- Dr Emily Hewson and Dr Chandrima Sengupta presented to the Asia Pacific Radiation Oncology Network (ASPRONET) on *Democratising Real-time Radiation therapy*.
- Jonathan Hindmarsh presented at the Institute of Medical Physics, USYD, on *Why and how to perform a hazard analysis*.
- Dr Nicholas Hindley presented *Real-time volumetric imaging: A 6-year update* to the Ingham Institute and Liverpool Hospital.
- Dr Nicholas Hindley presented in the NSW Cardiovascular Research Network Rising Stars Seminar Series on *Maximising access while minimising heart damage with real-time AI guidance during radiotherapy*.
- Alicja Kaczynska presented to the Asia-Pacific Radiation Oncology Network (ASPRONET) on *Real-Time Motion Monitoring for Radiation Therapy on a Standard Linear Accelerator* as part of an educational session.
- Prof Paul Keall gave a virtual presentation at the 11th Annual Loma Linda Workshop (California, USA) on *Towards real-time dose-guided radiation therapy: Similarities, differences, challenges and opportunities for proton and photon treatments*.
- Prof Paul Keall presented at the University of Malaya on *AI-powered targeted radiotherapy to halve treatment side effects for lung cancer patients*.
- Prof Paul Keall presented to the Orange and Dubbo Health Service radiation therapy treatment teams on *AI-powered targeted radiotherapy to halve treatment side effects for cancer patients*.
- Dr Andrew Phair presented to the SWSLHD & Ingham Institute Medical Physics program on A*ccelerating 3D Whole-heart Cardiac MRI*.
- Prof Paul Keall was a panelist in the meeting session *Optimising partnerships between researchers and consumer*s and pre-meeting technical workshop session *From Insight to Implementation - How Consumers Steer Research Success* for the TROG annual scientific meeting
- Dr Tess Reynolds gave an invited seminar at the University of Virginia on *Imaging Innovation in the Hybrid Theatre*.
- As well as leading the organisation of the 2025 Sydney Clinical Imaging Summit, Dr Tess Reynolds moderated the Infrastructure Updates session along with PhD Chen Cheng.
- Dr David Waddington presented to the USYD Medical Image Optimisation and Perception Group on *Fundamentals to Frontiers: Bench to Bedside Translation of Magnetic Resonance Technologies*.
- Dr David Waddington participated in an international webinar hosted by the American Association of Physicists in Medicine (AAPM) Global Early Career Research Subcommittee (GECRSC) and the Global Research Education Subcommittee (GRESC). The event, titled *"How to Start a Lab/Research Program"*, features speakers from around the world sharing their experiences in building a research program in medical physics.
- Dr David Waddington was a presenter and panelist for the Higher Degree by Research Careers Symposium.
- Dr David Waddington hosted and presented an immersive hands-on experience with a low field MRI scanner at the University of Sydney Community Festival.
- Dr David Waddington was a moderator at the International Society for Magnetic Resonance in Medicine for the session *Physics for Clinicians & Data Scientists*.

Conference Presentations

Picture: Mission submission - a one-day review of planned abstracts for 2026 conferences.

American Association of Physicists in Medicine Annual Meeting 2025 (Washington, DC, USA)

