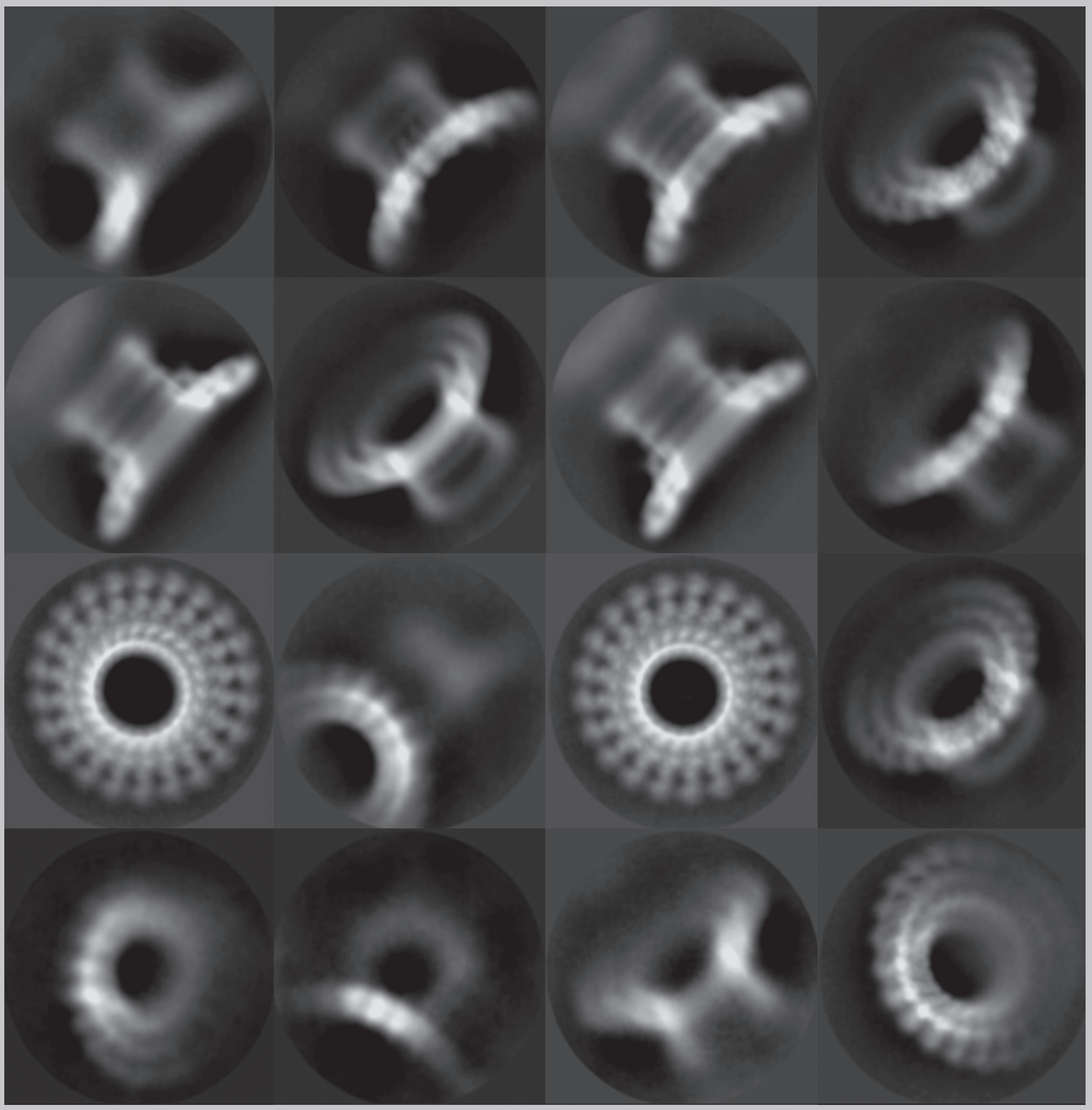
MASSIVE

Annual Report 2017–18



MASSIVE

Annual Report 2017–18

Partners

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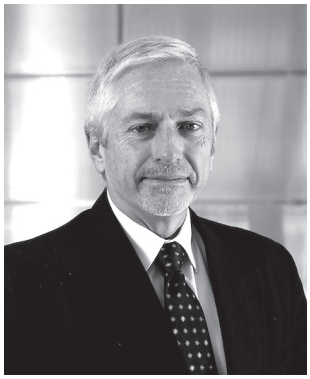


Dr Greg Storr
Chair, MASSIVE
Steering Committee

From the Chair

The disruption and innovation due to the digital revolution is evident in many aspects of how we live and work, and there are both great opportunities and risks that need to be managed to realise the potential of those opportunities. It has been a pleasure for me over the past two years to be involved with the MASSIVE project, which deals daily with opportunities and risks in the midst of the digital revolution.

MASSIVE's work in high performance computing, data analysis and data management, supports Australian scientific research that would not have been possible less than a generation ago. This annual report has been published at a time when there are many scientific endeavors, several which are summarised in this report, that use high-performance computing to improve the ability of researchers in academia, national laboratories and industry to understand and solve complex problems which lead to innovations that transforms society and the economy.

MASSIVE's technological capabilities and human expertise is having a national impact, as it supports research in several of the nine national focus areas identified in the National Research Infrastructure Roadmap report, including Characterisation and Digital data and eResearch. MASSIVE plays a significant role in discovery and research through the analysis of large amounts of data gathered from instruments that can measure and probe at length scales at molecular and atomic levels, and which allows researchers to meaningfully interpret that data using visualisation techniques. To meet the future growth of "big data", new imaging technologies and research that relies on linking these capabilities, MASSIVE will seek to partner with the best organisations and will support researchers who aim to solve problems that require specialised computing support.

I recognise the leadership and foresight of Monash University in establishing MASSIVE and the continuing support it has provided encouraging growth and developing contributing partnerships that reflect the growing diversity and networks necessary to make scientific research effective. I also recognise and thank the other major partners and Affiliate partners that have supported MASSIVE and wish them all continued success. MASSIVE's newest partner is the University of Wollongong which is expanding its capabilities in life-sciences microscopy, with two case studies in the report that demonstrate MASSIVE's expertise and value in optical and electron microscopy. I encourage you to read all the case studies provided in the annual report—they provide a snapshot of future transformation in our society.

The recent ISO9001 accreditation of the MASSIVE facility indicates an organisation that is committed to reliable operations which supports researchers and projects nationwide. This is a great offering which will enrich research outcomes and improve networks in important national science endeavors.

I express thanks to my colleagues on the MASSIVE Steering Committee for dedicating their time and expertise to assist with the governance and oversight of the MASSIVE facility, and my congratulations to the MASSIVE Director, Dr Wojtek Goscinski, and all of the MASSIVE team, for their successes and the expectation of many more in the future.

Dr Greg Storr, Chair, MASSIVE Steering Committee

Dr Wojtek James Goscinski
Coordinator, MASSIVE

Coordinator's Message

Welcome to our 2017-18 annual report. I'm very happy to report on a number of specific highlights, including our new partnership with University of Wollongong, ISO accreditation and continued growth of both the M3 system and our research.

It's with pleasure that I report that our M3 computer has received a serious upgrade, funded by Monash University, to over 4,000 CPU-cores and significant GPU capacity. This upgrade is essential to ensure that we're able to support our large user community once M1 and M2 are completely retired in December 2018. M3 is a software-defined HPC system that is built over the Monash research cloud. This architecture allows us to scale more efficiently and will mean we'll be able to upgrade the system with newer hardware with more frequency. Over the coming years, we plan to upgrade M3 up to twice per year. This will ensure that researchers have access to the newest possible hardware and allows MASSIVE to grow with demand.

MASSIVE has a commitment for ensuring quality, fairness and consistency in its operations, and reflecting this commitment, in 2017, we were accredited to the ISO9001:2015 Quality Management Standard. Our accreditation is the result of significant work in partnership with the Monash eResearch Centre and the Monash University Office of the Vice Provost (Research and Research Infrastructure) and I thank the Monash HPC team for this outcome.

I would like to very warmly welcome the University of Wollongong to the MASSIVE partnership. Their joining leverages the existing knowledge and workflows developed by MASSIVE in collaboration with the Ramaciotti Centre for Cryo Electron Microscopy at Monash University. I encourage you to read about the exciting University of Wollongong Molecular Horizons initiative and a snapshot of the work that will be undertaken using M3 (page 14-17). MASSIVE M3 now underpins four of the biggest data producing electron microscopes in the southern hemisphere.

It is worth highlighting two specific areas of growth that we have experienced since our last report. The growth in bioinformatics projects has been significant and to underpin this community, and it's growing needs, we have partnered with colleagues at the Monash Bioinformatics Platform (page 38-39).

Interest in applying machine learning techniques is also growing fast and this interest is well suited to MASSIVE hardware, our data processing focus and our partnership with NVIDIA. Researchers on M3 are quickly adapting new processing techniques, such as deep learning, to their data processing problems. I invite you to read about machine learning initiatives in robotic vision (page 32), neuroimaging (page 30), and language translation (page 46).

I would like to thank all the researchers who have contributed content and imagery to this report.

I would also like to thank the MASSIVE team, the Monash eResearch Centre, and the Monash University eSolutions team, who have all made outstanding contributions to the MASSIVE programme, and the MASSIVE Steering Committee for their governance.

Dr Wojtek James Goscinski, Coordinator, MASSIVE

Achievements in 2017-18

M3 has received a significant upgrade which is now available to researchers. The system consists of 4,112 CPU cores, and 168 NVIDIA GPUs across a range of configurations. M3 usage has grown to over 200 projects and over 600 users.

January 2017

MASSIVE and Monash University eSolutions moved both M2 and M3 computers to a new data centre with less than a week and a half of downtime. The new data centre facilities provide the highest level of environmental efficiency and accomodates future growth of the M3 system. With support from Monash University eSolutions, the MASSIVE team worked around the clock to ensure the move was completed as quickly and as efficiently as possible.

September 2017

MASSIVE is a key participant in the creation of *A Collaborative Australian Characterisation Informatics Strategy*, an outline the major informatics challenges faced by researchers using characterisation instruments, and the strategies that a coordinated Australian approach can apply to help address these challenges. Page 20 provides an outline of this strategy and the way that MASSIVE is collaborating with Universities and NCRIS capabilities to implement it.

September 2017

The Characterisation Virtual Laboratory is studied as part of a report commissioned by NeCTAR and undertaken by the Victorian Institute of Strategic Economic Studies on the impact of Virtual Laboratories. The report found researchers self reported an increased efficiency of 31% by using the CVL, and 75% of CVL users reported a moderate, major or severe impact if they could not access CVL resources.

November 2017

MASSIVE has a commitment for ensuring quality, fairness and consistency in its operations, and reflecting this commitment, the facility has been successfully accredited to the ISO9001 quality standard.

January 2018

After nearly 7 years and over 30 million CPU-core hours, the M1 system has been decommissioned. Through instrument integration work and workflows at Australian Synchrotron, M1 has underpinned 446 beamtime allocations, totaling over 791 investigators, across 94 Australian and International research institutions and industry. Likewise, the M2 system is scheduled to be turned off at the end of 2018—which is almost 8 years of continuous service.

March 2018

The M3 system is upgraded to 4,112 CPU-cores, and a 3PB parallel file system.

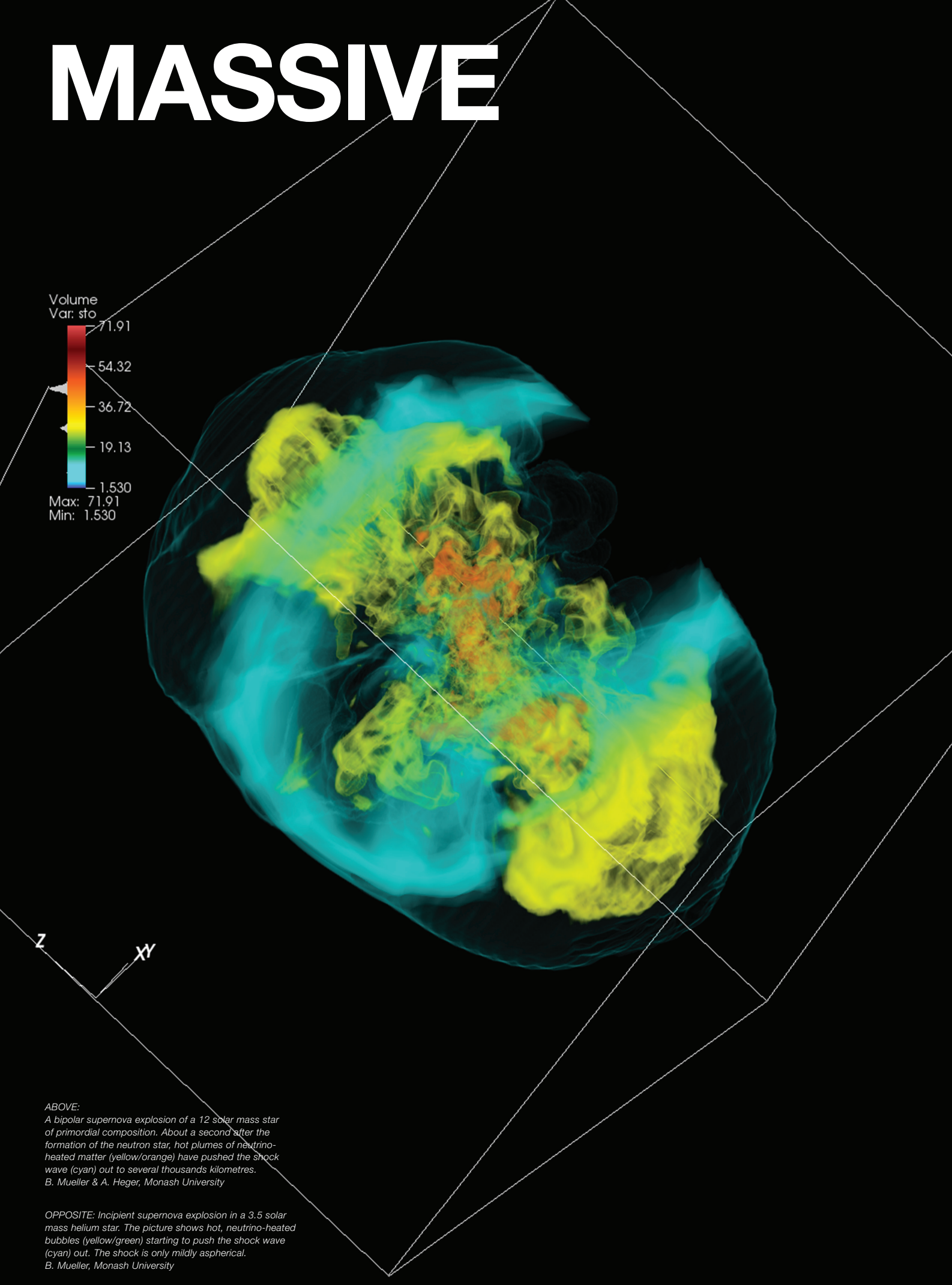
March 2018

MASSIVE has seen a significant growth of bioinformatics and data science projects, which now account for 14% and 11% of research projects. Neuroscience remains the largest cohort of users on the M3 system.

July 2018

The University of Wollongong joined the MASSIVE partnership to provide a critical computing infrastructure component to the $80m Molecular Horizons initiative. University of Wollongong now houses one of Australia's most powerful biological electron microscopes—the Titan Krios cryo-EM microscope—and high-powered optical microscopes will follow.

MASSIVE



ABOVE:
A bipolar supernova explosion of a 12 solar mass star of primordial composition. About a second after the formation of the neutron star, hot plumes of neutrino-heated matter (yellow/orange) have pushed the shock wave (cyan) out to several thousands kilometres.
B. Mueller & A. Heger, Monash University

OPPOSITE: Incipient supernova explosion in a 3.5 solar mass helium star. The picture shows hot, neutrino-heated bubbles (yellow/green) starting to push the shock wave (cyan) out. The shock is only mildly aspherical.
B. Mueller, Monash University

MASSIVE is a data processing engine for Australian science and it empowers researchers to unlock impactful research discoveries within scientific data.

What is MASSIVE?

MASSIVE is a world-class, quality-accredited, high performance, data processing facility that provides access to data processing capacity as the scale required to make impactful research discoveries. By building strong partnerships with research communities MASSIVE aims to underpin experimental and wet laboratory scientists who are capturing ever-increasing amounts of data.

The MASSIVE project is a collaboration between four partners: Monash University, CSIRO, ANSTO, University of Wollongong, and two affiliate partners; the ARC Centre of Excellence in Integrative Brain Function (CIBF), and the ARC Centre of Excellence in Advanced Molecular Imaging (Imaging CoE).

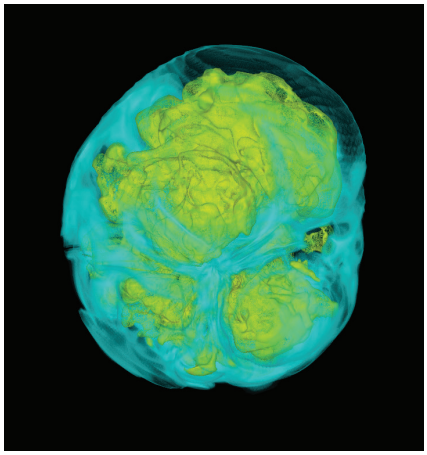
The MASSIVE facility has supported 2,500+ researchers from 100+ institutions and it has a national focus (41% of our users are from outside Victoria). MASSIVE is the only Australian HPC facility, to our knowledge, to receive ISO9001 accreditation, ensuring quality, fairness and consistency in operations.

MASSIVE runs two computers. M2 (2,224 cores, 328 NVIDIA GPUs, 650TB fast file system) is currently being decommissioned after nearly 7 years of life. Our newest computer, M3 (4,112 cores, 168 NVIDIA coprocessors, 3PB fast parallel file system), was purchased in 2016 and upgraded in 2018 through a $6m Monash University investment.

Data Processing for Next-Generation Science

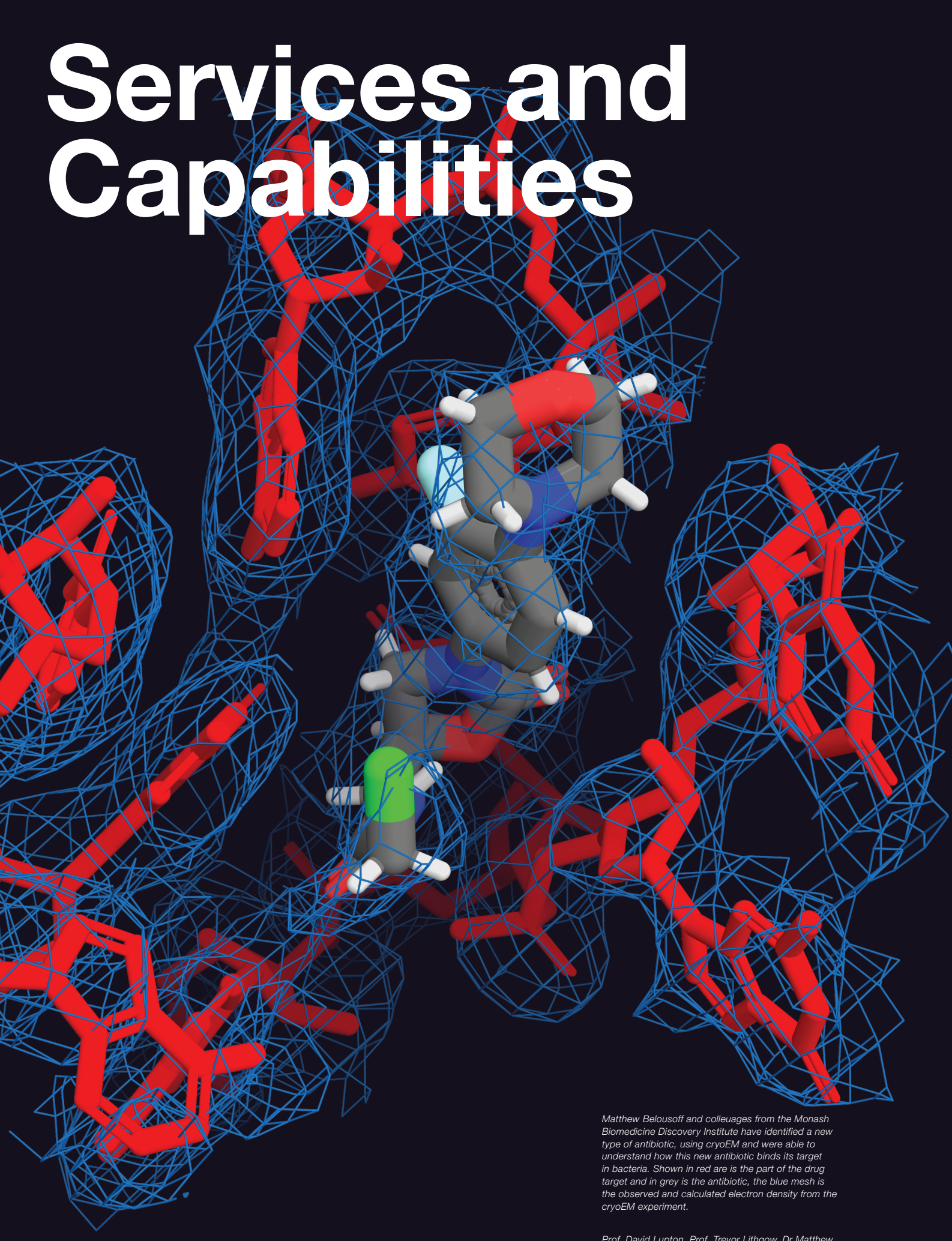
New technologies are providing revolutionary high resolution sensing and imaging capabilities across all of the scientific length scales. As a result, a range of scientific disciplines have rapidly entered into an unprecedented new era of “big data”, where routine analysis of multi-terabyte scale datasets and data collections are now essential across all of science. The scientists who apply modern techniques are thus no longer able to process data on desktop or laptop computers, and instead must rely on accessing specialized high performance computers in order to analyse their data. Data volumes are increasing with new detector technology, and processing requirements are increasing such that the science is being affected by the availability of computing.

MASSIVE is a platform to address multiple challenges that affect science broadly across many different disciplines. The design of the infrastructure is such that it permits data capture and processing from key instruments situated around Australia. Further, specialized, instrument specific compute workflows permit scientists from around Australia to deploy common approaches to challenging scientific problems. For many of the instruments attached to MASSIVE the workflows are optimized such that data analysis can be performed “in experiment”.



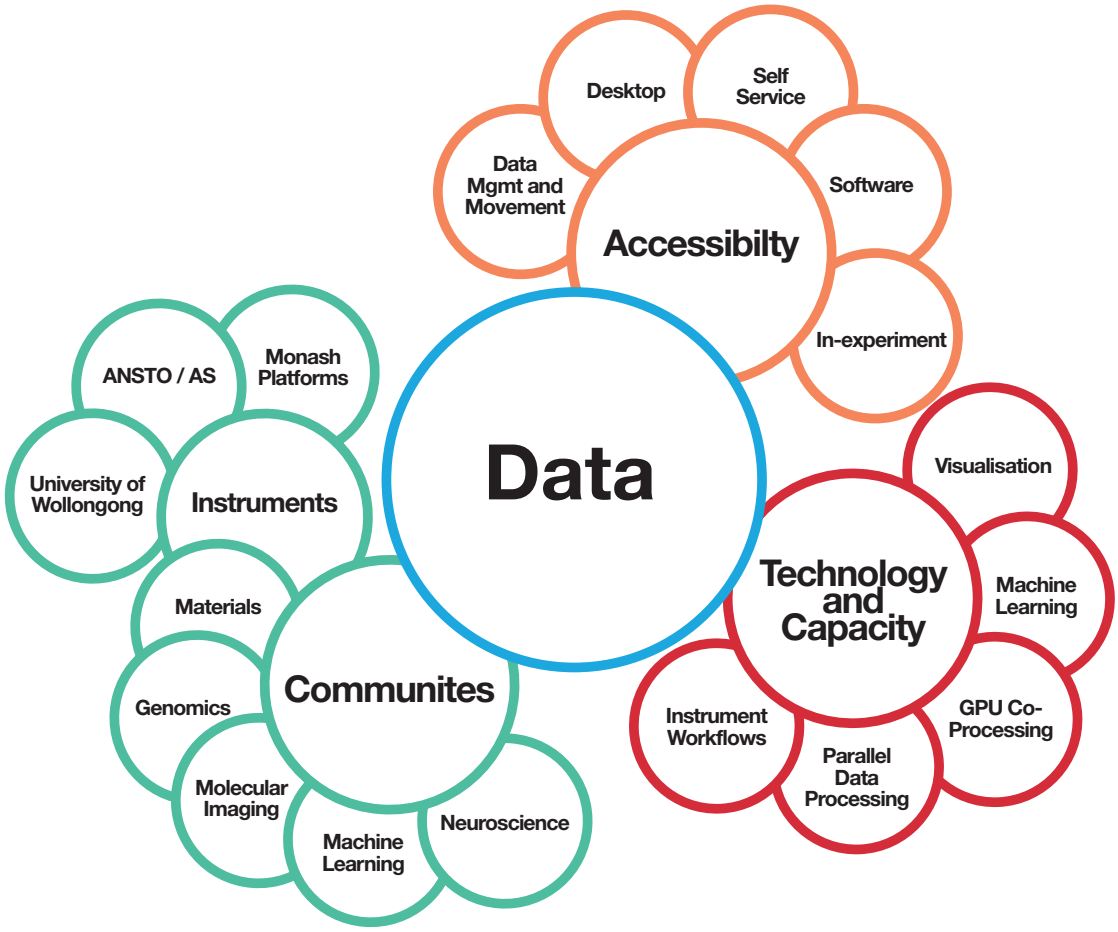
In particular, high-resolution imaging is revolutionizing science. For example, in biology the development of high throughput electron microscopes and direct electron detectors has resulted in a “resolution revolution” and the visualization of the structures of large macromolecules that previously were considered unattainable. These advances in imaging technologies, however, bring great challenges in regards to data quantity and data analysis. To address this problem access to advanced HPC is essential. MASSIVE addresses the needs of a significant proportion of our partner research community who rely on imaging for discovery. Further, the application of machine learning to extract quantitative information from large imaging datasets will permit the national research community to address problems previously considered impossible.

Services and Capabilities



Matthew Belousoff and colleuages from the Monash Biomedicine Discovery Institute have identified a new type of antibiotic, using cryoEM and were able to understand how this new antibiotic binds its target in bacteria. Shown in red are is the part of the drug target and in grey is the antibiotic, the blue mesh is the observed and calculated electron density from the cryoEM experiment.

Prof. David Lupton, Prof. Trevor Lithgow, Dr Matthew Belousoff, Alexander Wright, Samuel Seoner, Rebecca Bamert



Integrative High Performance Computing

With the goal of impacting wet lab and experimental scientists who are capturing ever-increasing amounts of data, the MASSIVE facility has intentionally taken an approach that is complementary to peak HPC. This approach is integrative and this means an emphasis on:

- usability by new HPC user communities over capacity;
- hardware suited to data processing over simulation;
- underpinning high performing wet and experimental laboratories, with growing data processing needs;
- workflows that increase return on investment in instruments; and
- porosity and flexibility to serve specific requirements in the life sciences.

MASSIVE delivers world-class data processing, analysis and visualisation capability through a focus on: Technology and Capacity; Community; and Accessibility

Technology and Capacity

MASSIVE provides access to high performance computing hardware that is designed for data processing, analysis and visualisation. This capability is delivered via M3 which was commissioned in 2016 and entered full production in 2017. It is a goal of the project to upgrade M3 twice per year with both a large-scale upgrade, and a smaller specialised upgrade.

At July 2018, M3 is composed of 4,112 CPU cores, 168 GPU co-processors across a range of products suited to parallel processing, visualisation and machine learning, and a 3PB fast parallel Lustre file system. M3 provides a combination of GPU coprocessors, including the NVIDIA K1 (for remote scientific desktops), K80, P100, V100, and the DGX1-V.

Communities

MASSIVE underpins a wide variety of research fields, including neuroscience, molecular imaging, genomics, material science and engineering. These fields share a number of characteristics:

- The increased availability of scientific instruments that produce large volumes of multidimensional or large-cohort data.
- The increased opportunity offered by the availability and volume of data that requires significant processing, analysis and visualisation to gain insight.
- The increased opportunity offered by data and compute intensive processing techniques, including machine learning.

Accessibility

With the goal of impacting wet lab and experimental scientists, MASSIVE has a strong focus on accessibility. To underpin this new generation of HPC users, MASSIVE applies a number of initiatives, including:

- An instrument integration program, to provide data capture, processing and visualisation from the point of capture, and in specific cases ‘in-experiment’.
- MASSIVE develops a curated remote desktop environment that is used by hundreds of researchers. The Strudel suite of software we developed to make interactive HPC easy is used at NCI, Pawsey, Jülich Supercomputing Centre, and many other HPC facilities.
- MASSIVE is deploying resource allocation management software, developed by the Monash eResearch Centre, to allow researchers easier self management of their projects, resources and accounts.

Hardware

The MASSIVE systems have the following hardware specifications

M2

To be decomissioned in late 2018

118 nodes (1720 CPU-cores total) in four configurations

244 NVIDIA GPUs
- 76 NVIDIA K20
- 20 NVIDIA M2070Q
- 148 NVIDIA M2070s

4 x QDR Infiniband interconnect

500TB of GPFS parallel file system

CVL

On the Monash Research Cloud

31 nodes (359 cores) in five configuration, setup for desktop and compute purposes.

NVIDIA K1 & K2 GPUs

M3

Stage 1 and 2

165 nodes (4,188 cores) in ten configuration, setup for desktop and compute purposes.

2.9PB Lustre parallel file system

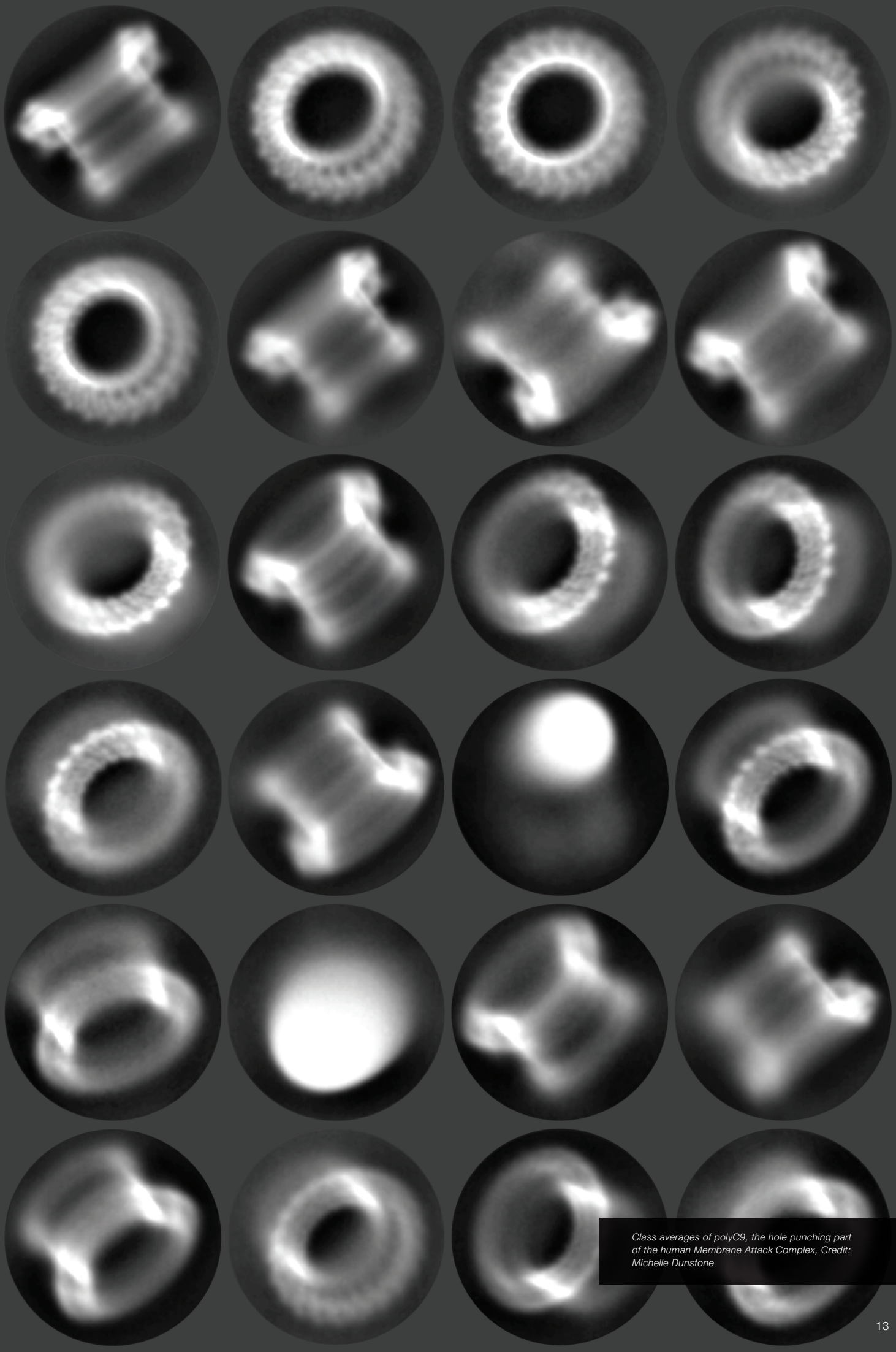
100Gb/s Ethernet Mellanox Spectrum network

Supplied by Dell, Mellanox, NVIDIA

MASSIVE aims to upgrade M3 on a yearly or twice yearly basis

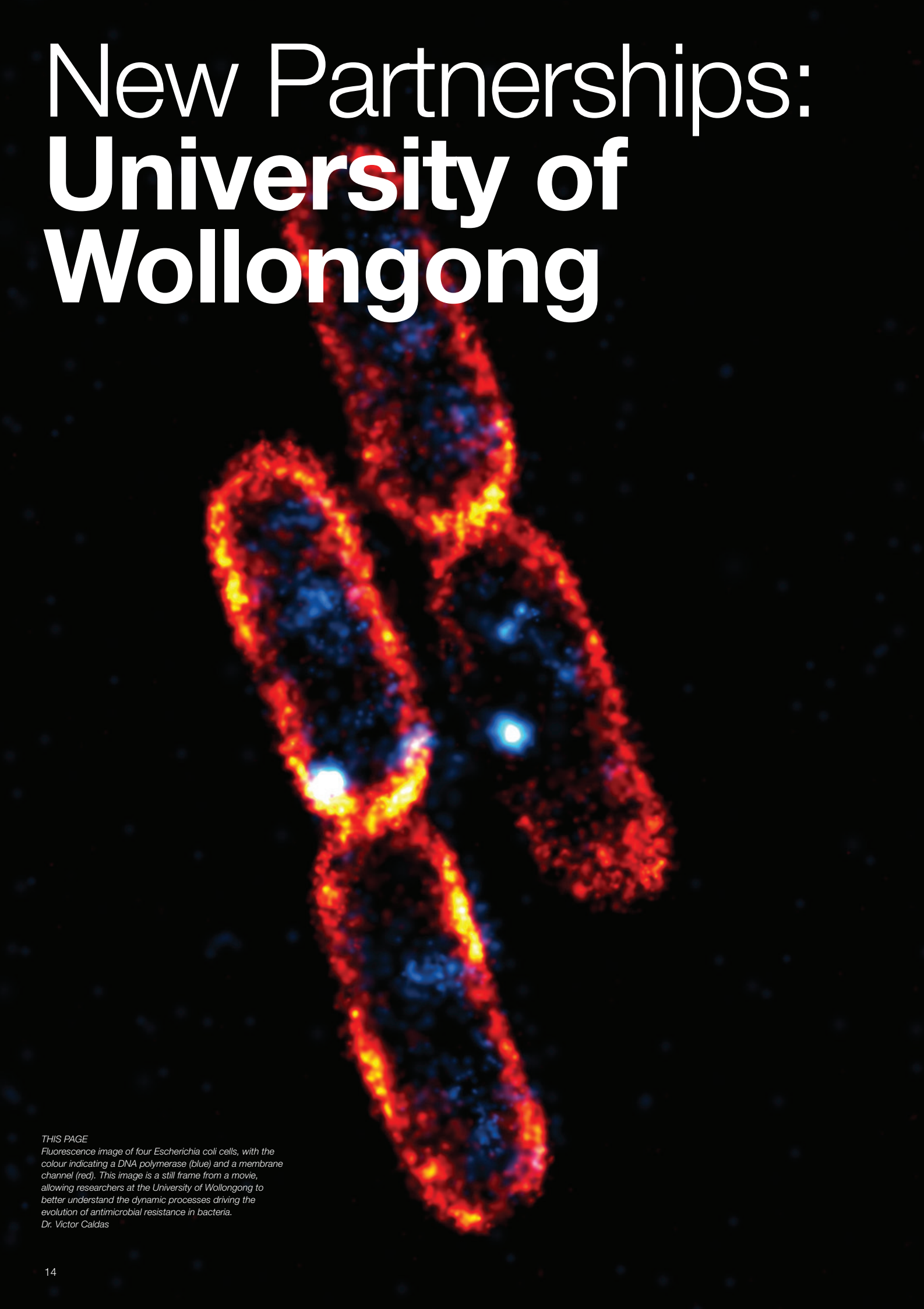
Purpose	Type	Nodes	Cores /Node	Processor	Memory /Node	GPU	GPUs /Node
Compute	Standard memory	22	24	2 x Intel Xeon CPU E5-2680 v3	128GB		
	Medium Memory	13	24	2 x Intel Xeon CPU E5-2680 v3	256GB		
	High-Density CPUs	48	36	2 x Intel Xeon Gold 6150	192GB		
	High-Density CPUs High Memory	1	36	2 x Intel Xeon Gold 6150	1TB		
GPU Compute	High-Density GPUs	1	24	2 x Intel Xeon CPU E5-2680 v3	256GB	NVIDIA Tesla K80	4
	P100	14	28	2 x Intel Xeon CPU E5-2680 v4	256GB	NVIDIA Tesla P100	2
	V100	20	36	2 x Intel Xeon Gold 6150	384GB	NVIDIA Tesla V100	3
	DGX-1V	1	40	2 x Intel Xeon CPU E5-2698 v4	512GB	NVIDIA Tesla V100	8

	Type	Desktop Sessions	Cores/ Desktop	Processor	Memory/ Desktop		GPUs/ Desktop
Desktop	Standard	32	3	2 x Intel Xeon CPU E5-2680 v3	16GB	NVIDIA Grid K1	1
	Large	26	12	2 x Intel Xeon CPU E5-2680 v3	128GB	NVIDIA Tesla K80	2



Class averages of polyC9, the hole punching part of the human Membrane Attack Complex, Credit: Michelle Dunstone

New Partnerships: **University of Wollongong**



THIS PAGE
Fluorescence image of four Escherichia coli cells, with the colour indicating a DNA polymerase (blue) and a membrane channel (red). This image is a still frame from a movie, allowing researchers at the University of Wollongong to better understand the dynamic processes driving the evolution of antimicrobial resistance in bacteria.
Dr. Victor Caldas

Optical microscopy: Connecting the data

Microscopes so powerful they can be used to show protein structures and peer inside the cells of a whole, living organism are being built at the University of Wollongong.

The $80 million Molecular Horizons initiative will see the university house one of Australia's most powerful biological electron microscopes—the Titan Krios cryo-EM microscope—as well as high-powered optical microscopes. The initiative has also led to a partnership between the University of Wollongong and MASSIVE, which will provide the supercomputing capacity and capability to support this major scientific initiative.

When the building to house this world-class equipment is completed in 2019, these microscopes will be capable of imaging not just individual biological molecules, but to visualise these molecules in action inside the cells of something as large as a roundworm or zebra fish.

"It's the kind of microscopy that can show you living cells at extremely high resolution and at high speed, and even living cells in a tissue context or in a whole organism," says Professor Antoine van Oijen, Australian Research Council Laureate Fellow and Director of Molecular Horizons. "It places the molecular knowledge in a cellular context."

This incredibly high-resolution microscopy generates vast amounts of data; potentially hundreds of terabytes every day. When it was developing the Molecular Horizons initiative, the University of Wollongong had the choice of either investing in its own data storage and processing capacity, or to collaborate with an institution that had already established that infrastructure. It went with the latter, and with MASSIVE.

The Molecular Horizons centre now transmits data from its cryo-electron microscope—which is already up and running—to MASSIVE via a high-speed glass-fibre connection. At MASSIVE, those hundreds of thousands of noisy images are cleaned and processed to generate the high-quality three-dimensional images of whatever protein or protein complex researchers are interested in. This agreement sets a benchmark for networks of data-generating microscopy and data-processing institutions such as MASSIVE, which is vital when dealing with such expensive pieces of equipment, van Oijen says.

"MASSIVE plays a key role there because they're setting up an ecosystem that allows people to do that," he says. "And that's really the strength—it's not just the massive storage and computational capacity, it's the way they have started to look at how people interact with their data."

Electron microscopy: Assembling a biological puzzle

Imagine trying to assemble a three-dimensional jigsaw consisting of hundreds of thousands of pieces, but without any sense of the final picture.

That's the challenge facing researchers at the University of Wollongong's cryogenic electron microscopy unit, who are using one of Australia's most powerful microscopes to determine the structure of proteins down to the level of the individual amino acids or even to the level of its individual atoms. Cryo-electron microscopy is a fundamental tool in structural biology, as it enables researchers to work out the function of a protein or protein complex by studying its 3D structure at the molecular level.

Unlike X-ray crystallography, which requires a protein to be grown into a crystal form to determine its molecular structure, cryo-electron microscopy involves vitrifying the protein, or freezing it in its hydrated form without generating ice crystals. This protects its structure from the vacuum of the electron microscopy chamber, and keeps the protein close to its native state as much as possible. "Freezing it also immobilises it, because you don't want things to move around when you're imaging them," says Dr Gökhan Tolun, senior lecturer in the School of Chemistry and Molecular Bioscience at the University of Wollongong.That protein is then imaged using a cryo-electron microscope. But this generates only two-dimensional images of a three-dimensional structure—like an X-ray of the human body.