- O Dillon*. Novel X-Ray Sources and Their Applications. Invited Talk
- M Gardner*. *Targeting the Invisible: AI-Powered Real-Time Markerless Tumor Tracking During Radiation Therapy*. Invited Talk
- P Keall*. *Medical Physicists Leading Clinical Trials: Insights for Future Trial Leaders*. Invited Talk
- P Keall*. *Troubleshooting respiratory motion management: Will Task Group 324 help solve my clinical challenges?* Invited Talk
- T Reynolds*. *3D printed surgical solutions for orthopaedic training, education, and research*. Invited Talk
- A Kaczynska*, F Jin, P Keall, N Hardcastle, J Booth, C Sengupta. *A Real-Time 6 Degrees-of-Freedom Image Guided Radiation Therapy Technology Using Internal-External Motion Correlation Modelling*. Oral Presentation
- C Cheng*, M Gardner, O Dillon, Y Ben Bouchta, P Sundaresan and P Keall. *Improving Head and Neck Radiotherapy Accuracy through Real-Time Volumetric Imaging Using a Kalman Filter Approach*. SNAP Oral presentation
- Dillon, M Alzaabi, A Yan, J Johnson, A Kanawati and T Reynolds*. *Developing a physiological carotid artery phantom and verifying a Bayesian geometric calibration method for extended field-of-view interventional CBCT artery imaging*. SNAP Oral presentation
- F Jin, A Macdonald, A Mylonas, P Keall*, C Sengupta. *Towards Real-time Marker-less Prostate Tracking on Standard Radiation Therapy Systems*. SNAP Oral presentation
- H Kertesz*, P Keall, H Byrne, T Reynolds, R O'Brien, O Dillon. *X-Ray Motion Tomography: Creating 3D Lung Motion From Sparse 2D X-Ray Projections*. SNAP Oral presentation
- O Dillon, A Kanawati and T Reynolds*. *Twin table-tilt imaging: rapid metal artifact reduction intraoperative CBCT imaging during pedicle screw spinal fixation.* Blue Ribbon Poster presentation

- O Dillon, S Alnaghy, S Hood, T Reynolds, R O'Brien, P Keall*. *Inverse Geometry Photon Counting CBCT*. General Poster presentation
- C Duncan, P Malek, A Kanawati and T Reynolds*. *Developing 3D-printed synthetic vertebrae with realistic surgical haptic feedback and biomechanical properties*. General Poster
- M Gardner*, N Hindley, A Mylonas, V Chin and P Keall. *AI-Powered Real-Time X-Ray Guided Tracking to Improve Stereotactic Arrythmia Radioablation: Proof of Principle*. General Poster presentation
- J Hindmarsh, S Dieterich, J Booth, P Keall*. *Prospective Hazard Analysis in Radiation Therapy – a Systematic Review*. General Poster presentation
- J Lim, J Kipritidis, H Byrne, P Keall*. *Sensitivity of CT Ventilation Imaging to Image Acquisition and Reconstruction Parameters: A Phantom Study*. General Poster presentation

Picture: Image X presenters at the American Association of Physicists in Medicine Annual meeting in Washington.

55th Annual Scientific Meeting of the Australian and New Zealand Society of Nuclear Medicine (Melbourne, VIC)

- H Kertész, P Kench*. *Phantom evaluation of CT-less attenuation correction using the Total-Body PET/CT system*. Oral presentation

Australian Society of Molecular Imaging 2025 Symposium (Adelaide, SA)

- D Waddington*. *Signals of Change: New MRI approaches to imaging brain cancer with oxygen, iron, and carbon*. Keynote talk
- T Boele*. *Ultra-low field ^{13}C MRI of SLIC SABRE hyperpolarized pyruvate*. Oral presentation

European Respiratory Society 2025 meeting (Amsterdam, Netherlands)

- K Blokland*, H Kertész, K Tonga, D Chapman, G King. *Lung derecruitment by oscillometry is not related to mean lung density in asthma*. Poster presentation

European Society of Radiation Oncology 2025 meeting (Vienna, Austria)