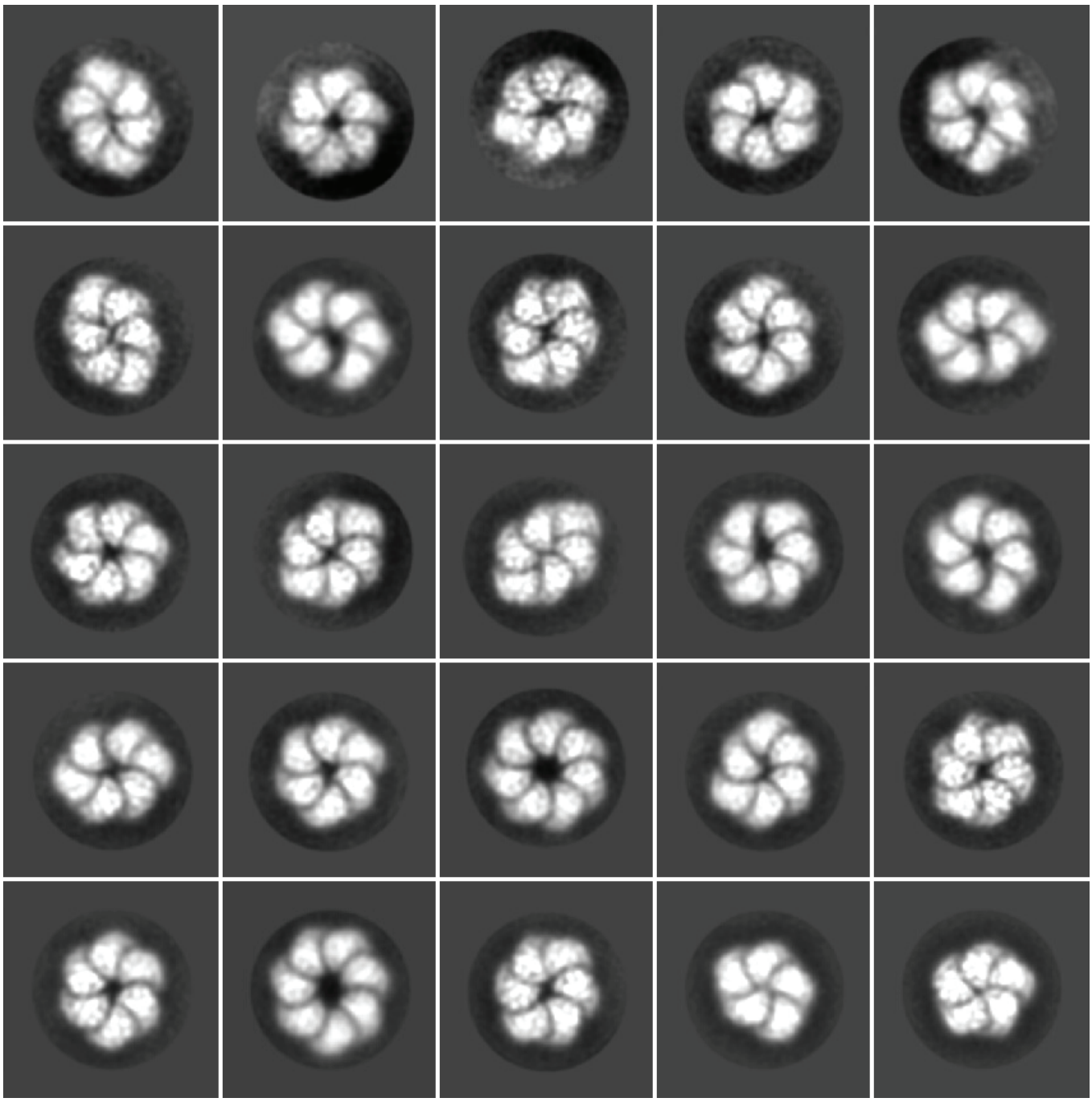
For the three-dimensional structure to be reconstructed, hundreds of thousands, even millions of protein particles have to be imaged to generate tens of thousands of quality images of the 'good' particles.

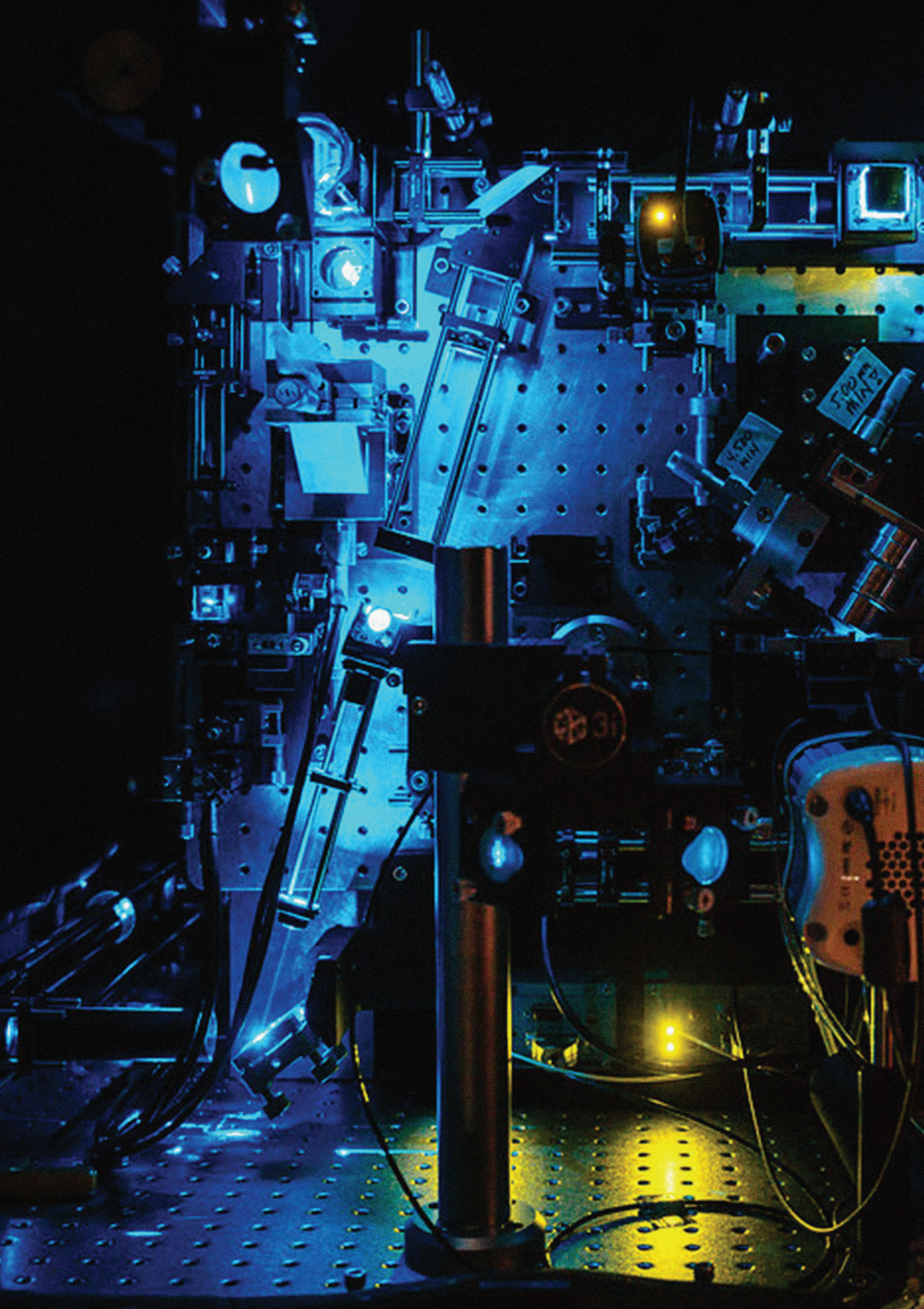
There are also a lot of artefacts in the images, which can sometimes make it difficult to clearly see the protein particles amid the noise or contamination. To make matters more complicated, the protein itself could be in any position; upside-down, sideways, or tumbling.

Putting together this three-dimensional structure therefore requires huge amounts of computing power, which is provided by MASSIVE. "To be able to back-project the two-dimensional images into three dimensions to reconstruct the three-dimensional structures of the proteins, protein complexes or nucleoprotein complexes, we have to know exactly at what angle they froze, which is called orientational assignment," Tolun says. "That's where we need computational power, because we are analysing hundreds of thousands of particles."

Quaternary structure variability of DnaB:
The cryo-EM image data analysis shows that E. coli DnaB, which is a protein involved in DNA replication, has at least three different oligomeric states: pentameric, hexameric and heptameric; made up of five, six and seven subunits, respectively.

The cryo-EM image data was collected from a Thermo-Fisher FEI Talos Artica cryo-electron microscope fitted with a Falcon III direct electron detector. Movies of each image were motion-corrected using Motioncorr2 and CTF-corrected using Gctf. RELION was used for picking ~230,000 particles, which were used for generating the select 2D class averages shown here. This result is a part of Dr Tolun's work-in-progress project towards determining the 3D structure of E. coli DnaB, preferably in all three of these states. This work helps to better understand the molecular dynamics of DnaB, and its function in DNA replication. This, in turn, will help reveal further molecular mechanistic details of DNA replication, a vital task in cells.




500 MW
450 MW

The lattice light sheet microscope at Monash Micro Imaging (MMI). This new type of microscope pushes the boundaries of the diffraction limit of light and produces large volumes of data in four dimentions. In 2017, MASSIVE worked closely with MMI, University of Queensland, University of New South Wales, and the Australian National Data Service, to develop and coordinate lattice light sheet data processing across Australia.

National Cloud and Data Projects

A Collaborative Australian Characterisation Informatics Strategy

Characterisation refers to the general process of probing and measuring the structures and properties of materials at the micro, nano and atomic scales.

"Australian characterisation infrastructure encompasses a wide selection of instruments and capabilities that are united by the need to address common informatics challenges. The multi-modal and distributed nature of the research, science and supporting instruments is a challenge that has been united in the past by the Australian characterisation community being able to successfully coordinate across key informatics initiatives."

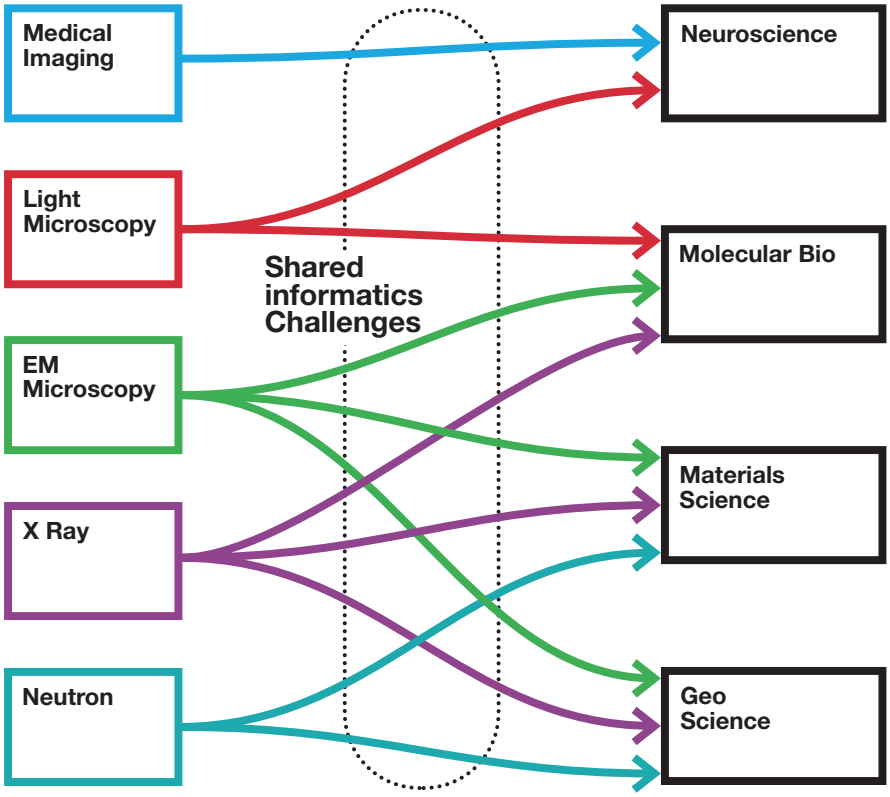
It is essential across natural, agricultural, physical, life and biomedical sciences and engineering. Characterisation facilities, as outlined in the 2016 National Research Infrastructure Roadmap, provide researchers in Australian universities, research centres, and industries with critical infrastructure, including both instrumentation and expertise, to enable quality research outcomes in an efficient and cost-effective manner.

These facilities are a key capability that underpin flagship Australian research collaborations including ARC Centres of Excellence which are both significant users and partners in the development of future characterisation techniques and applications. The Australian Characterisation community and our partners bring together thousands of researchers who are driving the future of Australian imaging and innovation.

Characterisation has become a capability where informatics infrastructure, expertise and best practice is essential to turning data into new discoveries.

As a collective, the Australian Characterisation community shares a number of significant informatics challenges, and we are working together to plan and implement strategies to overcome these challenges.

The Australian characterisation community provides a wide range of techniques that are applied across a variety of scientific domains. Common across these are a set of shared informatics challenges.



Emerging informatics challenges in the field and the way we plan to address them are:

Challenge:	Requires
Scale and complexity • Data volumes are increasing with new detector technology • Processing requirements are increasing – the "science is being affected by compute" • Opportunity offered by multi-site, Australia-scale data capture introduces specific challenges • Custom and specialised instrumentation requires custom workflows • Increasing need to perform analysis "in-experiment" • Analysis of of data from multiple instruments requires specialised skills and familiarity with the data	**A national infrastructure program that supports:** • Community driven instrument integration and data management initiatives to capture data from the point of generation • Rich online environments for characterisation in the cloud and on HPC platforms • Simple and seamless access across instruments, repositories and analysis environments • Programs for specialised and big data producing instruments
Working with digital objects • Data remains unpublished, is difficult to reuse, and it is often unclear whether it can be trusted • Data curation is a second priority to publication and data is often non reusable • Research software is often closed source and impossible to validate, can be challenging to newcomers and is often very specific to particular problems • Research outcomes are difficult to validate and are often unreproducible • To increase return on investment research outputs need to be machine readable	**Making Characterisation digital objects Findable, Accessible, Interoperable, and Reusable (FAIR).** **To achieve this requires:** • Community efforts to increase application of FAIR principles • Coordination across Australia to provide leadership and organisation • Commitment by data producers, in partnership with research communities and tools developers to increase uptake of FAIR principles
Expertise is rare • The characterisation community is increasingly reliant on datascience skills • Digital expertise coupled with applied characterisation knowledge is rare • Cross modality analysis requires multiple areas of expertise to facilitate new insights and discoveries • Where knowledge is available it is often in accessible beyond a local node or institution	**A national program to spread knowledge and underpin change, which includes:** • National training to uplift data skills across characterisation users • A national network of characterisation informatics experts with expertise in research software engineering, and specialist skills in specific modalities, as part of an overarching Australian characterisation experts network

The Australian Coordinated Informatics Strategy has been produced by a writing group with representatives from Monash University, MASSIVE, AMMRF, ANSTO and NIF, based on the outcomes of a series of open Characterisation Informatics workshops held on the 28th of February 2017, and the 12th May 2017, involving stakeholders from AMMRF, ANDS, ANSTO, BPA, MASSIVE, Monash, NeCTAR, NIF, RDS, UMelbourne, UNSW, UQ, UoW, UWA, USydney, Agilent and NVIDIA.

A copy of the strategy can be downloaded at: https://www.cvl.org.au/cvl-news/characterisation-informatics-strategy

The Characterisation Virtual Laboratory Economic Analysis

The Characterisation Virtual Laboratory (CVL) is one of the National eResearch Collaboration Tools and Resources (NeCTAR) supported Virtual Laboratories (VLs) covered by the new report *"Estimating the value and impact of Nectar Virtual Laboratories"* by the Victoria Institute of Strategic Economic Studies at Victoria University for NeCTAR.

Professor Gary Egan, Director of the ARC CoE for Integrative Brain Function, presenting the Characterisation Virtual Laboratory at the OpenStack Summit, Sydney 2017.

According to NeCTAR "the report has found that return on investment (ROI) is at least double the investment for every measure of each of the VLs studied, indicating the services have a significant economic and user impact" *(nectar.org.au/vls-have-huge-economic-research-impact/)*. Read more about the report and the full report on the NeCTAR website.

The three VLs covered by the study are:

- Biodiversity and Climate Change Virtual Laboratory (BCCVL)
- Characterisation Virtual Laboratory (CVL)
- Genomics Virtual Laboratory (GVL)

Five methods of value measurement were used, including the impact the VLs have on research and how much users would be willing to pay for the service if it did not already exist.

The return on investment varies depending on the metric and the associated method of calculation, however the report has found that return on investment (ROI) is at least double the investment for every measure of each of the VLs studied, indicating the services have a significant economic and user impact. By one measure the value of the VL was over 100 times the cost of investment.

The Characterisation Virtual Laboratory

CVL aims to integrate Australia's imaging equipment with specialised High Performance Computing capabilities and with data collection nodes and provide scientists with a common environment for analysis and collaboration. CVL has worked with or is working with 26 facilities to integrate over 100 instruments with a total value of around $250 million.

The mean amount that CVL users were willing to pay was $1,524 (median $900), while their mean willingness to accept was $14,130 (median $20,000). Using the mean value of $1,524 and the estimates of CVL users above, suggests that by December 2020 the contingent value of CVL would be $9.9 million or an average annual value of $1.2 million. Using the willingness to accept value this would be $91.6 million by December 2020, or $11.5 million annually.

Feedback from users captured in the report highlights the high value of VLs by researchers.

Dr Keith Schulze, Image Analyst at Monash Micro Imaging, Monash University, said, "The tools for automated handling and storage of data provided by Characterisation Virtual Laboratory [CVL] are a key enabler for researchers to derive the most benefit from these large datasets, i.e. they spend less time struggling with data transfers and more time extracting interesting information from their data."

"Moreover, CVL and Nectar provide a crucial platform on which tools to analyse and visualise this data can be developed and deployed."

A copy of the report can be downloaded at: https://nectar.org.au/wp-content/uploads/2016/06/Estimating-the-value-and-impact-of-Nectar-Virtual Laboratories-2017.pdf

The Characterisation Virtual Laboratory Economic Analysis By the numbers

3,281
Number of users of CVL technology or services

31%
the average efficiency increase researchers reported using the CVL

28%
The amount of research time the average researcher spent working within the CVL

75%
of researchers reported a moderate, major or severe impact if they could not access the CVL

The Design House Virtual Laboratory

Design House is a part of the Australian National Fabrication Facility (ANFF), funded by the National Collaborative Research Infrastructure Strategy (NCRIS). It was created to provide Australian researchers with a way to access a suite of core software packages needed for the design and fabrication of sensors and devices on the micro- and nano-scale.
This environment is now available through the cloud.

The original server-based approach offered by the Design House had limitations, the main one being that it required researchers who wanted to tap into the software library to present physically at an ANFF node where they could gain access to a Design House workstation.

Dr Sean Langelier, originally a process engineer and now general manager of ANFF Victoria and the Melbourne Centre for Nanofabrication, has worked alongside MASSIVE and the Characterisation Virtual Laboratory to bring into effect a virtual laboratory space and overcome that limitation.

Under the current arrangement, the Design House software is in the cloud and accessible through any web-enabled laptop. Dr Langelier notes that one advantage of the virtual laboratory is the ability to track the use of the different licenced software and know who is using which package and for how long.

One of the projects supported by the Design House-MASSIVE relationship involves improving the design of IR sensors, such as those used for monitoring environments, studying the IR spectrum in astronomy, and, closer to home, receivers on remote controls.

The need for cooling has been a limiting factor in the wider use of IR sensors. The current project is aimed at decreasing the cooling needs. The project relies on software from the Design House collection for modelling the newly designed sensor and for process simulation (for optimising the technical processes that will ultimately take the design to a reality).

Another project under way via Design House software relates to micro-electro-mechanical systems or MEMS. In general, MEMS are made of mechanical micro -structures, -sensors, -actuators and -electronics.

Optimisation of MEMS structures that could improve the accuracy of electro-optical devices relies on Design House software for computer modelling of experimental outcomes.

Micro- and nano-scale sensors and devices can be designed using Design House, before being fabricated in cleanrooms like this one at the Melbourne Centre for Nanofabrication. Credit: ANFF-VIC

MyTARDIS at University of Newcastle

MyTARDIS is a data management system, developed by Monash University and partners, which focus was on the integration of scientific instruments and their associated facilities. It allows data from high-end imaging and other equipment to be stored and accessed in a way that is user friendly and enabling easy collaboration.

Dr Jamie Flynn from the 3D Tissue Clearing and Lightsheet Microscopy Facility, University of Newcastle Hunter Medical Research Institute, together with Dr William Palmer and Dr Antony Martin, saw the potential to gather and process the wealth of imaging and clinical data from the Hunter Cancer Biobank to set up a Virtual Biobank. Their interest in the technology behind 3D tissue clearing—a prerequisite for effective 3D imaging, was a driving force behind the project.

Why a Virtual Biobank? There are several pros. The samples last forever and can be accessed anywhere and at any time. Experiments can be repeated readily and access to a virtual biobank circumvents the months of time and piles of paperwork associated with obtaining human ethics approval to work with the original samples.

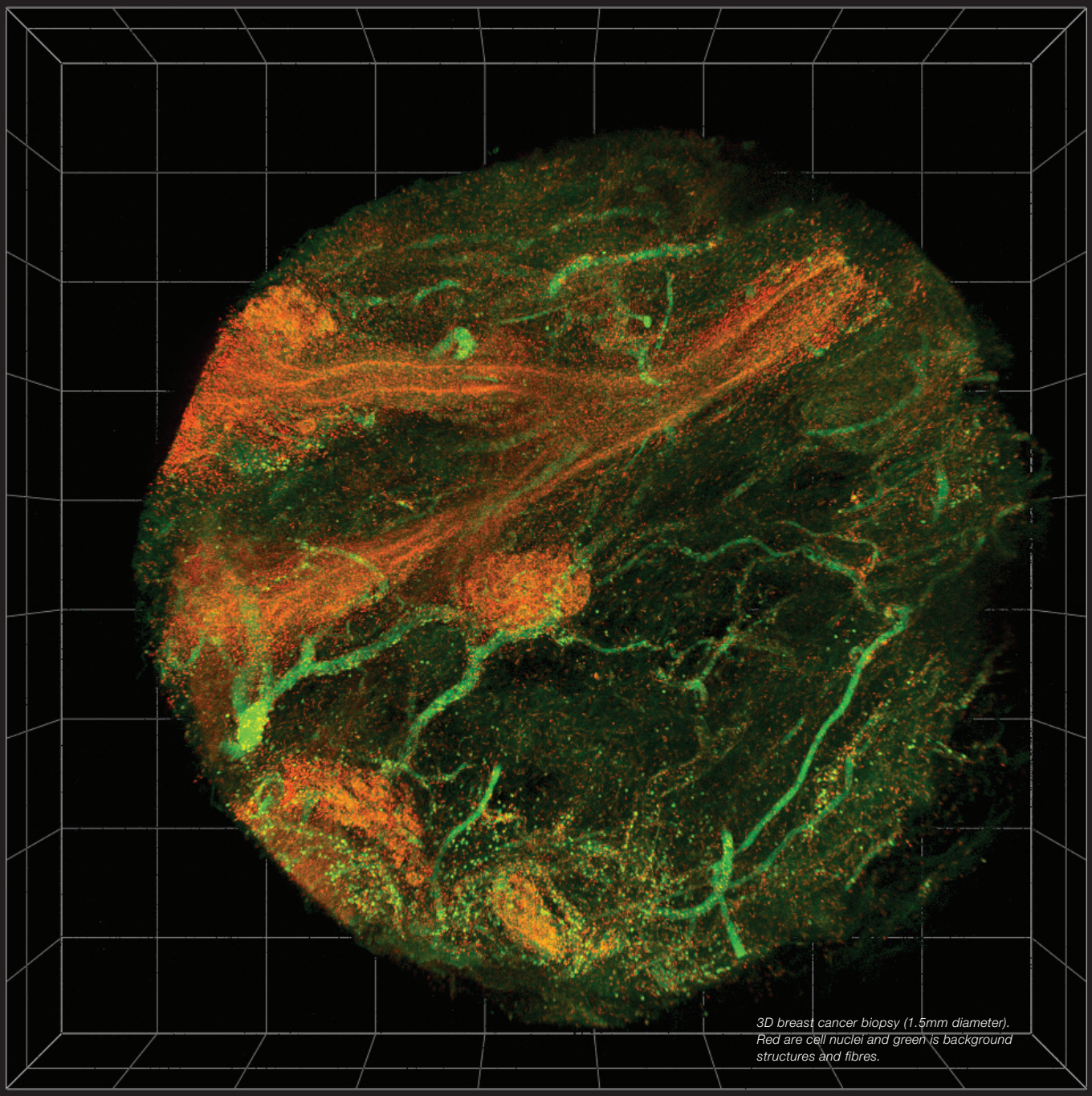
Jamie and colleagues opted to start the project with breast cancer biopsies because they comprised more than 42% of the Hunter collection of about 7,500 samples and were associated with more-or-less complete metadata.

When it came to set up the Virtual Biobank, Jamie and colleagues found that MyTARDIS, due to its requirement from the outset for high-quality data, was already geared to handle every challenging angle or requirement they put to the test.

Another advantage of tapping into MyTARDIS has been the ability to set up flexible licences for each dataset, based on the principles of attribution (BY), non-commerciality (NC) and share alike (SA).

MyTARDIS is part of the software stack that is deployed under the Charactersation Virtual Laboratory. Its development is coordinated by Monash University with contributions from University of Queensland, University of Western Australia and other partners.

Project website: https://virtualbiobank.newcastle.edu.au
MyTardis Website: www.mytardis.org



3D breast cancer biopsy (1.5mm diameter). Red are cell nuclei and green is background structures and fibres.

Astronomy: Reach for the Cloud

MASSIVE and Swinburne University of Technology are working together to provide easy remote desktop access to the new Swinburne-based OzSTAR supercomputer

The idea of a national networkof 'remote desktop virtual laboratories'—online infrastructure that supports collaboration and the sharing of ideas between researchers around Australia—has been supported for many years and supercomputing facilities are joining the network.

To make accessing remote tools simple and seamless, Monash University developed the Scientific Remote Desktop Launcher (or Strudel), several years ago. This tool connects researchers via their own desktop computers to MASSIVE's supercomputer data processing capacity in neuroscience, structural biology, atom probe and X-ray science.

Now Swinburne University of Technology is looking to do the same thing. It has enlisted MASSIVE's help to set up a similar interface to connect its research community with its new OzSTAR supercomputer, with a particular focus on astronomy and data visualisation tools.

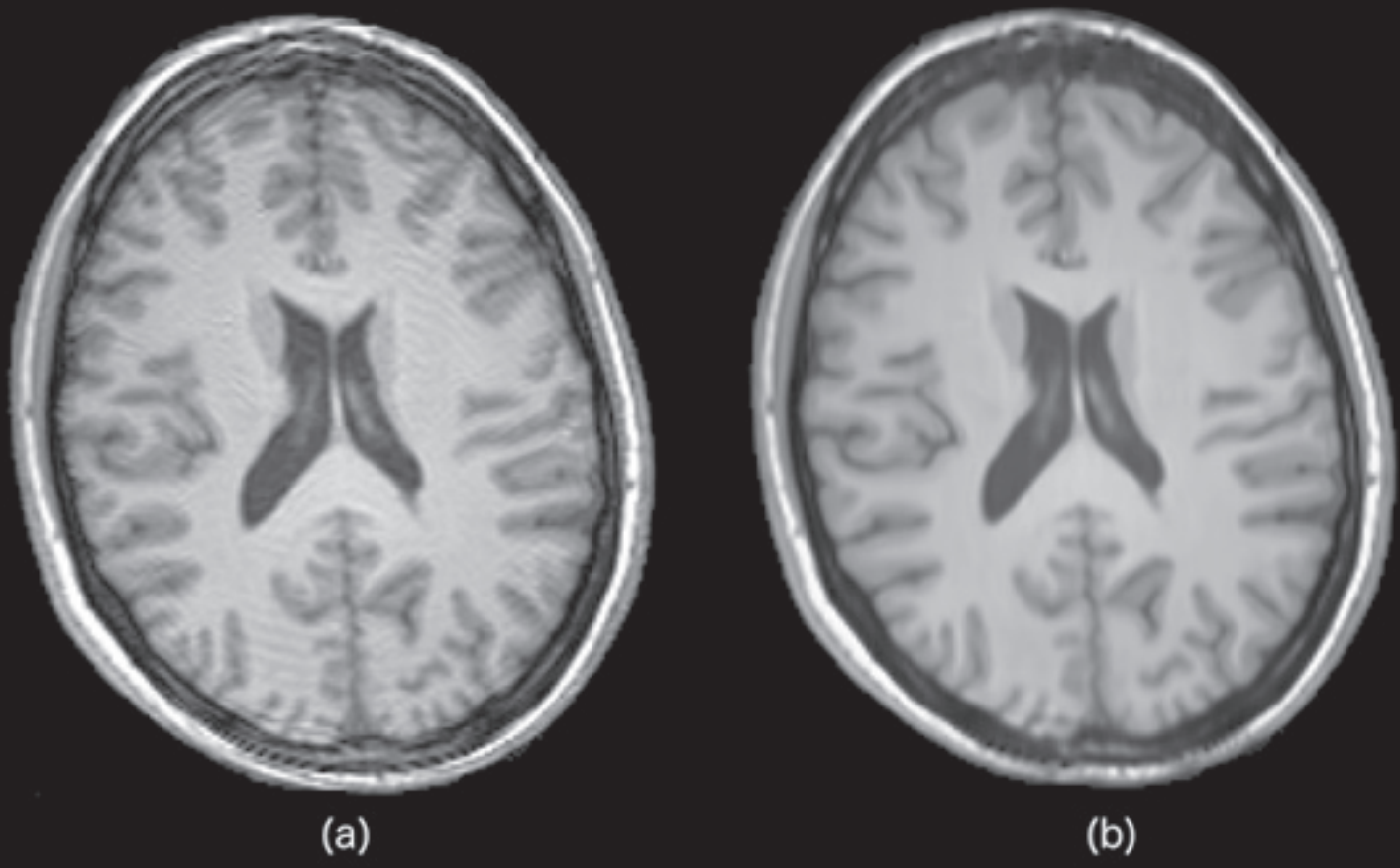
While the fundamental principles of the virtual laboratory connection are the same, there's a big difference between looking at biological molecules and looking at far-off galaxies.

"The Characterisation Virtual Laboratory for Strudel was mainly developed for people using various types of imaging, such as light and electron microscopy," says Dr Amr Hassan, now eResearch Delivery Leader at Monash University. "For the first time, we're moving to the other side, which is to serve a completely different society; radio astronomy and optical astronomy.". Swinburne is developing a rich environment that will allow researchers to access astronomy data remotely.

The aim is to simplify access to supercomputing resources, where researchers can now simply open up their desktop with the installed interface, and start work with the tools optimised for their workflow at their fingertips.

"You don't need the very big machine under your desk, and at the same time you can access the high performance computing system with a virtual desktop-like environment," Hassan says.

AI in Focus: **Improving Magnetic Resonance Imaging**



OPPOSITE:
Magnetic resonance scanner at Monash Biomedical Imaging.

THIS PAGE:
(a) Experimental case when volunteer moved during the scan (a) Image without using machine learning algorithm (b) Image after using learning algorithm

Magnetic resonance imaging has revolutionised medicine and medical research, but one of the biggest issues radiographers still grapple with are the artefacts created when patients shift around during the scan.

Magnetic resonance imaging has revolutionised medicine and medical research, but one of the biggest issues radiographers still grapple with are the artefacts created when patients shift around during the scan.

Now machine learning techniques are being used to teach magnetic resonance technology to recognise these artefacts and remove them, giving a much cleaner image for the clinician or researcher to work with.

A single magnetic resonance scan can take anything from few seconds to 30 minutes, and can resolve details less than a millimetre in size. Unfortunately, this means that if the person being scanned moves by more than a millimetre, the resulting image is distorted by ripples that can blur vital structural details.

The current approach to dealing with these artefacts uses motion capture technology—similar to that used for computer-generated imagery in the film industry—to record the patient's movement and adjust the image accordingly. This requires use of a special camera that can function while an MRI scan is taking place, and is both painstaking and expensive.

A team of researchers from Monash Biomedical Imaging are applying what's called instrumentational deep learning—where the instrument itself has embedded deep learning algorithms to process the raw images—to the problem.

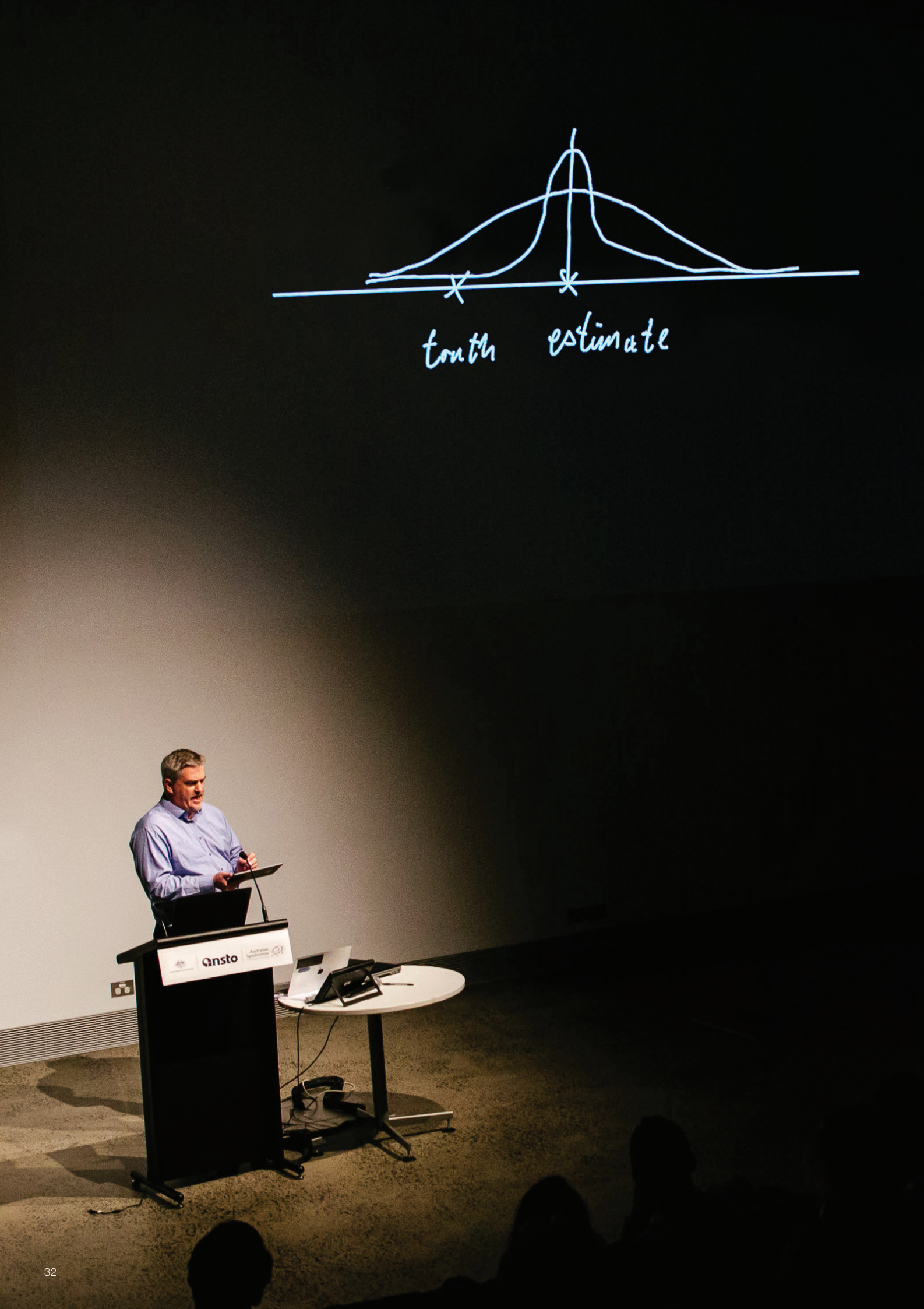
To begin with, they acquired a series of normal magnetic resonance images using healthy volunteers, and used these to genereate simulated motion artefacts. This learning data set was then used to train a machine learning model to recognise and remove these motion artefacts.

"The training of all these algorithms is very intensive," says Dr Kamlesh Pawar, research fellow at Monash Biomedical Imaging. "It's not possible to do this kind of training on a personal computer, as high performance computing is needed."

Then when the system encounters a scanned image distorted by movement, it can recognise the artefacts and remove them from the image resulting in an image that visually appears to be artefact free.

"I'm just amazed at how good it does," says Professor Gary Egan, director of Monash Biomedical Imaging. "With a typical system, you might get a 3%–5% error rate and with these deep learning techniques we're down to 1%–1.5% residual error."

So far the system has been trained using images from healthy volunteers. The next step is to train it using images from real patients with clinical disorders. This will teach the system not only to identify movement artefacts but tell the difference between a movement-related artefact and a genuine disease-related pathology.


truth
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A.I. in Focus: **Robotic Vision**

OPPOSITE:
Professor Tom Drummong presenting at the Monash University Machine Learning Symposium, organised by the Monash eResearch Centre and MASSIVE.

Professor Tom Drummond of Monash University is working on computer-based models of the human brain's visual cortex that will enable robots to make rapid decisions, based on a programmed understanding of their visual environment.

Perhaps the best-known example of a robot responding to visual cues is the self-driving car. But robots can also be deployed in aerial vehicles, for example to inspect tunnels for safety, or agricultural crops for the distribution of water and nutrients such as nitrates and phosphates. They could even be used to make a call on which fruit in an orchard is ready for harvesting.

"The key to advances in this area is the confluence of big data and big computing," Professor Drummond said.

"Our involvement with MASSIVE's super-computing capability, particularly their arsenal of GPUs (graphics processing units) enables us to tap into the truly colossal amount of computation required to train a robot to understand the world around them."

While robots are well-established in the structured environment of, say, a factory production line, Professor Drummond wants to take them into 'unstructured' environments, like those they face on public roads, where they must negotiate the sudden, random appearance of lampposts and kerbs, pedestrians and cyclists.

The interpretation of data from video cameras requires two techniques. One is old-fashioned geometry, to triangulate and compute relative locations.

The second, called 'deep learning', is inspired by the biological brain in which complex networks of neurons communicate via electrical signals, which in turn cause them to fire or not to fire.

Deep learning requires the building of multilayered neural networks. The object patterns in the first layer might refer to edges, or simple shapes. More complex patterns such as faces, and the shapes of heads and shoulders are incorporated into the deeper layers.

Robots need training to understand data sets of painstakingly coloured (pixel-by-pixel, by a human) video images to give a faithful representation of physical objects.

"'Training' a robot is extremely computer-intensive. It can take one week's use of a high-performance GPU to train one network, with the computer working at a rate of one trillion bits of information per second," Professor Drummond said.

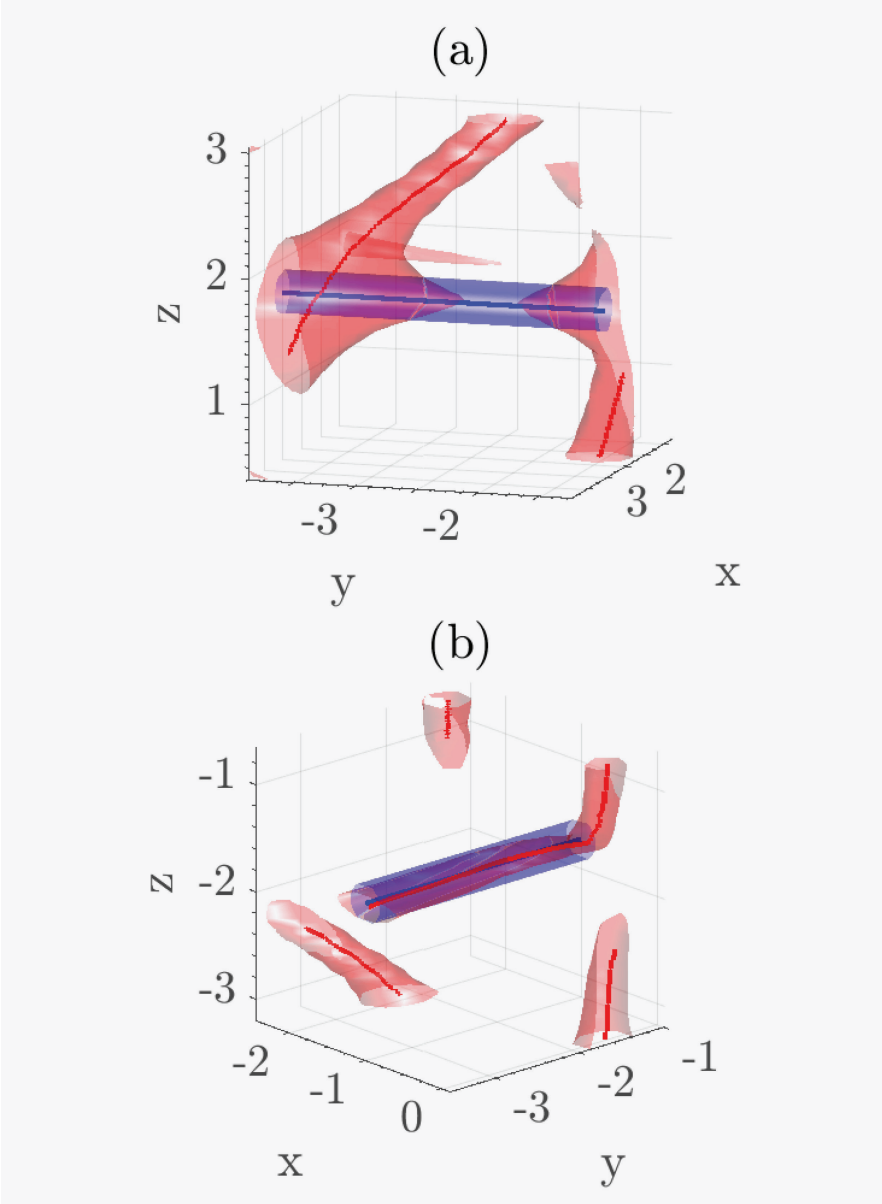
MASSIVE delivers that huge amount of computing power to the desk top computers in the Drummond laboratory.

Gravitational waves and neutron stars

Astrophysicist Professor Andrew Melatos was one of 100s of international scientists who found the first evidence of the existence of gravitational waves. The three senior physicists behind the momentous discovery received the 2017 Nobel Prize in Physics.

THIS PAGE:
Non-trivial geometry of neutron vortices pinned to the misaligned array of flux tubes in a neutron star arises naturally due to the "frustration" of the system caused by the competing forces on the superfluid. The vortices do not crystallise into a rectilinear array as they do when the rotation and magnetic axes are aligned. Instead, they settle into a complex, partially polarised, interlocked pattern, called a "vortex crystal";. This figure depicts the deformation and pinning of vortices (shaded in red) in a vortex crystal due to interactions with flux tubes (shaded in blue) which are tilted 90° with respect to the rotation axis. (a) Close-up snapshot of "vortex spike". (b) A pinned vortex.

(Drummond L. V., Melatos A., 2018, Monthly Notices of the Royal Astronomical Society, 475, 910).



Einstein predicted the existence of such waves about 100 years earlier, when formulating his general theory of relativity. The first detected gravitational wave arose when two orbiting black holes, together the size of about 65 suns, coalesced some 1.3 billion light years away.

"Researchers more-or-less gave up looking for the tiny waves until the advent, among other things, of extremely good lasers and computers," Professor Melatos said. "Even today, my research remains computationally limited. In this field, more is always better."

Gravitational waves are produced when a massive object accelerates or is disturbed. They carry energy and radiate from the 'event' that caused them, rather like ripples from the point a stone enters a pond.

The gravitational wave detected in the Nobel Prize-winning work was vanishingly small at 10-19 metres. Enhancing the sensitivity of the detection process is a key challenge to finding more gravitational waves and thereby learning about the nature of gravity and the immense events in the universe that generated them.

Professor Melatos provided input on theoretical aspects and computer modelling to the successful project for about 10 years before the gravitational wave was detected. At the outset, he used supercomputing provided by a consortium of Victorian universities. He then made the seamless transition with the formation of MASSIVE 8 years ago.

He now draws on the supercomputing provided by MASSIVE to design, write and test algorithms (some not unlike those found in mobile phones) to extract a delicate signal from all the noise caused by interfering vibrations from sources as wide-ranging as ocean waves, traffic, construction and even the wind.

"From my experience with supercomputing, when the overall service provision doesn't work, it's rarely the hardware. It's all the rest, like management of data. In addition to providing reliable hardware, MASSIVE does a fantastic job of support and data management," Professor Melatos said.