- O Dillon*, B Lau, S Vinod, P Keall, T Reynolds, J-J Sonke, R O'Brien. 4DCBCT with clinical confidence in 63% less time and with 85% less dose: Results of the ADAPT clinical trial (NCT04070586). Oral presentation
- E Hewson*, S Lydiard, L Mejnertsen, P Keall. *Dose-optimised MLC tracking for stereotactic arrhythmia radioablation: striving toward eliminating treatment margins*. Oral presentation
- F Kan, F Jin, A Mylonas, B Zwan, T Moodie, N Hardcastle, T Nguyen, YY Lee, T Wang, P Ramachandran, D Mason, P Keall, C Sengupta*. *Deep Learning-Based Framework for Liver Tumour Motion Detection Using Fiducial Markers in Kilovoltage X-ray Images*. Poster presentation
- A Yan, C Sengupta, E Mathias, J Johnson, P Keall*. *Performance characterisation of the first open-source couch tracking system for accurate and efficient real-time adaptive radiotherapy*. Poster presentation
- C Sengupta*, B Zwan, F Jin, P Keall. *First implementation of an AI-enabled marker tracking algorithm on a clinical radiation therapy system*. Poster presentation
- J Booth*, A Ahmed, L Madden, M Stewart, G Metz, M Shepherd, C Coronel, P Keall, A Kneebone, G Hruby. *A patient-specific 2D contour prediction model for sub-millimetre tracking in real-time pancreas SBRT using deep-learning*. Poster presentation
- K Klucznik*, T Ravkilde, S Skouboe, P Keall, L Happersett, H Pham, B Leong, P Zhang, G Tang, P Poulsen. *First clinical online real-time motion-including target and bladder dose reconstruction during prostate SBRT delivery*. Oral presentation

European Society of Radiation Oncology Physics Workshop (Toulouse, France)

- C Sengupta*. *Achievements and challenges of AI-driven real-time image guided radiation therapy*. Invited talk

Experimental Nuclear Magnetic Research Conference 2025 (Pacific Grove, CA, USA)

- T Boele*, S McBride, M Pike, E Curran, P TomHon, D Waddington, T Theis, M Rosen. 10^6 x enhancement of ^{13}C-enriched pyruvate via in situ hyperpolarization in an ultra-low field MRI scanner. Oral presentation

International Society for Magnetic Resonance in Medicine & European Society for Magnetic Resonance in Medicine and Biology 2025 Annual Meeting (Honolulu, HI, USA)

- D Waddington*. *Junior Fellows & Lab Exchanges*, in the Educational Symposium*, Networking & Getting Involved with ISMRM?* Invited talk

- T Boele*, S McBride, P TomHon, D Waddington, T Theis, M Rosen. *10^6 x enhancement of ^{13}C-enriched pyruvate via in situ hyperpolarization in an ultra-low field MRI scanner*. Poster presentation
- J Grover*, S Shan, P Keall, D Waddington. *Ultra-acceleration: compounding AI reconstruction methods with end-to-end training to achieve over fifty-fold acceleration*. Poster presentation

Interspeech 2025 (Rotterdam, Netherlands)

- M Proctor, T Szalay, T Piyadasa, C Jin, N Sanaei, A Gully, D Waddington, S Foster, K Ballard. *Rhotic Articulation in Australian English: Insights from MRI*. Conference paper
- T Piyadasa, J Glaunès, A Gully, M Proctor, K Ballard, T Szalay, N Sanaei, S Foster, D Waddington, C Jin. *Constrained LDDMM for Dynamic Vocal Tract Morphing: Integrating Volumetric and Real-Time MRI*. Conference paper
- T Szalay, M Proctor, A Gully, T Piyadasa, C Jin, D Waddington, N Sanaei, S Foster, K Ballard. *Lateral Channel Formation in Australian English /l/: Insights from Magnetic Resonance Imaging*. Conference paper

IUPESM 2025 World Congress on Medical Physics and Biomedical Engineering (Adelaide, SA)