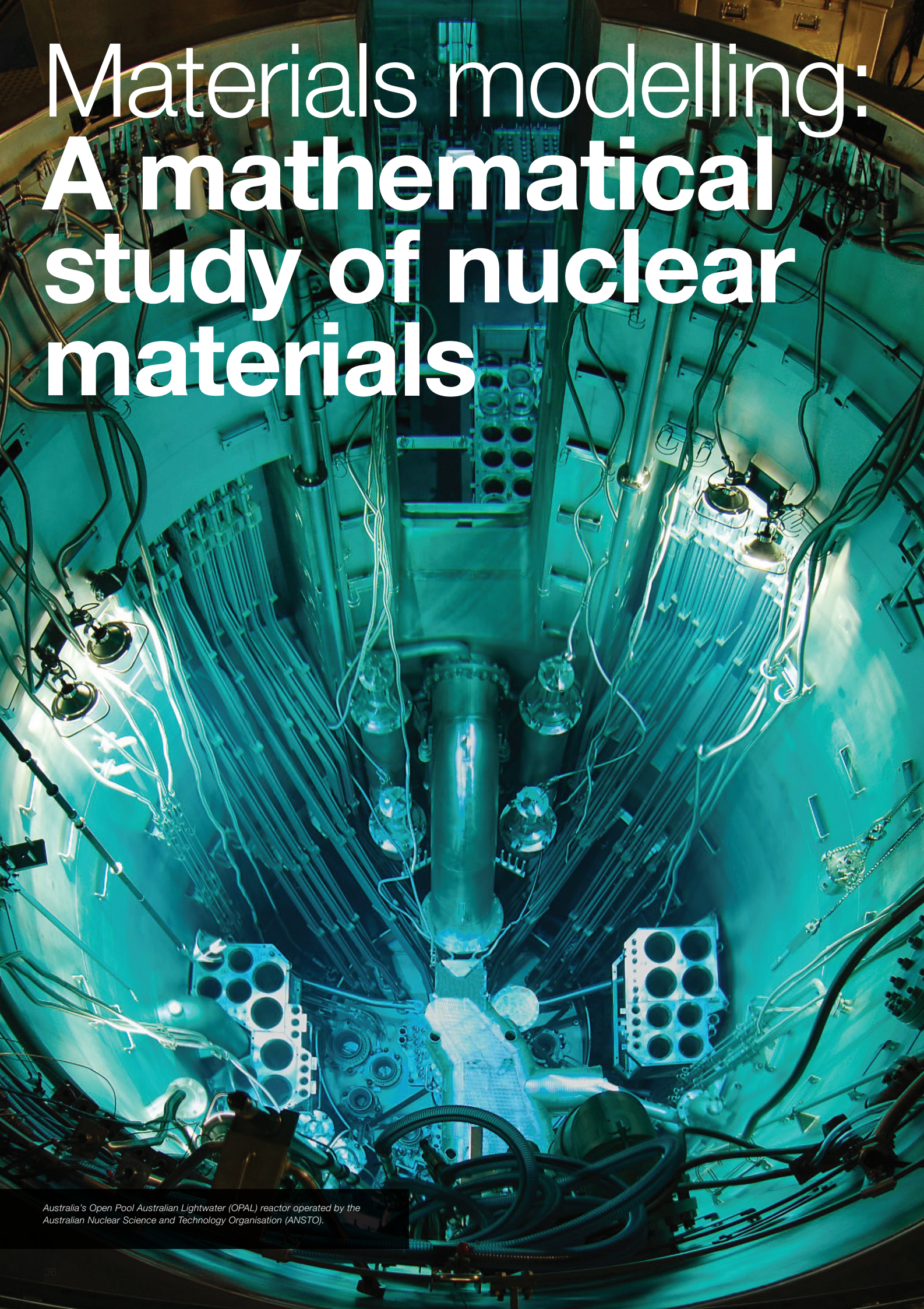
A second project that relies on MASSIVE supercomputing relates to neutron stars, which form at the end of a star's life when there is insufficient fuel to support the star against gravity.

The star collapses and explodes to form a super nova. Most of the resulting material is scattered across the universe, but some of it forms an extremely dense neutron star—one teaspoon of which is said to weigh 1 billion tonnes!

With the help of MASSIVE, the Melatos lab is conducting computer-intensive simulations of the core material of the neutron star, seeking answers to such questions as: Is it a superfluid? Is it like liquid helium which, at absolute zero, has no friction and could flow down a pipe forever?

Professor Melatos gained supported access to MASSIVE via the National Computational Merit Allocation Scheme: https://ncmas.nci.org.au/

Materials modelling: A mathematical study of nuclear materials



Australia's Open Pool Australian Lightwater (OPAL) reactor operated by the Australian Nuclear Science and Technology Organisation (ANSTO).

When a radioactive element's half-life is measured in hundreds of thousands of years, studying its behaviour in real-time is out of the question.

But when that element is found in radioactive waste, it's essential that we understand exactly how it will behave over long periods of time following encapsulation in a material for long-term storage; will it remain locked and safe within the storage material for as long as is needed?

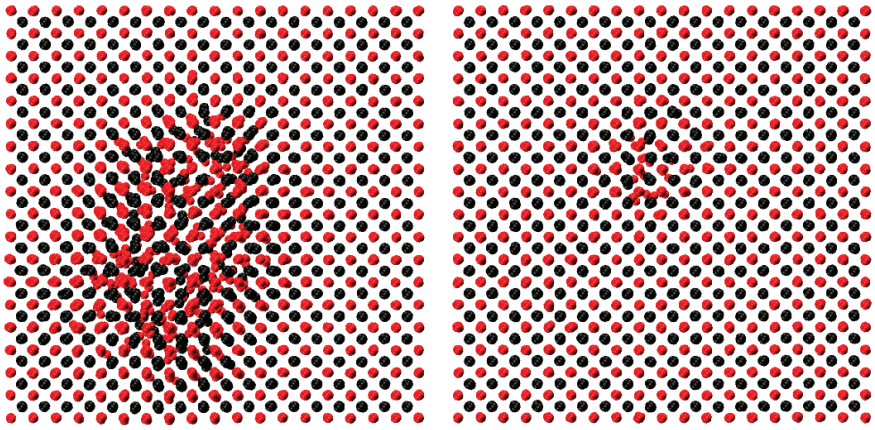
To answer that question within something approaching a human lifespan, scientists at the Australian Nuclear Science and Technology Organisation (ANSTO) are building virtual versions of the materials found in radioactive waste.

But these aren't just digital versions of the ball-and-stick models from high-school chemistry; these are mathematical calculations of energy and structural changes at the level of electrons, and they are so complex they require the supercomputing power of MASSIVE to model just a few hundred atoms.

"It's got to calculate the energy of the atomic structure, and then it will move the atoms around a bit and see how that energy can change," says Dr Eugenia Kuo, a physicist at ANSTO.

The idea is to calculate the lowest energy state of a material—because that's the state that any material will head to—then calculate what that structure might look like.

For example, technetium-99 is one of the most challenging components of spent nuclear fuel rods. Over time, technetium-99 decays into ruthenium. The question is then how that decay impacts the chemistry of the material technetium-99 is encapsulated in: how stable is the process, and how stable is the end product?



Snapshots in time (L to R) from a molecular dynamics simulation of radiation damage in uranium dioxide (UO2), a nuclear fuel. The black atoms are uranium, the red ones oxygen. The snapshots include about 10,000 atoms from a total of about half a million. L: large damaged area at the time of radiation; R: structural changes after radiation.

"We're trying to understand the local interactions and how that affects the stability of the structure that we're interested in," Kuo says.

Other materials being investigated with the use of MASSIVE supercomputers are those used inside the reactor itself.

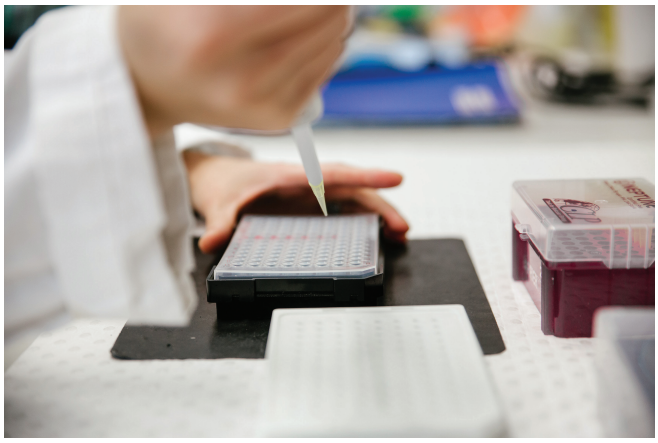
The inside of a nuclear reactor is one of the most complex engineering environments that exist. Materials used in reactors, such as the ceramic fuel cells, have to be able to withstand intense radiation without being compromised or changed in such a way that might risk their integrity.

But studying that in situ is essentially impossible, so researchers are turning to computer-assisted simulations.

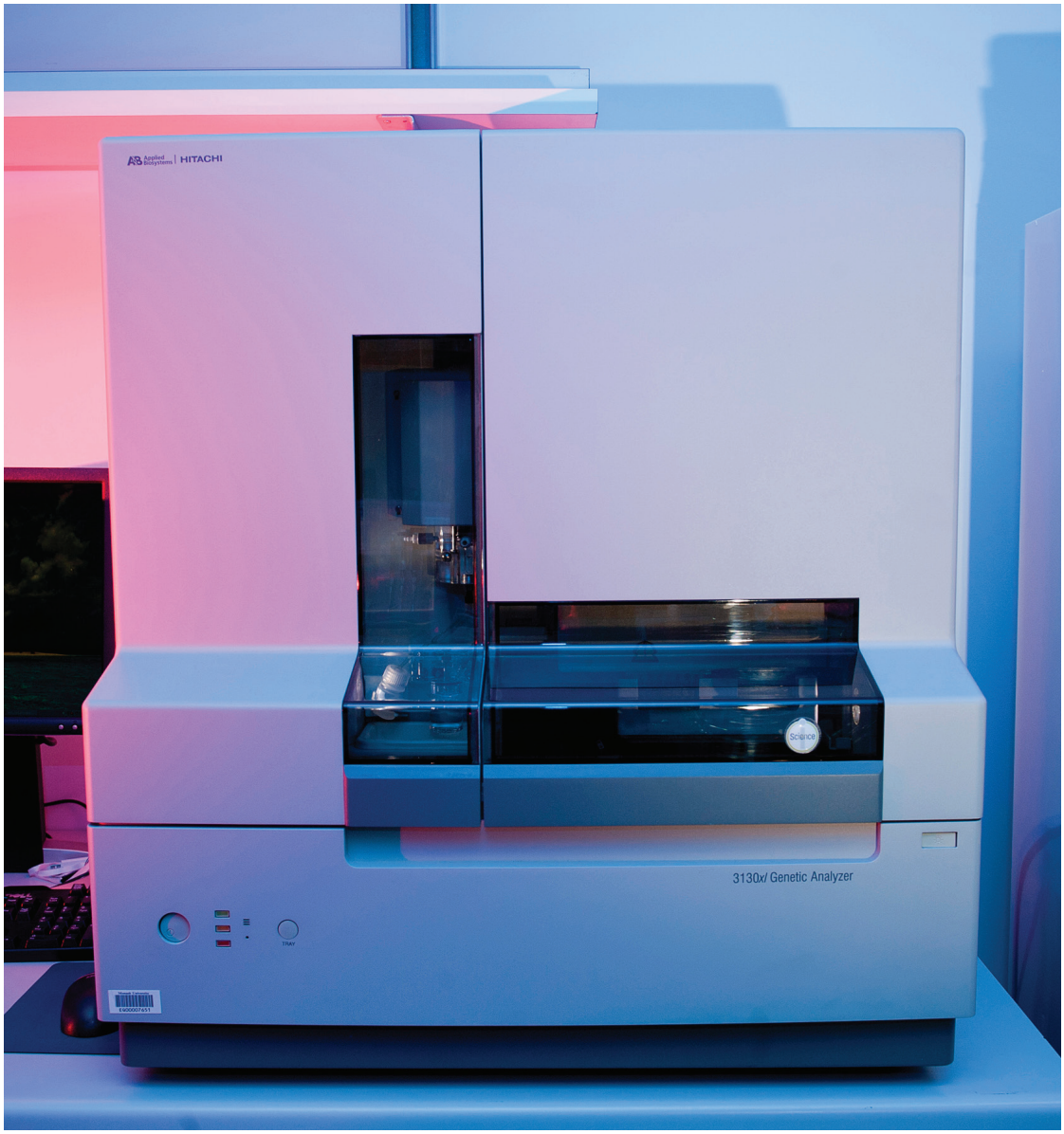
"We use MASSIVE's computer cluster to do computer simulations of a material's properties so we can get a better understanding of how these structures change at the atomic level when a reactor is operational, and how the change of structures is going to change the properties," says Dr Meng Jun Qin, a physicist at ANSTO.

These simulations model the molecular dynamics of millions of atoms, with the goal of finding or developing materials that will be as radiation-tolerant as possible.

Bioinformatics: **Finding the needle in the data haystack**



When the human genome was first sequenced, it took thirteen years and around US$1 billion to get the first draft ready. Today, sequencing a human genome takes less than a week and costs around $1000.



With advances in sequencing technology, as well as developments in large-scale, automated 'high throughput' molecular biology, an extraordinary amount of data on the minute workings of the genome and cell is now available for scientists to analyse.

The challenge they face is sifting through these vast databases for the proverbial needle; a significant association between the activity of a gene, protein or metabolite, and a disease or health outcome.

This is where the Monash Bioinformatics Platform comes in. Using Massive's computing infrastructure, staff at the Platform take the terabytes and petabytes of big data generated from biological studies, and work with the researchers to make sense of it.

"You need special data-wrangling skills and software development skills and understanding biology and that's what our staff is equipped with," says Dr Sonika Tyagi, bioinformatics manager at the Monash Bioinformatics Platform.

To get the best quality data, the platform's staff get involved with a study at the earliest stages, when the experiments are being designed. This means they can help researchers set up an experiment that will generate the most useful data.

Once the experiment is complete, the bioinformatics experts take massive files containing the raw data, and process them into tables, spreadsheets, graphs and other forms of data visualisation to help the researchers interpret the data..

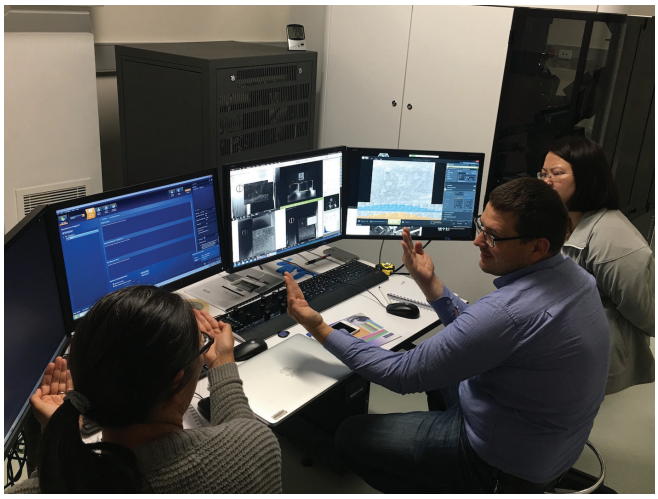
The platform has also co-founded a Data Fluency community of practice, in collaboration with the Monash Library at Monash University. Under this initiative, the Bioinformatics Platform is collaborating with the Monash e-Research to run digital data upskilling activities on topics such as computer programming, Unix shell and high-performance computing.

This then empowers researchers who are doing data-intensive research with basic coding and data manipulation skills, which in turn helps them not only to take charge of their own data but it also facilitates communication between bioinformaticians and computer system admins.

The Bioinformatics Platform has been involved in a wide range of life sciences studies, including cancer, congenital heart conditions, diabetes, infectious diseases, agriculture and environmental studies; bioinformatics being an interdisciplinary field that has applications across the realm of science.

The rise of bioinformatics is also supporting the rapidly growing field of personalised medicine; the design of therapies to a disease measured against personal genome. The detailed analysis of genomic, proteomic and metabolomics activity in disease conditions is enabling clinical researchers to hone in on new clinical targets that might only be present in a tiny percentage of patients. But for those few patients, bioinformatics could make the difference between life and death.

Underpinning Instruments: **Australia's First Cryogenic Focused Ion Beam-Scanning Electron Microscope**



THIS PAGE and OPPOSITE: the Cryo-FIB/SEM at the Monash Ramaciotti Electron Microscopy Centre

The Monash Ramaciotti Electron Microscopy Centre, in partnership with the Imaging CoE, has installed Australia's first cryoFIB/SEM. The instrument was purchased in part through the award of an ARC LIEF grant awarded to Dr Georg Ramm Director, Ramaciotti Centre for Cryo-Electron Microscopy, Prof. James Whisstock, Prof Kat Gaus and colleagues. The cryo-FIB/SEM functions as a exquisitely fine molecular milling machine. In the context of biology, cryo-FIB/ SEM's are used to carve out specific portions (or cryolamella) of cryogenically preserved cells.

This step is essential, as cells themselves are too thick to image at high resolution using transmission electron microscopy. The advantage of using a cryo-FIB/ SEM over simpler approaches (for example cryo-sectioning) is that users can very precisely target and prepare the region of the cell that they are interested in studying. Once suitably prepared cryolamella derived from cells are transferred to a Titan Krios TEM, and detailed images are obtained using an approach called tomography. Here, the cryo-lamella are imaged at a sweep of different angles, and a 3-dimensional picture (or tomogram) is produced. MASSIVE is used extensively for CryoEM tomography and will be ab important tool for structural biologists using the cryo-FIB/ SEM.

The availability of this instrument sets the scene for Australian scientists being able to conduct "in situ" structural biology experiments. Here, through averaging of different tomograms, large protein complexes are imaged in the context of their native, cellular environment. The cryo-FIB/SEM thus moves us one step closer to one of the great ambitions of modern biology – the visualization of cells at near molecular resolution. In the context of the Imaging Centre, we anticipate using the cryo-FIB/ SEM in a wide variety of experiments, for example in the context of understanding how immune effectors interact with target cells.

The Imaging CoE is a affiliate partner of MASSIVE.

Original source: imagingcoe.org/wp-content/uploads/2018/04/2017_Annual-Report_ARC-CoE-in-Advanced-Molecular-Imaging.pdf

Underpinning Instruments: **The Australian Cancer Research Foundation Eiger Detector**

The $2.8M The Australian Cancer Research Foundation Eiger Detector installed at the Australian Synchrotron has allowed for Serial Crystallography experiments for the first time

In February 2017, the muchly anticipated Australian Cancer Research Foundation Eiger Detector was installed at the Australian Synchrotron on the MX2 beamline, bringing with it an unparalleled capacity to capture user datasets in tens of seconds instead of minutes.

This upgrade in processing power and quality is critical to provide real-time data analysis so that users can collect higher volumes of data and optimise experiments 'on-the-fly' whilst there crystals are being measured.

The $2.8m upgrade was thanks to an equipment grant from the Australian Cancer Research Foundation (ACRF), topped up with further funding from partner organisations and has opened up a world of new possibilities thanks to its ultra-fast image acquisition, excellent signal-to-noise, high data quality slicing, faster rendering and a "shutterless" design to reduce jitter in images.

One of the first groups to take advantage of the Eiger 16M capabilities in 2017 was led by Imaging CoE researcher Dr Peter Berntsen, who has been managing a joint project with the Australian Synchrotron to develop a new national capability for serial millisecond crystallography (SMX).

This project is the result of several years' worth of effort in developing new methods for delivering protein crystals to the X-ray beam in a serial fashion using custom injector technology developed by La Trobe University, in partnership with a local engineering firm.

Much of 2017 was spent working closely with the Australian Synchrotron to commission this injector to work on the MX2 beamline.

"The last equipment could not achieve this —not even close. The much simpler sample preparation and additional relative improvements being made to data collection and processing environments meant that we could realistically attempt a serial crystallography experiment, which we believe has the potential to be the method of choice for room-temperature structure determination and protein screening approaches."
Said Dr Berntsen.

"Serial millisecond crystallography at synchrotrons is made possible thanks to this new generation of fast frame rate detectors together with the high-viscosity injector, developed at La Trobe, set to extrude a micrometer diameter stream of crystal laden Lipid Cubic Phase (LCP, or other viscous carrier) vertically through the interaction region with the X-ray beam. "SMX enables fast, straightforward structure determination at room-temperature for large soluble macromolecular complexes as well as membrane proteins.

An international research group recently showed that using SMX, a much larger dose can be distributed over many crystals, resulting in higher resolution structures with less-radiation damage compared with classical room-temperature methods.

"The time required to get useful data can be less than 90minutes, which previously would have taken days, if not weeks. So you can understand our excitement at this new research domain being implemented at the Australian Synchrotron for the Australian scientific community and users of the MX2 beamline." said Dr Bernsten In 2018. we plan to further develop this facility into a general platform for both national and international crystallography users.

MASSIVE has worked with Australian Synchrotron and Imaging CoE to develop workflows to processing MX2 data. These workflows, currently open to all Monash University MX2 users, allow researchers to process data within minutes of data capture.

Original source: http://imagingcoe.org/wp-content/uploads/2018/04/2017_Annual-Report_ARC-CoE-in-Advanced-Molecular-Imaging.pdf

A "super" receptor that helps kill HIV infected cells

While treatments for HIV mean that the disease is no longer largely fatal, the world still lacks a true therapy that can eradicate the virus across a globally—and genetically different—population.

Monash researchers, together with colleagues from the Pasteur Institute in Paris, have discovered a unique set of "super" receptors on immune cells capable of killing HIV across genetically diverse populations, making them a potential candidate for immunotherapy treatments. The work was published in the journal Science Immunology.

Associate Professor Stephanie Gras and her team from Monash University's Biomedicine Discovery Institute (BDI) and ARC Centre of Advanced Molecular Imaging, and her colleagues from the Pasteur Institute in Paris, studied fifteen unique individuals who all had been infected with HIV (ANRS CO21 CODEX cohort), but have immune systems that protect them from AIDs progression. These rare individuals, called HIV controllers, could hold clues to the cure for the disease.

Upon HIV infection, CD4 T cells, which are an important part of our protective immune system, can be depleted and drop dramatically in numbers, leading to a weak immune system with the progression of the disease to AIDS. These CD4 T cells can remain low even when the disease is kept in check with anti-retroviral therapy (ART), which is currently provided to more than half of people living with HIV globally. ART lowers the risk of mortality but does not eradicate the virus.

Associate Professor Gras and her colleagues found that HIV controllers are able to retain CD4 T cells of a higher quality, and are able to detect and react to minute amounts of virus, therefore representing a great opportunity to study their potential role in HIV infection.

"We discovered that those CD4 T cells, usually viewed as helper cells for the killer CD8 T cells that destroy infected cells, could be turned into killer cells themselves in HIV controllers. These killer CD4+ T cells could recognise very low amounts of HIV thanks to the expression of "super" T cell receptors on their surface. Importantly when they studied these receptors—they found identical receptors across multiple HIV controllers," Associate Professor Gras said.

"The likelihood of finding the exact same T cell receptor in different individuals is extremely low, like winning the lottery, and is likely playing a role in the control of HIV" Monash BDI's Dr Carine Farenc, a co-lead author of the study said.

T cell receptors recognise virus or bacteria fragments bound to specialised molecule called Human Leukocyte Antigen (HLA). HLA molecules are like fingerprints: every person has a specific combination of HLA molecules, which help the immune system recognise foreign invaders like bacteria or viruses.

Monash University researchers used the Australian Synchrotron, effectively a giant microscope the size of a football field, to study the binding of this super T cell receptor in complex with the HIV antigen. This revealed another remarkable feature of those killer CD4 T cells: their ability to recognise HIV fragment in genetically diverse individuals (with different HLA molecules).

The Gras team and their colleagues found that these killer CD4 T cells can bind with HLA molecules shared by a quarter of world population, a figure that is likely to increase as studies progress, according to Associate Professor Gras.

Source: https://www.monash.edu/discovery-institute/news-and-events/news/a-super-receptor-that-helps-kill-hiv-infected-cells

Statistics from the World Health Organisation in 2016:

36.7 million

People living with HIV

1.0 million

Died from the disease

19.5 million

People living with HIV were receiving antiretroviral treatment (ART)

BELOW:
Associate Professor Stephanie Gras at the Australian Synchrotron

A.I. in Focus: **Translating Natural Language**

A big challenge in the development of artificial intelligence is the programming of computers to respond in a human-like way to input from the senses, including touch, vision and hearing.

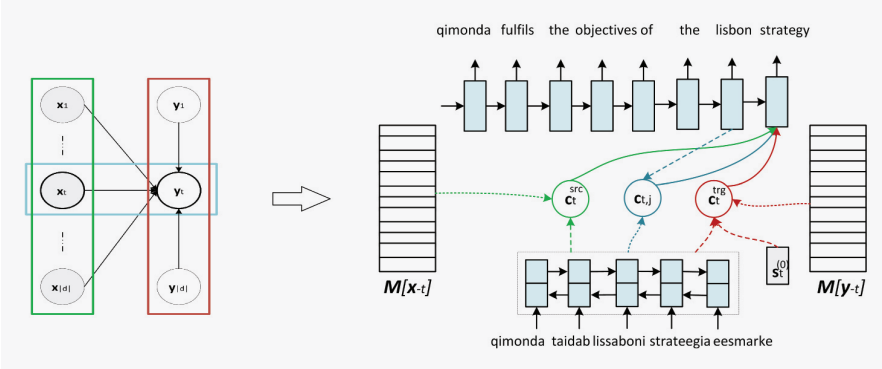
Dr Reza Haffari is making inroads in the study of natural language processing (NLP). His goal is to enable computers to do language-related human tasks such as translation and 'summarisation'—the taking on of detailed information and distillation of the essence of the knowledge it contains.

The prime goal in the field of NLP is to develop models of language such that computers will be able to recognise patterns, then use them to make correct predictions based on input from the real world with minimal human involvement.

As with other applications that rely on MASSIVE (see the story on Professor Tom Drummond) for super computing power, Dr Haffari is using the method of deep learning to train computers.

The concept is not new. Google Translate is a widely-used platform that allows users to move back and forward between two languages.

But Dr Haffari's model is very different. Whereas Google relies on a vast database of translated examples (so-called 'annotated data') for the computer to draw on when solving a problem of translation, Dr Haffari's model is based on a relatively small pool of annotated data and a much bigger volume of 'unannotated' data.



Example of the Document-Context Neural Machine Translation. This image shows what the generic-NMT model does i.e. translate sentence-by-sentence. We use the complete document context (source and/or target side) to improve NMT performance.
Image: Sameen Maruf

Critical to Dr Haffari's research to enable computers to make sense of linguistic patterns in untranslated data is access to MASSIVE's super-computing power and all-important graphics processing units (GPUs), which are costly to purchase and otherwise not readily available to Australian scientists.

"We use MASSIVE all the time," Dr Haffari said. "For our research, MASSIVE is the air that we breathe."

It's not only the computing power per se that is so important. MASSIVE also provides much-needed support for the software and hardware that comprise the enabling technological package behind Dr Haffari's research.

As well as machine translation, Dr Haffari is working on the problem of summarisation, which requires that a computer be trained to apply understanding and reasoning to grasp the essential message contained in a body of information and present it succinctly.

Behind his approach to both problems is Dr Haffari's rationale that humans can learn more than one linguistic skill, so suitably trained computers should be able to do the same. Such computers would need to apply previous learning to the solution of unfamiliar problems.

Governance

The Steering Committee is composed of the MASSIVE Partners, Affiliated Partners and independent members.

It is chaired by an independent member, Dr Greg Storr.

MASSIVE Steering Committee Members

Greg Storr
Chair, 2012 – June 2016

Dr Miles Apperley
ANSTO

Prof Paul Bonnington
Monash University member

Gary Egan
ARC CoE for Integrative Brain Function

Dr Alf Uhlherr
Independant member

Antoine van Oijen
University of Wollongong

James Whisstock
ARC CoE for Advanced Molecular Imaging

Dr John Zic
CSIRO member

Wojtek James Goscinski
Coordinator, MASSIVE
Ex-officio

Training and outreach

Training

Title		Location	Date/s
M3 for Biomedical Imaging	MASSIVE team	Monash Biomedical Imaging, 770 Blackburn Rd, Monash University, Clayton Campus, VIC	20/03/17
IEEE International Symposium on Biomedical Imaging (ISBI) 2017	Monash eResearch, NVIDIA, MASSIVE team (Tutorial)	Melbourne Convention and Exhibition Centre (MCEC), South Wharf, VIC	18/04/17 – 21/04/17
MX2 Processing Workshop	MASSIVE team	21 College Walk, Monash University, Clayton Campus, VIC	15/05/17
2017 EMBL Australia PhD Course	The Clive and Vera Ramaciotti Centre for Structural Cryo-Electron Microscopy and MASSIVE team	23 College Walk, Monash University, Clayton Campus, VIC	09/07/17 – 21/07/17
Longitudinal MRI Workshop, hosted by the School of Psychology at the Australian Catholic University (ACU)	MASSIVE team	The Daniel Mannix Building, Australian Catholic University, 17 Young St, Fitzroy VIC	10/07/17
Introducing the Characterisation Virtual Laboratory and Cytometry Workbench	MASSIVE team and Centre for Microscopy, Characterisation and Analysis (CMCA) -The University of Western Australia (UWA)	Harry Perkins Institute of Medical Research, QEII Medical Centre, 6 Verdun St, Nedlands WA	25/07/17
Monash Bioinformatics Platform Seminar and Training	MASSIVE team (Presentation)	19/23 Innovation Walk, Monash University, Clayton Campus, VIC	06/09/17
Deep Learning for Life Sciences Workshop	NVIDIA and MASSIVE	Menzies Building, 20 Chancellors Walk, Monash University, Clayton Campus, VIC	30/10/17
Lightsheet Microscopy Workshop	MASSIVE team (Presentation)	Biomedical Imaging Facility (BMIF), Lowy Cancer Research Building, University of New South Wales (UNSW), Sydney	29/11/17 – 01/12/17
Monash Bioinformatics Platform Training and Drop-In Help Sessions	MASSIVE team (HPC support)	15 Innovation Walk, Monash University Clayton Campus (main venue)	Weekly on Fridays from 09/02/18
Introduction to SLURM for Bioinformatics Researchers	MASSIVE team	23 Innovation Walk, Monash University Clayton Campus	21/02/18
Machine Learning Symposium	MASSIVE team and Monash eResearch Centre	National Centre for Synchrotron Science, 800 Blackburn Road, Clayton VIC	19/03/18
CryoEM data processing workshop	University of Wollongong (UoW) CryoEM facility and MASSIVE team	University of Wollongong (UoW)	24/05/18


MACHINE
LEARNING
SYMPOSIUM
The capability to develop computer programs that learn through experience, using techniques such as deep neural networks, has generated significant interest across a wide range of fields, including medicine, biology, engineering, astronomy, economics, and law.
The Machine Learning Symposium is a one-day applied Artificial Intelligence event to hear how researchers are applying machine learning techniques in their research. The day will include a broad range of participants, that includes both:
machine learning experts and practitioners; and
researchers and data scientists with an interest in applying ML techniques.
The Machine Learning Symposium will be applications-focused, and cover applications of ML to topics such as natural language processing, human-computer interaction, computer vision and robotics, medical imaging, financial and economics modelling and big data processing, as well as the state-of-the-art computing infrastructure that underpins these efforts.
To be held on Monday 19th of March, the symposium will be opened by our keynote speaker Professor Geoffrey Webb, data scientist and 2019 recipient of the Eureka Prize for excellence in data science research, and co-convened by Professor Simon See of Nanyang Technological University and Director of the NVIDIA AI Technology Centre.
CALL FOR DATA PRESENTATIONS
Australian researchers are generating more data than ever before through improvements in instrumentation, compute, storage and workflow automation. We are calling for five-minute presentations for researchers to present a dataset of untapped potential or a research problem that may gain value from the application of machine learning or artificial intelligence. If you would like to nominate for a five-minute data presentation, please email Jason.Ryle@monash.edu, providing your details and a short abstract.
TOPICS
Go to www.massive.org.au for an updated schedule.
Language & Text
Medical imaging
Health
Robotics & Computer vision
Art & Design
Economics
High Performance Computing
MONDA
19.03.20
MONAS
University
Register on Eventbrite:
https://goo.gl/8UKgg7
National Centre for Synchrotro
800 Blackburn Road Clayton,
Victoria, 3168, Australia
www.massive.org.au
NVIDIA.

Training and outreach

Training Continued

Title		Location	Date/s
Half Day Intel Parallel Studio XE (IPSXE) Information Session	Intel and MASSIVE team	Green Chemical Futures, 13 Rainforest Walk, Monash University Clayton Campus	30/05/18
Avizo help and information session(s)	FEI Visualization Sciences Group	Monash University Clayton Campus	06/06/18
Introduction to the command line (The Unix Shell)	MASSIVE team (HPC Support)	Teaching Room 1, Matheson Library Monash University, Clayton Campus"	29/6/2018
Fundamentals of Deep Learning for Computer Vision Workshop	NVIDIA	Learning & Teaching Building, 19 Ancora Imparo Way, Monash University Clayton Campus	12/07/18
Introduction to HPC and the SLURM Workload Manager"	MASSIVE team (HPC Support)	"Teaching Room 1, Matheson Library Monash University, Clayton Campus	3/8/2018

Outreach

Title		Location	Date/s
eResearch NZ 2017	MASSIVE team (Presentation)	Queenstown, 38-54 Lake Esplanade, Queenstown, New Zealand	20/02/17 – 22/02/17
Characterisation Informatics Workshop	MASSIVE team	Monash University Conference Centre, Level 7, 30 Collins Street, Melbourne VIC	28/02/17
Characterisation Informatics Workshop	MASSIVE team	University of Wollongong Sydney Business School, 1 Macquarie Place, Circular Quay NSW	12/05/17
GPU Technology Conference (GTC) 2017	MASSIVE team (Presentation)	San Jose McEnery Convention Center, 150 West San Carlos Street, San Jose CA USA	07/05/17 – 11/05/17
16th INCF Nodes Workshop	MASSIVE team (Representation)	Georg Sverdrups hus, Moltke Moes vei 39, University of Oslo, Oslo, Norway	29/05/17 – 30/05/17
OpenStack Australia Day Melbourne 2017	MASSIVE team (Presentation)	Rydges Melbourne (CBD), 168 Exhibition St, Melbourne VIC	01/06/17
Neuroinformatics 2017	MASSIVE team (Presentation)	The Intermark 348 Jalan Tun Razak, Kuala Lumpur, Malaysia	20/08/17 – 21/08/17
Monash University NCMAS information session	National Computational Merit Allocation Scheme (NCMAS), National Computational Infrastructure (NCI), The Pawsey Supercomputing Centre, The University of Queensland (UQ) Flashlite and MASSIVE	Menzies Building, 20 Chancellors Walk, Monash University, Clayton Campus, VIC	12/09/17

Global BioImaging (GBI) Exchange of Experience (EOE) II	MASSIVE team (Presentation)	National Centre for Biological Sciences (NCBS), Bangalore, India	15/09/17 – 16/09/17
Robinhood User Group (RUG) 2017 and Lustre Administrator and Developer Workshop (LAD) '17	MASSIVE team (Presentation)	Hôtel des Arts et Métiers, 9 bis Avenue d'Iéna, 75016 Paris, France	03/10/17 – 05/10/17
eResearch Australasia 2017	MASSIVE team (Birds of a Feather (BoF))	Brisbane Convention & Exhibition Centre, Merivale Street, South Brisbane, Brisbane QLD	16/10/17 – 20/10/17
NVIDIA AI Conference	MASSIVE team (Presentation)	Suntec Singapore International Convention and Exhibition Centre, Singapore	24/10/17
OpenStack Summit – Sydney	MASSIVE team (Presentations, Panel, Birds of a Feather (BoF))	International Convention Centre (ICC) Sydney, 14 Darling Drive, Sydney NSW	06/11/17 – 08/11/17
Supercomputing 2017	MASSIVE team (Birds of a Feather (BoF))	Colorado Convention Center, 700 14th St, Denver, CO 80202 USA	12/11/17 – 17/11/17
ANDS/NeCTAR/RDS Monthly Tech Talk in February	MASSIVE team (Presentation)	15 Innovation Walk, Monash University Clayton Campus	02/02/18
Red Hat Ansible Automates – Melbourne	MASSIVE team (Participation)	ACMI, Federation Square, Flinders Street, Melbourne VIC 3000	08/02/18
Brain Summit 2018	MASSIVE team (Participation)	Nobel Forum, Karolinska Institute, Stockholm, Sweden	24/04/18
2018 Lustre User Group (LUG) Meeting	MASSIVE team (Presentation)	Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, Illinois, USA	24/04/18 – 26/04/18
OpenStack Summit – Vancouver	MASSIVE team (Birds of a Feather (BoF), Working Group, Panel)	Vancouver Convention Centre – West Building, 1055 Canada Pl, Vancouver, BC V6C, Canada	21/05/18 – 24/05/18
NSW CryoEM User Group Meeting	MASSIVE team (Presentation)	University of Wollongong (UoW), Northfields Avenue, Wollongong NSW 2522	25/05/18
ARDC Monthly Tech Talk in July	MASSIVE team (Presentation)	15 Innovation Walk, Monash University Clayton Campus	06/07/18

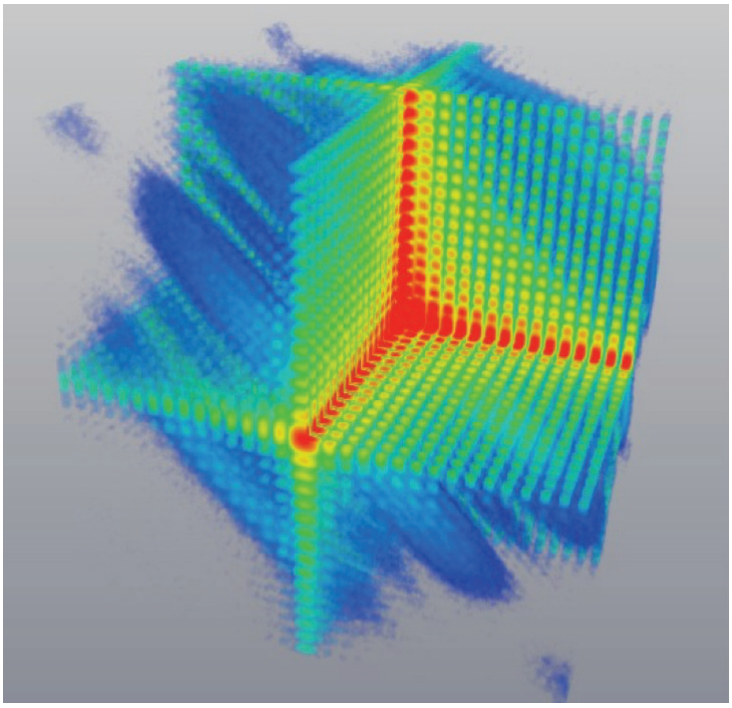
Usage and Users

In 2017-2018 MASSIVE has underpinned hundreds of projects across M1, M2 and M3. The organisations involved cover research institutes, hospitals, universities, private industry and government departments across Australia and internationally.

Facility Access

Access to MASSIVE is open and free of charge to all users who secure an allocation through a partner or through merit allocation scheme, or use the system through an integrated instrument.

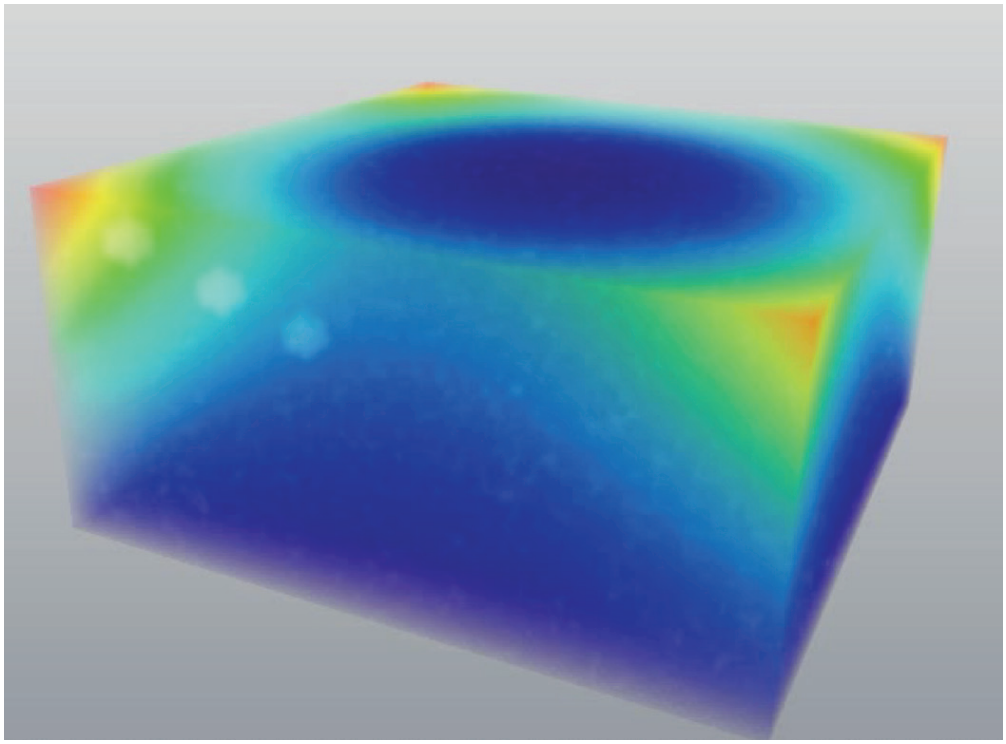
The MASSIVE partners have made available 10% of the facility for national access based on merit and managed through the National Computational Merit Allocation Scheme (NCMAS—http://ncmas.nci.org.au).



Please email help@massive.org.au for advise on how to access MASSIVE.

An imperfect crystal (RIGHT) is reconstructed from a simulated three-dimensional x-ray diffracted intensity pattern (LEFT), via a new analytical solution [Pavlov et al, Scientific Reports, 2017]. This kind of imaging, known as Bragg coherent diffraction imaging, allows researchers to look at samples that are only a few microns or even less than a micron across, with a spatial resolution limited only by the wavelength of the x-rays. For this sample, a crystal, both imperfections (white) and strain (colours) can be retrieved. Coherent diffraction imaging has historically required an iterative procedure to reconstruct the sample from a diffraction pattern, which can take a long time to compute and can have multiple possible answers. This analytical solution is fast to compute and has one unique solution.