- C Cheng*, M Gardner, O Dillon, Y Ben Bouchta, P Sundaresan, P Keall. *Volumetric IGRT for head and neck radiotherapy using 2D x-ray images*. Oral
- C Duncan, H Wang, P Malek, A Kanawati, T Reynolds*. *3D-printed synthetic vertebrae: towards alternatives to human cadavers for orthopaedic surgical training and research*. Oral
- E Hewson*, S Lydiard, L Mejnertsen, P Keall. *Real-time cardiorespiratory motion adaptation using dose-optimised MLC tracking for stereotactic arrhythmia radioablation*. Oral presentation
- J Hindmarsh*, S Dieterich, J Booth, P Keall. *Prospective hazard analysis in radiation therapy – A systematic review*. Oral presentation
- A Kaczynska*, F Jin, P Keall, N Hardcastle, J Booth, C Sengupta. *The development and investigation of an internal-external motion correlation technology that enables real-time 6 degrees-of-freedom image guided radiotherapy*. Oral presentation
- G Kaur*, N Hardcastle, J Kipritidis, B Zwan, A Espinoza, J Beech, L Seddon, A Murray, K Grimberg, K Asgari, V Luong-Poole, A Moore, N Eikelis, H Byrne, P Keall. *Treatment planning guidelines for functional lung sparing in prospective randomised trials*. Oral presentation
- H Kertész, P Keall, H Byrne, T Reynolds*, R O'Brien, O Dillon. X-ray Motion Tomography: *A novel method to estimate lung motion directly from sparse 2D X-ray projections*. Oral presentation
- TK Nguyen, N Hindley, T Moodie, B Zwan, T Wang, YY Lee, DT Nguyen, P Keall, C Sengupta*. *Tracking The Invisible: Marker-less Liver Tumour Segmentation on Standard Radiation Therapy Systems*. Oral presentation
- C Sengupta*, F Jin, A Mylonas, P Keall. *The Next Generation of Tumour Tracking Technology: Towards Real-time Marker-less Prostate Tracking on Standard Radiation Therapy Systems*. Oral presentation

Medical Image Computing and Computer Assisted Intervention 2025 (Seoul, Korea)

- J Grover*, A Phair, M Ferraro, D Waddington. *Enhancing Ultra-low-field MRI with Segmentation-guided Adversarial Learning*. Poster presentation

MedPhys2025 (Sydney, NSW)

- J Hindmarsh*. *System theoretic process analysis of real-time radiotherapy using helical tomotherapy*. Oral presentation
- G Willson*. *Tracking the Invisible: Real-time Markerless Tumour Segmentation for Liver Radiotherapy Patients*. Oral presentation

National Imaging Facility 2025 Scientific Symposium (Adelaide, SA)

- D Waddington*. *Beyond T1 and T2: Unlocking New Contrast Mechanisms with Ultralow Field MR*. Invited talk

NSW Cancer Summit (Sydney, NSW)

- N Hindley*. *Maximising access while minimising toxicity: Real-time AI-guided radiation therapy*. Oral presentation

3rd NZ Workshop on Uncertainty Quantification and Inverse Problems (Auckland, NZ)

- O Dillon*. *Quantum Computed Tomography: Carbon Nanotube Sources to expand access and applications of 3D x-ray imaging*. Plenary talk

Optimisation Days workshop (Sydney, NSW)

- N Hindley*. *Real-time respiratory motion modelling during image-guided radiotherapy*. Invited talk

SPIE Medical Imaging 2025 (San Diego, CA, USA)

- T Reynolds*, C Duncan, P Malek, A Kanawati. *Comparison between masked stereolithography and fused deposition modelling 3D-printed synthetic vertebra for surgical training and simulation of pedicle screw fixation*. Oral presentation

Sydney Clinical Imaging Summit (University of Sydney)

- T Boele*. *Quantum-enabled accessible metabolic MRI*. Oral presentation
- N Hindley*. *Maximising access while minimising toxicity: Real-time AI-guidance during radiotherapy*. Oral presentation
- H Kertesz*. *X-ray Motion Tomography: A novel method to calculate lung ventilation images from sparse 2D x-ray projections*. Oral presentation
- D Waddington*. *Infrastructure update - Portable MRI at the University of Sydney*. Oral presentation

Thoracic Society of Australia and New Zealand (ANZ) / ANZ Society for Respiratory Science annual meeting (Adelaide, SA)

- O Dillon*. *Introducing Quantum CT*. Oral presentation

37th TROG Cancer Research Annual Scientific Meeting (Brisbane, QLD)

- P Keall*. *AI-powered targeted radiotherapy to halve treatment side effects for lung cancer patients*. Invited talk

GOVERNANCE AND OPERATIONS

Image X Institute Staff and Students

Academic Staff

Professor Paul Keall, Director, NHMRC Leadership Fellow

D Tess Reynolds, Deputy Director, Cancer Institute NSW and Robinson Fellow

Dr Youssef Ben Bouchta, Research Fellow

Dr Thomas Boele, Research Associate

Dr Vicky Chin, Research Associate

Dr Owen Dillon, Research Fellow

Dr Mark Gardner, Research Fellow

Dr Emily Hewson, Cancer Institute NSW Early Career Fellow

Dr Nicholas Hindley, Cancer Institute NSW Early Career Fellow

Dr Hunor Kertész, Research Associate

Dr Andrew Phair, Research Associate

Dr Chandrima Sengupta, Cancer Institute NSW Early Career Fellow

Dr Sophie van Rosendael, Research Associate

Dr David Waddington, NHMRC Emerging Leadership Fellow

Dr Zhuang Xiong, Research Associate

Ann Yan, Research Associate

Research Support Staff

Dr Helen Ball, Operations Manager
Kiran Benedict, Technical Assistant
Alen Biju, Research Assistant
Michael Ferraro, Research Assistant
Rose Hodges, Research Assistant
Freeman Jin, Software Engineer
Julia Johnson, Design & Communications Officer
Marcel Schulz, Clinical Trial Coordinator
Shona Silvester, Clinical Trials Lead
Fawazilla Utomo, Technical Assistant
Shirley Wang, Technical Assistant

HDR Students

Jad Boutros, Doctor of Philosophy
Chen Cheng, Doctor of Philosophy
James Grover, Doctor of Philosophy
Jonathan Hindmarsh, Doctor of Philosophy
Alicja Kaczynska, Doctor of Philosophy
Kankean Kandasamy, Doctor of Philosophy
Guneet Kaur, Doctor of Philosophy
Jeremy Lim, Doctor of Philosophy
Adam Mylonas, Doctor of Philosophy
Dr Yuvnik Trada, Doctor of Philosophy
Gregory Willson, Doctor of Philosophy

Undergraduate and Visiting Students

Laura Büttgen, Doctor of Philosophy, University of Hamburg
Kiran Benedict and Putu Jyoti Prema Putri, Dalyell individual research project
Elisa Levain, Masters of Imaging Medical and Surgical Robotics, Télécom Physique Strasbourg (internship)
Alistair MacDonald, Aidan Riethmuller, Alicia Sanggalo, Rawan Ayyash and Miles Stewart, Bachelor of Biomedical Engineering Honours projects
Michael Ferraro (Masters of Medical Physics), Alistair MacDonald (Bachelor of Biomedical Engineering), Tuan Khai Nguyen (Bachelor of Computer Science, Paramvir Singh (Masters of Computer Science), Shirley Wang (Bachelor of Advanced Computer Science/Bachelor of Science), and Hannah Yin (Bachelor of Biomedical Engineering) undertook Summer Vacation Research Projects.

Governance Committee

Our Governance Committee oversees the governance and progress of the Institute and provides direction and support in helping us to achieve our goals through the removal of barriers. The Image X Institute sits within the Clinical Imaging node of the Sydney School of Health Sciences and Faculty of Medicine, and the committee has representation from the institute, school and faculty levels as well as Research Operations and Finance.

Professor Collins (Chair), Associate Dean (Research Performance), Faculty of Medicine and Health

Professor Paul Keall, Image X Institute Director

Dr Helen Ball, Image X Institute Operations Manager

Mina Tang, Finance Manager, Sydney School of Health Sciences

Mark Kay, Director Post Award, Research Portfolio

Dr Tess Reynolds, Image X Institute Deputy Director

Dr David Waddington, Image X Institute Early Career Fellow

Professor Martin Ugander, Head of Clinical Imaging, Sydney School of Health Sciences

Executive Committee

Our Executive committee provides direction on key issues and operations of the institute.

Its membership includes senior/early career research academic, student and professional staff representation; Paul Keall, Helen Ball, Tess Reynolds, Nicholas Hindley, David Waddington and James Grover.

Picture: Image X researchers at the 2025 Research Planning retreat.