Courtesy of: Konstantin Pavlov, University of Canterbury, Vasily Punegov, Russian Academy of Sciences, Kaye Morgan and David Paganin, Monash University Gerd Schmalz, University of New England



MASSIVE M3 and M2 combined usage data (CPU-core hours)

		Jan-Jun 2017	Jul-Dec 2017	Jan-Jun 2018	Total
Total Available		11,327,723	13,626,319	16,497,826	41,451,868
Dynamically Scheduled					
	Monash	1,448,660	2,963,009	3,142,405	7,554,074
	National Merit Allocation	455,138	948,172	884,481	2,287,791
	ANSTO	1,184,572	1,321,166	826,600	3,332,338
	CSIRO	149,823	170,711	519,688	840,222
	ARC CIBF	621,879	540,377	1,086,660	2,248,916
	ARC ImagingCoE	367,409	303,868	213,540	884,817
	Discretionary	271,217	329,291	286,307	886,815
Reserved usage					
	CVL Desktop	926,279	1,902,693	1,759,333	4,588,305
	Default and instrument prioritised	1,929,714	2,590,877	2,451,558	6,972,149
Other					
	System Testing and Maintenance	103,525	433,121	553,054	1,089,700
Total Used		**7,458,216**	**11,503,285**	**11,628,334**	**30,589,835**
Unused		**3,869,507**	**2,123,034**	**4,869,492**	**10,862,033**
Percentage Unused		**34.16%**	**15.58%**	**29.52%**	**26.20%**

THIS PAGE:
Sentinel-2 image of Melbourne (c) 2018 ESA/SentinelHub". Dr François Petitjean and his team are using image series captured by the Sentinel-2 satellites to monitor the evolution of our planet's surface and create land-cover/land-use maps. MASSIVE is currently used to learn machine learning models of land-cover that will be used to create a map of western Victoria

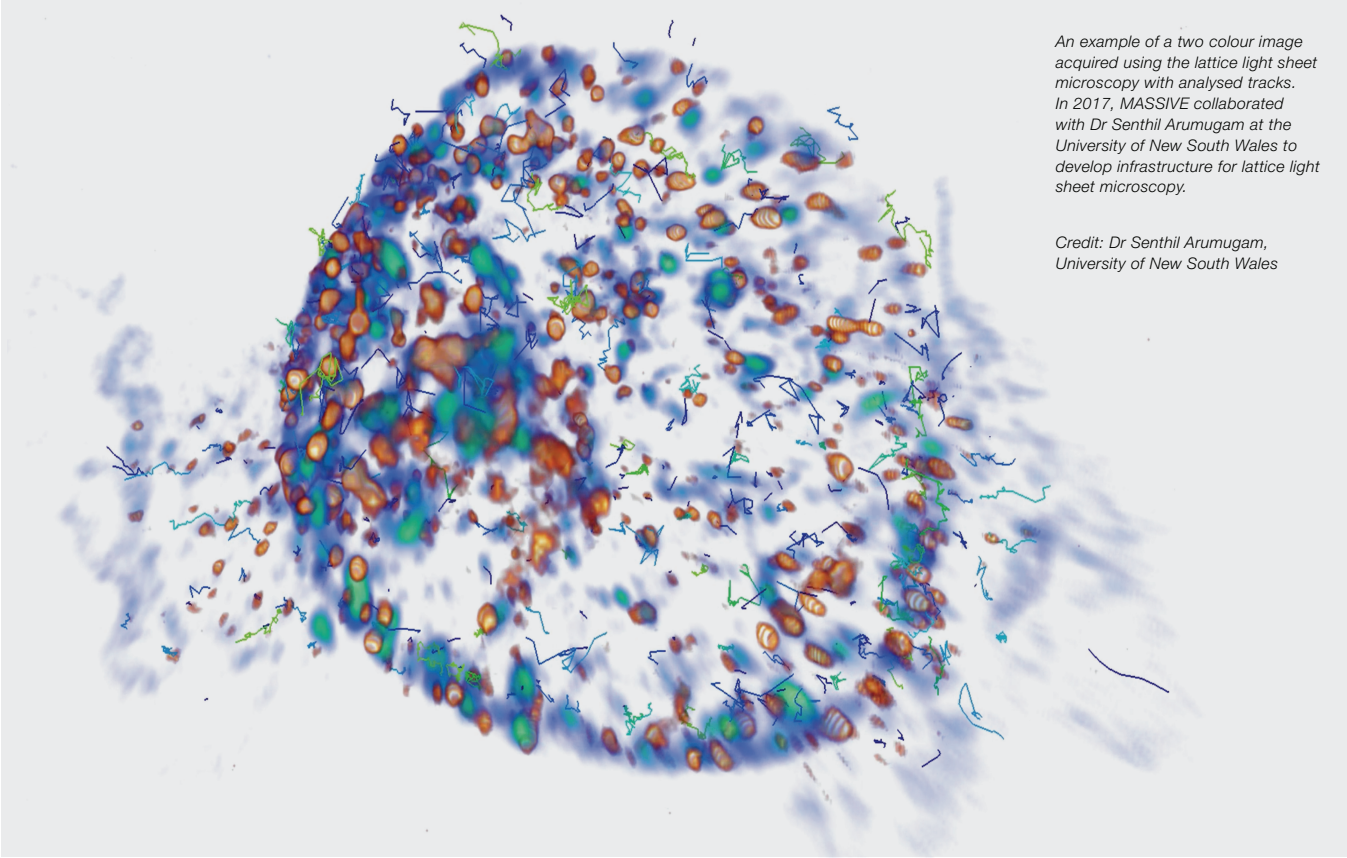
Projects

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
3D EM reconstruction of plasma-derived proteins	Monash University	Adam Costin, Andrew Ellisdon, Bradley Spicer, Charles Bayly-Jones, Christina Lucato, Christopher Lupton, Georg Ramm, Hariprasad Venugopal, James Wettenhall, Kai Xi, Lance Wilson, Mazdak Radjainia, Michelle Dunstone, Natalya Dudkina, Natasha Lukoyanova, ruby law, Siew Siew Pang	Partner Share	M1 / M2
3D fracture network evolution of geomaterials under static-dynamic coupled loading	Monash University	Qianbing Zhang, Kai Liu	Partner Share	M3
3D modelling of small scale geological structures	Monash University	Alexander Cruden, Mathias Egglseder	Partner Share	M1 / M2
3D Simulations of the Interiors of Stars	Monash University	Simon Campbell	Partner Share	M3
3D structure of cellulose nanofibre sheets	Monash University	Aysu Onur, Kirubanandan Shanmugam	Partner Share	M1 / M2
A brain-machine interface for control of dexterous movements	Monash University	Yan Wong, Hersh Umesh Nevgi, Maureen Hagan, Timothy Allison-Walker	Partner Share	M3
A functional magnetic resonance imaging (fMRI) study addressing cognitive function in individuals with Friedreich Ataxia	Monash University, Uniklinik RWTH Aachen	Cathlin Sheridan, Ian Harding, Louisa Selvadurai, Monique Stagnitti, Nellie Georgiou-Karistianis, Rosita Shishegar	Partner Share	M1 / M2, M3
A new, high spatial-resolution, dataset on internet use in Australia	Monash University	Klaus Ackermann, Simon Angus	Partner Share	M1 / M2
ACAS-CLIC Collaboration	University of Melbourne, Technische Universiteit Eindhoven, ANSTO	David Peake, Jim Franssen, Mark Boland, Mark Boland, Xavier Stragier	Partner Share	M1 / M2
Accurate Monte Carlo Dose Calculations for Microbeam Radiation Therapy at the Imaging and Medical Beamline	ANSTO, RMIT University, University of Wollongong, Monash University, University of Melbourne	Christopher Poole, Iwan Cornelius, Jayde Livingstone, Jeffrey CROSBIE, Liam Day, Matthew Cameron, Matthew Dimmock, Pauline Fournier	Partner Share	M1 / M2
Aggregating Crowdsourced Labels with Deep Learning	Monash University	Mark Carman, Yuan Jin	Partner Share	M3
Aggregation and Disaggregation of Antomicrobial Peptides	Monash University	Lisa Martin, Sourav Ray, Torsten John	Partner Share	M1 / M2
AI_Music_Generator	Monash University	Nick Birbilis, William Nash, Tim Herzog	Partner Share	M3
An investigation of the effects of intranasal oxytocin on socio-emotional brain regions in Huntingtons disease	Australian Catholic University	Govinda Poudel, Izelle Labuschagne	Partner Share	M1 / M2
Analysis of Brain MR images for the study of Alzheimer's disease	CSIRO, Monash University	Amir Fazlollahi, Kaikai Shen, Kerstin Pannek, Lee Reid, Parnesh Raniga, Pierrick Bourgeat, Saba Momeni	Partner Share	M1 / M2
Analysis of longitudinal structural MRI for TasCOG and CDOT studies (NCI 10974)	Murdoch Children's Research Institute, University of Melbourne, Monash University	Amanda Wood, Jian Chen, Joseph Yang, Michele Callisaya, Richard Beare, Sally Richmond	National Merit Allocation	M1 / M2
Analysis of UK Biobank MRI and genetic data	Monash University	Richard Beare	National Merit Allocation	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Analysis of XFEL data and simulations	La Trobe University	Connie Darmanin, Hannah Coughlan, Hugh Marman, Leonie Flueckiger, Susannah Holmes	Partner Share	M1 / M2
Anatomical Image Processing and Biomechanical Modelling	Monash University	Michelle Quayle, Alexander Mcdonald, Emma May Handley, Hazel Richards, Justin Adams	Partner Share	M3
Anatomical Image Processing and Biomechanical Modelling	Monash University	Alexander McDonald, Alistair Evans, Christopher Walmsley, Colin McHenry, Hazel Richards, Justin Adams, Luca Fiorenza, Matthew McCurry, Michelle Quayle, Ratheesraj Ratinam, Ruth Nagassa, Sophie Franklin	Partner Share	M1 / M2
Apolipoprotein-D	University of Wollongong	Simon Brown, Claudia Sybille Kielkopf	Partner Share	M3
Application of Soundless Cracking Demolition Agents (SCDAs) for underground mineral extraction process: The effect of confinement	Monash University, ANSTO	Andrew Stevenson, Anton Maksimenko, Avanthi Isaka Badulla Liyanage, Catleya Rojviriya, Christopher Hall, Jayde Livingstone, Pabasara Wanniarachchige, Radhika De Silva, Robert Acres	Partner Share	M1 / M2
Applying 4DxCT to idrug delivery and lung function change of inhaled therapies	Monash University	Freda Rothschild, Jian Li, Jiping Wang, Nusaibah Abdul Rahim, Rhiannon Murrie, Richard Carnibella, Yu-Wei Lin	Partner Share	M1 / M2
ARC Centre of Excellence for Robotic Vision	Monash University	Tom Drummond, Andrew Spek, Thanuja Dharmasiri	Partner Share	M1 / M2, M3
ASPREE Data Science	Monash University	Jessica Lockery, Jason Rigby	Partner Share	M3
Assessing lung function in rat models of cystic fibrosis lung disease	ANSTO, Monash University, Government of South Australia, University of Tasmania, University of Adelaide	Anton Maksimenko, Christopher Hall, David Parsons, Ellen Bennett, Freda Werdiger, Graeme Zosky, Marcus Kitchen, Martin Donnelley, Patricia Cmielewski, Robert Acres	Partner Share	M1 / M2
Atom Probe	University of Sydney, University of Queensland, Monash University	Anna Vallarta Ceguerra, Jafaruddin Lie, Lena-Pia Frommeyer, Ning Mo	CVL	M3
Atom Probe Workbench	University of Sydney, Monash University, University of Alabama	Anna Vallarta Ceguerra, Gregory Thompson, Jafaruddin Lie, Lance Wilson, Li Liu, Thomson Chow	CVL	M3
Atomistic simulations for physical and electronic properties of nanomaterials	Monash University	Junkai Deng, Mahdi Javadi, Majid Mortazavi, Marten Jurg, Nikhil Medhekar, runhong HUANG, Yuefeng Yin	National Merit Allocation	M1 / M2
Atomistic Simulations of Nuclear Materials	ANSTO	Gregory Lumpkin, Eugenia Kuo, Meng-jun Qin	National Merit Allocation	M3
Australian Synchrotron Scientific Programming Group	ANSTO, University of New England, Monash University, University of Melbourne, University of Adelaide, Country Fire Authority, Eindhoven University of Technology	Andreas Moll, Daniel Kelly, David Aragao, Dominique Appadoo, Gary Ruben, John Marcou, Jonathan de Booy, Junda Li, Mark Boland, Matthew Sale, Max Avdeev, Neale Hutcheon, Nicholas Hobbs, Paul Martin, Ramzi Kutteh, Richard Davies, Robbie Clarken, Ron Bosworth, Saliya Wimalaratne, Sebastiaan van der Geer, Terry Cornall, Ulrich Felzmann, Xavier Stragier	Partner Share	M1 / M2
Automation, processing and visualisation of large multi-dimensional micro-imaging datasets generated at Monash Micro Imaging	Monash University	Genevieve Buckley, Keith Schulze, Kirstin Elgass, Richard Beare	Partner Share	M1 / M2
AVG Lab	Monash University	Ian Harding, Benjamin Ray Castine, Chao Suo, Katharina Voigt, Naomi Kakoschke	Partner Share	M3
Berry-Xray	Monash University	Richard Berry	Partner Share	M3
Beryllium intermetallics for fusion applications	University of New South Wales, Imperial College London, ANSTO	Bowen Zheng, Daniel King, Daniel King, Daniel Lambert, Dillon Frost, Patrick Burr, Samuel Oliver, Simon Middleburgh, Thomas Whiting	Discretionary	M1 / M2
BHP – IMBL – High Temperature Melt Cylinders	CSIRO, University of Newcastle, ANSTO	Andreas Moll, Anton Maksimenko, Belinda Godel, Christopher Hall, Gareth Penny, Robert Acres, Tom Honeyands, Xinliang Liu	Partner Share	M1 / M2
Biocementation of coarse granular soil	Monash University	Aamir Mahawish, Abdelmalek Bouazza, Louis King, Mayu Tincopa, Toby Maywald	Partner Share	M1 / M2

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Bioinformatics and systems biology for investigating genomics to delivering personalised therapy in multiple myeloma	Monash University	Maoshan Chen	Partner Share	M3
Blood and cancer image analysis	University of Western Australia	Evan Ingley	CVL	M3
Blood Cancer Therapeutic Centre	Monash University	Kevin Gillinder, Graham Magor, Helen Mitchell, Kerri Wait, Ngoc Vo, Nick Wong	Partner Share	M3
BlueScope ML Research Project	Monash University	Nick Birbilis, William Nash, Tim Herzog	Partner Share	M3
BlueScope Steel XFM Using X-ray Fluorescence Microscopy to Aid Development of Improved, Value-Added Flat-Steel Products	ANSTO, University of Queensland, University of Queensland, BlueScope Steel Australia	Alan RiboldiTunnicliffe, Daryl Howard, David Paterson, Dongdong Qu, Kazuhiro Nogita, Martin de Jonge, Matthew Gear, Wayne Renshaw	Partner Share	M1 / M2
Bluff body aerodynamics	Monash University	Mark Thompson	Partner Share	M3
Borg Laboratory	Monash University	Natalie Borg, Sarah Atkinson	Partner Share	M3
Brain and Mental Health Lab	Monash University, University of Melbourne, University of Wollongong, Imperial College London,University of Hong Kong, Deakin University, Bellvitge Biomedical Research Institute, Swinburne University, Australian Catholic University	Alex Fornito, Chao Suo, Alexandria Wulff, Ali Ghasem-zadeh, Anna Earl, Ari Pinar, Ashlea Segal, Aurina Arnatkeviciute, Ben Fulcher, Benjamin Ray Castine, Camilla Beale, Carl Henning Lubba, Carsten Murawski, Eugene Mctavish, Gladys Lau, Gustavo Deco, Irene Esteban-cornejo, James Coxon, James Morrow, John Robert David Fallon, Josh Hendrikse, Kaitlin Day, Katharina Voigt, Kevin Aquino, Kristian Rotaru, Kristina Sabaroedin, Linden Parkes, Lucy Albertella, Mana Biabanimoghadam, Marianne Oldehinkel, Meadhbh Brosnan, Melissa Kirkovski, Michelle Lamblin, Naomi Kakoschke, Nigel Rogasch, Oren Contreras, Paul Klauser, Sarah Christina Thompson, Sarah Thompson, Sid Chopra, Stuart James Oldham, Suzan Maleki, Tamara Simpson, Tribikram Thapa, Valentina Lorenzetti, Vicente Pallares Picazo, Xiaoliu Zhang, Yann Ying Chye, Yantao Hu, Yifat Glikmann-johnston, Yuvan C	Partner Share	M1 / M2, M3
Brain Network Modelling of the Human Subcortex	Florey Institute of Neuroscience and Mental Health, Monash University	Amir Omidvarnia, Erynn Christensen, Ian Harding	Partner Share	M1 / M2
Brain stimulation and neural networks	QIMR Berghofer, University of Queensland	Luca Cocchi, Jinglei Lv, Luke Hearne	Partner Share	M1 / M2, M3
Breast cancer rotational radiotherapy with synchrotron radiation: energy optimization and study of contrast- and dose-enhancement effect	ANSTO, INFN Torino	Andrew Stevenson, Anton Maksimenko, Antonio Sarno, Christopher Hall, Francesca DiLillo, Jayde Livingstone, Paolo Russo, Robert Acres	Partner Share	M1 / M2
Cakile population genomics	Monash University	Kathryn Hodgins, Emma Mien-Siung Barnett, Hanna Rosinger, Lotte Van Boheemen, Nissanka De Silva	Partner Share	M3
CAP-sgras	Monash University	Stephanie Gras, Andrea Nguyen, Carine Farenc, Christian Alexander Lobos, Christoper Szeto, Dimitra Chatzileontiadou	Partner Share	M3
Carbon on Si/SiC	RMIT University, Monash University	Lance Wilson, Hiep Tran Le Ngoc	CVL	M3
CD39 in ischemic stroke	Monash University	Maithili Sashindranath, Richard Beare	Partner Share	M3
Cellranger and QIIME	Monash University	Scott Coutts, Callum James Nott, Lynze Cheung, Piyumi Thilakarathna, Rebekah Henry	Partner Share	M3
CF PCXI	Monash University, University Hospital Heidelberg, University of Adelaide	Clare Robinson, Ivan Lee, James Pittard, Karen Siu, Kaye Morgan, Konstantin Pavlov, Linda Croton, Mark Wielpuetz, Martin Donnelley, Phung Ly, Regine Gradl, Rhiannon Murrie, Ryan Green	Partner Share	M1 / M2
Challis_group	Monash University	Daniel Griffiths, Hussain Bhukya	Partner Share	M3
Characterisation of build quality for AMed components	Monash University	Louis Ngai Chiu	CVL	M3
Characterising the oligomeric state of the M17 aminopeptidases	Monash University	Sheena Mcgowan, Matthew Belousoff, Nyssa Drinkwater, Tess Rosalie Malcolm	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Characteristion of Radiation dosimeters	University of Wollongong	Jeremy Davis	CVL	M3
Chemical Crystallography for Functional Molecules, Complexes and Materials	Monash University	David Turner	Partner Share	M3
Climate adaptation in Ambrosia artemisiifolia	Monash University	Kathryn Hodgins, Jacqueline Lee, Lotte Van Boheemen	Partner Share	M3
Clinical Genomics	Monash University	Mark Waltham, Heidi Fettke, Jason Steen, Sarah Williams, Tu Nguyen-Dumont	Partner Share	M3
Cluster Analysis	University of Alabama	Gregory Thompson	CVL	M3
Coherent Diffraction Imaging	La Trobe University, Curtin University, Queensland University of Technology	Alaleh Amin Zadeh, Anirudh Jallandhra, Arie van Riessen, Gerard Hinsley, Giang Tran, Grant van Riessen, Michael Jones, Nick Phillips	Partner Share	M1 / M2
Commissioning: In-line phase-contrast mammographic CT	Monash University, University of Melbourne, ANSTO	Andrew Stevenson, Anton Maksimenko, Christopher Hall, Daniel Hausermann, Matthew Dimmock, Patrycja Baran, Robert Acres	Partner Share	M1 / M2
Commissioning: Testing the LAPS with large sample – Rhino skull	ANSTO	Anton Maksimenko, Christopher Hall, Daniel Hausermann, Mitzi Klein, Robbie Clarken, Robert Acres	Partner Share	M1 / M2
Comparison of vascular imaging parameters obtained under different anesthesia protocols	ANSTO, Monash University, University of Melbourne, Hudson Institute of Medical Research, National Cerebral and Cardiovascular Center	Amanda Edgley, Anton Maksimenko, Bryan Leaw, Catherine Li, Christine Bui, Christopher Hall, Claudia A Nold, Dandan Zhu, Daniel Hausermann, Erin McGillick, Hirotsugu Tsuchimochi, James Pearson, Jane Bourke, Jonathan Ho, Kelly Crossley, KyungjoonJoon Lim, LynnJee Kim, Magdalena Kolodziej, maverick lau, Megan Wallace, Michael Deveer, Mitzi Klein, Rebecca Lim, Robert Acres, Shreya Rana, Simon Royce	Partner Share	M1 / M2
Comparison of X-ray and Neutron CT	ANSTO	Andreas Moll, Anton Maksimenko, Christopher Hall, FilomenaFloriana Salvemini, Robert Acres	Partner Share	M1 / M2
Complexity and evolution of jaw muscles in agamid lizards and a comparison with Sphenodon (Reptilia: Lepidosauria)	University of Adelaide, ANSTO	Anton Maksimenko, Christopher Hall, Ellin HofmannThorpe, Jaimi Gray, Marc Jones, Robert Acres	Partner Share	M1 / M2



An example of a two colour image acquired using the lattice light sheet microscopy with analysed tracks. In 2017, MASSIVE collaborated with Dr Senthil Arumugam at the University of New South Wales to develop infrastructure for lattice light sheet microscopy.

Credit: Dr Senthil Arumugam, University of New South Wales

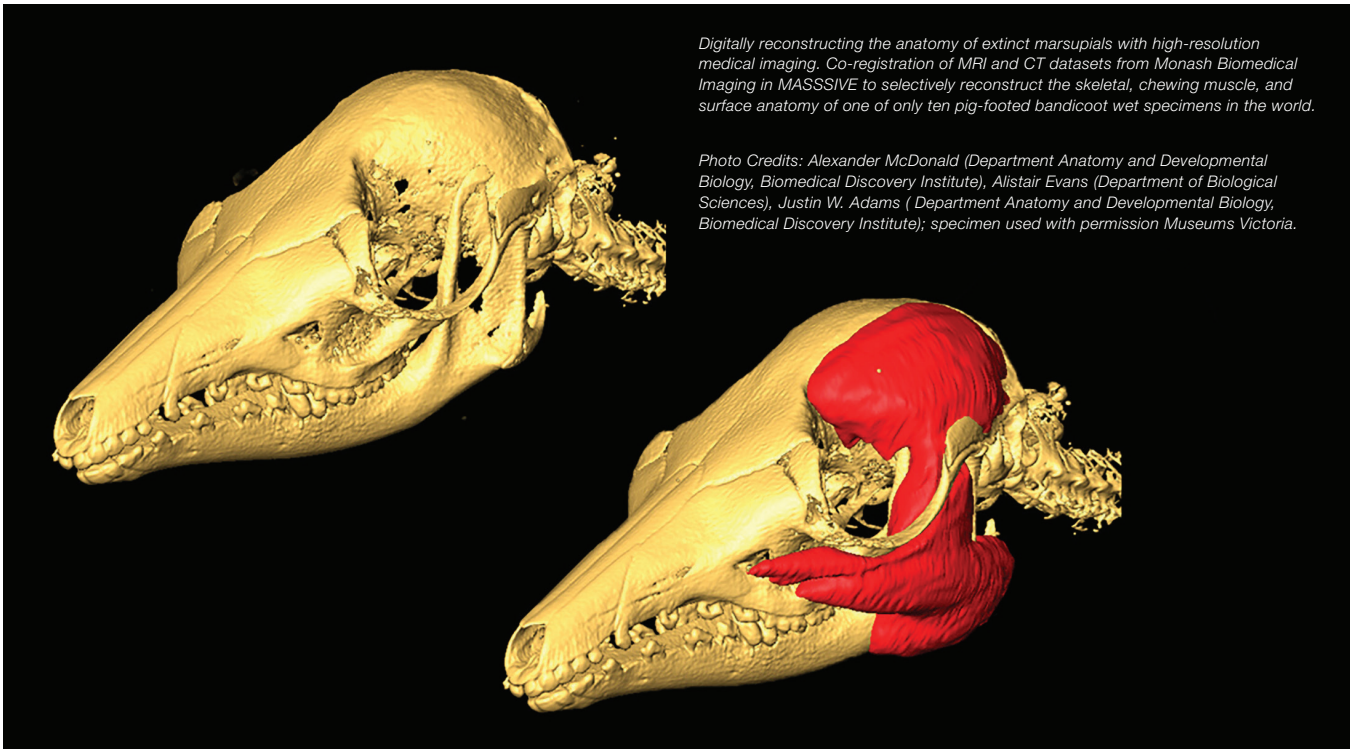
Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Comprehensive study of the background for the Pixel Vertex Detector at Belle II	ANSTO	Andreas Moll	Partner Share	M1 / M2
Computation modelling of Hippo/ YAP signalling in breast cancer	Monash University	Shabnam Khatibi	Partner Share	M3
Computational approaches towards the neuronal basis of consciousness	Monash University, University of South Alabama	Ajay Peddada, Alon Loeffler, Andrew Haun, Andrew Haun, Angus Leung, Dilshan Goonatillake, Dror Cohen, Elise Rowe, Fabiano Baroni, Irene Graafsma, Jamin Wu, Jochem van Kempen, Lisandro Kaunitz, Lucas Tobar, Mana Fujiwara, Matt Davidson, Mengyi You, Miao Cao, Miro Grundei, Naotsugu Tsuchiya, Piengkwan Sribanditmongkol, rafik hadfi, Rannee Li, William Wong, Yota Kawashima, Yuqi Zhang, Zeenat Hameed, Zhao Hui Koh	National Merit Allocation	M1 / M2, M3
Computational modelling and dynamics analysis of cancer signalling pathways	Monash University	Sungyoung Shin	Partner Share	M3
Computer-aided design of ionic media for organic and metal batteries	Monash University	Ekaterina Pas, Abhishek Singh, Anh Nguyen, Debopriya Sadhukhan, Fairuz Halimah Hashim, Luke Adam Wylie, Peter Halat, Philip Chan, Shu Gwee, Zaili Wang, Zoe Seeger	Partner Share	M3
Controls on trace element partitioning and enrichment in deep-sea ferromanganese nodules	Monash University, ANSTO	Andrew Frierdich, Barbara Etschmann, Cameron Kewish, Daryl Howard, David Paterson, Joel Brugger, John Marcou, Martin de Jonge, Robbie Clarken, Tobias Hens	Partner Share	M1 / M2
Coronary Artery Plaque Growth Modelling in Humans	Monash University	Isaac Pinar, Adam Brown, Alex Michael Horner, Tomasz Strus	Partner Share	M3
Coulibaly Lab	Monash University	Fasseli Coulibaly, Josh Hardy, Lance Wilson	Partner Share	M3
Creating a map of Victoria every 5 days	Monash University	Francois Petitjean, Benjamin Lucas, Chang Wei Tan, Charlotte Pelletier, Geoff Webb	Partner Share	M3
Creation of diffusion MRI fixel based brain white matter fibre tract atlas	Florey Institute of Neuroscience and Mental Health, University of Melbourne	Alan Connelly, Lea Vinokur	Discretionary	M3
Cross-channel analysis of multi-channel elecrtophysiological data in space, time and frequency	Monash University	Andrew Haun, Dror Cohen, Fabiano Baroni, Jochem van Kempen, Lisandro Kaunitz, Masafumi Oizumi, Miao Cao, Naotsugu Tsuchiya, William Wong	Partner Share	M1 / M2, M3
CRYO-EM Facility	Monash University	Georg Ramm, Adam Costin, Alex De Marco, Brad Spicer, Christina Lucato, Cyril Reboul, Hans Elmlund, John Mansour, Josh Hardy, Lynn Liang, Matthew Belousoff, Richard Berry, Sarah Le, Siew Pang	Partner Share	M3
Cryo-EM of small membrane proteins	Monash University	Adam Costin, Georg Ramm, James Wettenhall, Lynn Liang, Mazdak Radjainia	Partner Share	M1 / M2
Cryo-EM structures of DNA replication complexes	University of Wollongong	Gokhan Tolun, Timothy Newing, Timothy O'shea	Partner Share	M3
Cryoem Processing Optimisation	Monash University	George Vidalis, Hari Venugopal, Jafaruddin Lie, John Mansour, Lance Wilson, William Nash	Partner Share	M3
Cryoemfacility 2018	Monash University	Hari Venugopal	Partner Share	M3
CryoFIB on M3 – Helios	Monash University	Gediminas Gervinskas, Georg Ramm	Partner Share	M3
CSIRO ASC Support (MOSP support)	CSIRO	Alex Kruger, Gareth Williams, Greg Johanson, Justin Baker, Peter Campbell, Peter Tyson, Robert Bell, Tim Ho	Partner Share	M1 / M2
Decoding stimulus features from neuronal activity	Monash University	Tristan Chaplin	Partner Share	M3
Deep Learning for Cybersecurity	Monash University	Dinh Phung, Dai Nguyen, Mahmoud Mohammad Ahmed Ibrahim, Nhan Dam, Trung Le, Tu Nguyen, Van Nguyen, Viet Huynh	Partner Share	M3
Deep Learning in Medical Imaging – MRI and PET	Monash University	Zhaolin Chen, Kamlesh Pawar, Andrii Pozaruk, Anthony Jason Fernandez, Connor Thomas Squires, Elijah Tongpangkokba Longchar, Shen Li, Thomas David Kowal	Partner Share	M3
Deep learning transport applications	Monash University	Le Hai Vu, Cuong Nguyen, Gary Au	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Defect Structure in Materials by Additive Manufactured	Monash University	Greg Ingram, Amal Shaji Karapuzha, Daniel Schliephake, Dina Bayoumy, Greg Ingram, Haopeng Shen, Jeremy Rao, Kai Zhang, Louis Ngai Chiu	Partner Share	M3
Defective piles within piled embankments	Monash University, Deakin University University, ANSTO	Anton Maksimenko, Christopher Hall, Frazer Saunders, Louis King, Nicholas MasonSmith, paul satur, Robert Acres, Will Gates	Partner Share	M1 / M2
Defects identification in selective laser melting process	Monash University	Andrey Molotnikov, Marten Jurg, Zach Ryan	Partner Share	M3
Defining poly-C-binding protein stabilised RNA structures essential for viral genome translation and replication	Monash University	Matthew Wilce, Hari Venugopal, Matthew Belousoff, Mehdi Youssefi Matak	Partner Share	M3
Density waves in dipolar gases	Monash University	Chris Billington, Meera Parish	Partner Share	M1 / M2
Depth Resolution In X-ray Fluorescence Microscopy (DXFM)	Monash University	Carlos Pena, Linda Kelly, Matthew Dimmock	Partner Share	M1 / M2, M3
DHVL – Design House Project	Australian National University, Monash University, RMIT University, University of Technology Sydney, University of South Australia	Lance Wilson, Stanley Luong, Aiswarya Pradeepkumar, Chris Hines, Jafaruddin Lie, Phuong Le Yen, Thuy Thi Thanh Pham, Duk Yong Choi	CVL	M3
DHVL – Design House Project	Monash University	Jafaruddin Lie,	CVL	M3
Determining protein structures using transmission electron microscopy	Walter and Eliza Hall Institute of Medical Research, University of Queensland, Monash University	Bin Wang, Carlo Hamalainen, Clara Iin, Georg Ramm, Ignatius Bourke, James Wettenhall, john mansour, Kai Xi, Mazdak Radjainia, tony hodder, Wilson Wong, YIBIN XU	Discretionary	M1 / M2
Determining the role of Myc in Small Cell Lung Cancer	Hudson Institute, Monash University	Daniel Gough, Jasmine Chen	Partner Share	M3
Development and commissioning	ANSTO	Anton Maksimenko, Christopher Hall, Damien Leong, Robert Acres	Partner Share	M1 / M2
Development and Evolution of the Vertebrate Musculoskeletal System	Monash University	Peter Currie, Frank Tulenko	Partner Share	M3
Development, testing and commissioning	ANSTO	Anton Maksimenko, Christopher Hall, Mitzi Klein, Robert Acres	Partner Share	M1 / M2
DHVL – Design House Project	Monash University	Shan Don, Yang Lim	CVL	M3
DHVL – Design House Project	Monash University	Shan Don, John Paul Teodosio	CVL	M3
DHVL – Design House Project	Monash University	Victor Cadarso, Hazem Abdelmaksoud	CVL	M3
Differences in upper airway anatomy in oronasal vs nasal CPAP masks using magnetic resonance imaging (MRI)	Monash University	Bradley Edwards, Shane Landry, Richard Beare	Partner Share	M3
Distribution of arsenic and trace elements in Fe oxide nodules	ANSTO, RMIT University, University of New South Wales	Daryl Howard, David Paterson, Hannah Mikkonen, Martin de Jonge, Richard Collins, Robbie Clarken, Robert van de Graaff, Suzanne Reichman	Partner Share	M1 / M2
Do Mg-carbonates sequester toxic metals as well as CO2? Putting to rest a 20-year old question about environmental protection during carbon sequestration in minerals	University of Sydney, University of Queensland, Monash University, ANSTO	Bree Morgan, Connor Turvey, Daryl Howard, David Paterson, Gordon Southam, Jenine McCutcheon, Jessica Hamilton, Martin de Jonge, Sasha Wilson	Partner Share	M1 / M2
Dopamine	Monash University	Alex Fornito, Ari Pinar, Aurina Arnatkeviciute, Beth Johnson, Chao Suo, Tarrant Cummins	Partner Share	M1 / M2
Dose Quantificationa and Enhancement in Hadron Therapy	ANSTO, University of Wollongong	Mitra Safavi-Naeini, Abdella-Mohammednur Ahmed, Andrew Chacon, Harley Rutherford	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Drought tolerance of plant root systems	ANSTO, Western Sydney University, University of Tasmania	Anton Maksimenko, Brendan Choat, Christopher Hall, Madeline CarinsMurphy, Markus Nolf, Markus Nolf, Robert Acres, Rosana Lopez, Rosana Lpez, Tim Brodribb	Partner Share	M1 / M2
Drug-target interaction prediction based on Deep learning	Monash University	Campbell Wilson	Partner Share	M1 / M2
Durability of FRP within Seawater and Sea Sand Concrete	Monash University	milad bazli, Xiang Yu, Xiao-Ling Zhao, Yinglei Li, Zike Wang	Partner Share	M1 / M2
Dynamic computed tomography of lungs in motion	Monash University	Andreas Fouras, David Wenger, Freda Rothschild, George Goonan, James Taylor, Melissa Preissner, Michael Curtis, Rajeev Samarage, Rhiannon Murrie, Richard Carnibella, Si Liu, Stephen Dubsky	National Merit Allocation	M1 / M2
Dynamo setup	Monash University	Alex de marco	Partner Share	M1 / M2
Effect of delayed liquid clearance on lung function and blood flow in preterm rabbit kittens at birth	Monash University, Synchrotron Thailand, The Hudson, ANSTO	Alison moxham, Andrew Stevenson, Annie McDougall, Anton Maksimenko, Catleya Rojviriya, Christopher Hall, Dylan OConnell, Emily Phillips, Erin McGillick, Gary Ruben, Jayde Livingstone, Karyn Rodgers, Katie Lee, Kelly Crossley, Linda Croton, Marcus Kitchen, Megan Wallace, Robert Acres, Rosemary Waghorn, Shigeo Yamaoka, Stuart Hooper	Partner Share	M1 / M2
Effect of Heat-treatment on the EBM produced Ti6Al4V microlattices	CSIRO, ANSTO	Anton Maksimenko, Christopher Hall, Darren Fraser, Robert Acres	Partner Share	M1 / M2
Effective ways of applying Soundless Cracking Demolition Agents (SCDA) for an optimal deep underground mineral extraction process: Effects of applied stress and degree of saturation	Monash University, ANSTO	Anton Maksimenko, Christopher Hall, Radhika De Silva, Ranjith Pathegama, Robert Acres	Partner Share	M1 / M2
EGFR in nanodiscs	Monash University	Ruth Mitchell	CVL	M3
Elemental distribution at sub-cellular level in nickel hyperaccumulator tissue	University of Adelaide, University of Queensland, University of Sydney, ANSTO	Antony vanderEnt, Barry Noller, Daryl Howard, David Paterson, Hugh Harris, Martin de Jonge, Rachel Mak	Partner Share	M1 / M2
Elemental structure and XANES speciation of particles from nuclear and non-nuclear tests in Australia with focus on Pu and Fe	ANSTO, University of New South Wales	Atsushi Ikeda, Daryl Howard, David Child, David Paterson, Martin de Jonge, Mathew Johansen, Michael Hotchkis, Nicholas Howell, Richard Collins, Robbie Clarken	Partner Share	M1 / M2
Elmund Lab	Monash University, University of Oxford	Hans Elmlund, Cyril Reboul, Lance Wilson, Marion Boudes, Michael Eager, Monica Caggiano, Sarah Le, Susan Lea	Partner Share	M3
EMAP	University of Sydney, AMETEK, AMMRF, Nanjing University of Science and Technology, University of Queensland, Instytut Technologii Elektronowej (Poland), Intersect Australia, Tohoku University, University of North Texas, University of Washington, University of Melbourne	Alec Day, Alistair Milne, Andrew Breen, Anitha Kannan, Anna Ceguerra, David Reinhard, EMAP Admin, Frontdesk Frontdesk, Gang Sha, Graham Galloway, Jafaruddin Lie, Jakub Kaczmarski, Jeff Christiansen, Jeremy Hammond, Jupiter Hu, Lance Wilson, Leigh Stephenson, Li Liu, Maixi Cai, Matthew Foley, morgan tort, nasrun syafiq anas bakhtiar, Nathan Wallace, Nur Fatin Binti Che Hassan, penny chen, Peter Liddicoat, Ross Marceau, Sandeep Manandhar, Suqin Zhu, Talukder Alam, tim petersen, Tong Li, Varvara Efremova, Xu Xiandong	Discretionary	M1 / M2
Energy materials modelling	University of New South Wales	Bowen Zheng, Daniel King, Daniel Lambert, Dillon Frost, Patrick Burr, Samuel Oliver, Vidur Tuli	National Merit Allocation	M1 / M2, M3
Energy Optimisation	Monash University	Ariel Liebman, Edward Lam	Partner Share	M3
Epigenetic Regulation Struture & Function	Monash University	Chen Davidovich, Mazdak Radjainia, Nicholas McKenzie, Philip Chan, Qi Zhang, Vita Levina	Partner Share	M1 / M2
Epigenetics in Human Health and Disease Laboratory	Monash University	Antony Kaspi, Kerri Wait, Mark Ziemann	Partner Share	M3
Epilepsy_genomics	Monash University	Alison Anderson, Kerry Mullan, Nick Wong	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Epileptogenicity in Tuberous Sclerosis Complex: an ultra-high field MRI study of tuber microstructure	Murdoch Children's Research Institute, Monash University	Joseph Yuan-Mou Yang, Richard Beare	National Merit Allocation	M3
Evolution of the braincase of early vertebrates – Soft tissue preservation in fossil lungfish	Flinders University University, Australian National University, ANSTO	Alice Clement, Andreas Moll, Anton Maksimenko, Christopher Hall, John Long, Robert Acres, Vincent Dupret	Partner Share	M1 / M2
Exercise-induced gastrointestinal syndrome and the gut microbiome	Monash University	Ricardo Da Costa	Partner Share	M3
Exploring National Treasure: Automatic Photo Search for the Large Collection of National Archives of Australia	University of Wollongong, Wrocław University of Science and Technology	Lei Wang, Ian Comor ,Yan Zhao, Maciej Zieba, Zhimin Gao	National Merit Allocation	M1 / M2, M3
Faster and more flexible XANES imaging at XFM	Monash University, ANSTO	Barbara Etschmann, Daryl Howard, David Paterson, Martin de Jonge, Michael Favero	Partner Share	M1 / M2
Florey_fMRI	University of Melbourne, Florey Institute of Neuroscience and Mental Health	David Abbott, Chris Tailby, David Vaughan, Donna Parker, Farnoosh Sadeghian, Magdalena Kowalczyk	CVL	M3
Flow Cytometry	University of Western Australia, Western Sydney University	Andrew James Mehnert, Andrea Lisa Holme, Andrew John Warnock, Jahmila Parthenay, Nadia Stephanie Sloan, Nathanael James Yates, Paul Joseph Rigby, Timothy Stait-Gardner, Wei Ming Li, Yutthapong Tongpob	CVL	M3
Fly RNAseq & proteomics_aa balance	Monash University	Matthew Piper, Javier Gomez Ortega	Partner Share	M3
Functional brain imaging of interoception	Monash University	Damian Azzollini, Damien Leong, EMMANUEL ILEJAY, Letty Chong, Matthew Dimmock, Michael Farrell, Tara Bautista, Varsha Kumar, Xingwen Liang	Partner Share	M1 / M2
Functional Compensation in Huntington's Disease	Monash University	Nellie Georgiou-Karistianis, Maria Soloveva, Sharna Jamadar	Partner Share	M3
Functional imaging and modelling of the lung	Monash University	Stephen Dubsky, Melissa Helene Preissner	Partner Share	M3
Genetics of brain structure and function	QIMR Berghofer Medical Research Institute, University of Queensland, CSIRO	Angus Wallace, Kaikai Shen, Katie McMahon, Lachlan Strike	National Merit Allocation	M1 / M2
Genome-wide association studies of Attention Deficit Hyperactivity Disorder	University of Melbourne, Trinity College Dublin, Monash University	Ashleigh Salmon, Hannah Yates, Janette Tong, Jochem van Kempen, Meadhbh Brosnan, Ziarih Hawi, Nicole Stefanac, Shou-han Zhou	Partner Share	M1 / M2, M3
GeoPIXE software AS users access	ANSTO, CSIRO, and 32 other institutions	Chris Ryan, and 331 members	Partner Share	M1 / M2
GPU-based DEM Simulation of Particulate Systems	Monash Univesity	Jieqing Gan, Angga Herman, Lulu Jiao, Siyuan He, Tengfang Zhang, Xin Li	Partner Share	M3
Gravitational Waves from Turbulent Neutron Stars	University of Melbourne, Duke University	Andrew Melatos, Emily Kuhn, Emma Barnett, George Howitt, Hannah Middleton, Jack Lonnborn, James Douglass, Liam Dunn, LING SUN, Lisa Drummond, Mark Bennett, Patrick Clearwater, Paul Lasky, Sofia Suvorova, Wee Chaimanowong	National Merit Allocation	M1 / M2
GWAS analysis of splicing in 1001 genomes of Arabidopsis	Monash University	Sureshkumar Balasubramanian, Craig Ian Dent, Shilpi Singh	Partner Share	M3
Heavy Metals as a Cause of Amyotrophic Lateral Sclerosis and Alzheimer's Disease	University of Sydney, ANSTO	Daryl Howard, David Paterson, Joonsup Lee, Martin de Jonge, Peter Lay, Rachel Mak, Roger Pamphlett	Partner Share	M1 / M2
High speed train aerodynamics	Monash University	Mark Thompson, Shibo Wang	Partner Share	M1 / M2
HIV01	Monash University, University of Melbourne, Griffith University, Deakin University, Max Planck Institute of Biophysics	Alex De Marco, Andrew Leis, Chandan Kishor, Chris Lupton, Denis Korneev, Dhananjaya Ekanayake, Hari Venugopal, Johnson Mak, Josh Hardy, Kendra Leigh, Md Mahmud, Misha Kudryashev, Rommel Mathias, Sergey Gorelick	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
HLA Class II	Monash University	Jan Petersen	Partner Share	M3
Host microbiota interactions	Monash University	Benjamin Marsland, Celine Pattaroni	Partner Share	M3
How fracturing fluid type affects the effectiveness of creating fracture network through hydro fracturing in deep geological formations?	Monash University, ANSTO	Anton Maksimenko, Ayal Wanniarachchi, Christopher Hall, Ranjith Pathegama, Robert Acres	Partner Share	M1 / M2
High Performance Computing Cambridge Collaboration	University of Cambridge, Monash University	Wojciech Turek, Wojtek Goscinski, Matt Raso-Barnett, Paul Browne, Stuart Rankin	CVL	M3
Human Studies of Motivation and Cognitive Processing	Monash University	Trevor Chong, Ariel Goh, Bridgitt Mary Shea, Shou-han Zhou	Partner Share	M3
Image processing intensive application in big data	Australian Defence Force Academy, University of New South Wales	Andrew Asfaganov, Jiankun Hu, Quang Tran, Xuefei Yin, Yanming Zhu	National Merit Allocation	M1 / M2
ImageHD	Monash University, Australian Catholic University	Nellie Georgiou-Karistianis, Sharna Jamadar, Chantelle Doulis, David Barnes, Govinda Poudel, Ian Harding, Juan Dominguez, Lotta Ahveninen, Louisa Selvadurai, Maria Soloveva, Media Flux, Rosita Shishegar, Shenjun Zhong, Sudeshna Rajapakse	Partner Share	M1 / M2, M3
Imaging and Medical Beamline	CSIRO, University of Wollongong, ANSTO	Alberto Astolfo, Astrid Kibleur, Christopher Hall, Darren Thompson, Iwan Cornelius, Jayde Livingstone, Matthew Wallis, Robert Acres	Partner Share	M1 / M2
Imaging compensation in Huntington's Disease	Australian Catholic University, Monash University	Govinda Poudel, Maria Soloveva	Partner Share	M1 / M2
Imaging of pipe soil interactions	Monash University	Jayantha Kodikara, Rukshan Azoor, Sameera Pitawala	CVL	M3
Imaging the deformation and fracture onset in human femurs	Flinders University, ANSTO	Anton Maksimenko, Christopher Hall, Egon Perilli, Robert Acres, Saulo Martelli	Partner Share	M1 / M2
IMBL commercial placeholder 2017/2	ANSTO	Andrew Stevenson, Anton Maksimenko, Christopher Hall, Jayde Livingstone, Robbie Clarken, Robert Acres	Partner Share	M1 / M2
Impact of interfaces on coke behaviour	ANSTO, University of Wollongong, University of Newcastle, University of Queensland, CSIRO, University of New South Wales	Anton Maksimenko, Brian Monaghan, Christopher Hall, David Jenkins, Hannah Lomas, Harold Rogers, Karen Steel, Lauren North, Merrick Mahoney, Ray Longbottom, Reydick Balucan, Robert Acres, Sheridan Mayo, Xing Xing	Partner Share	M1 / M2



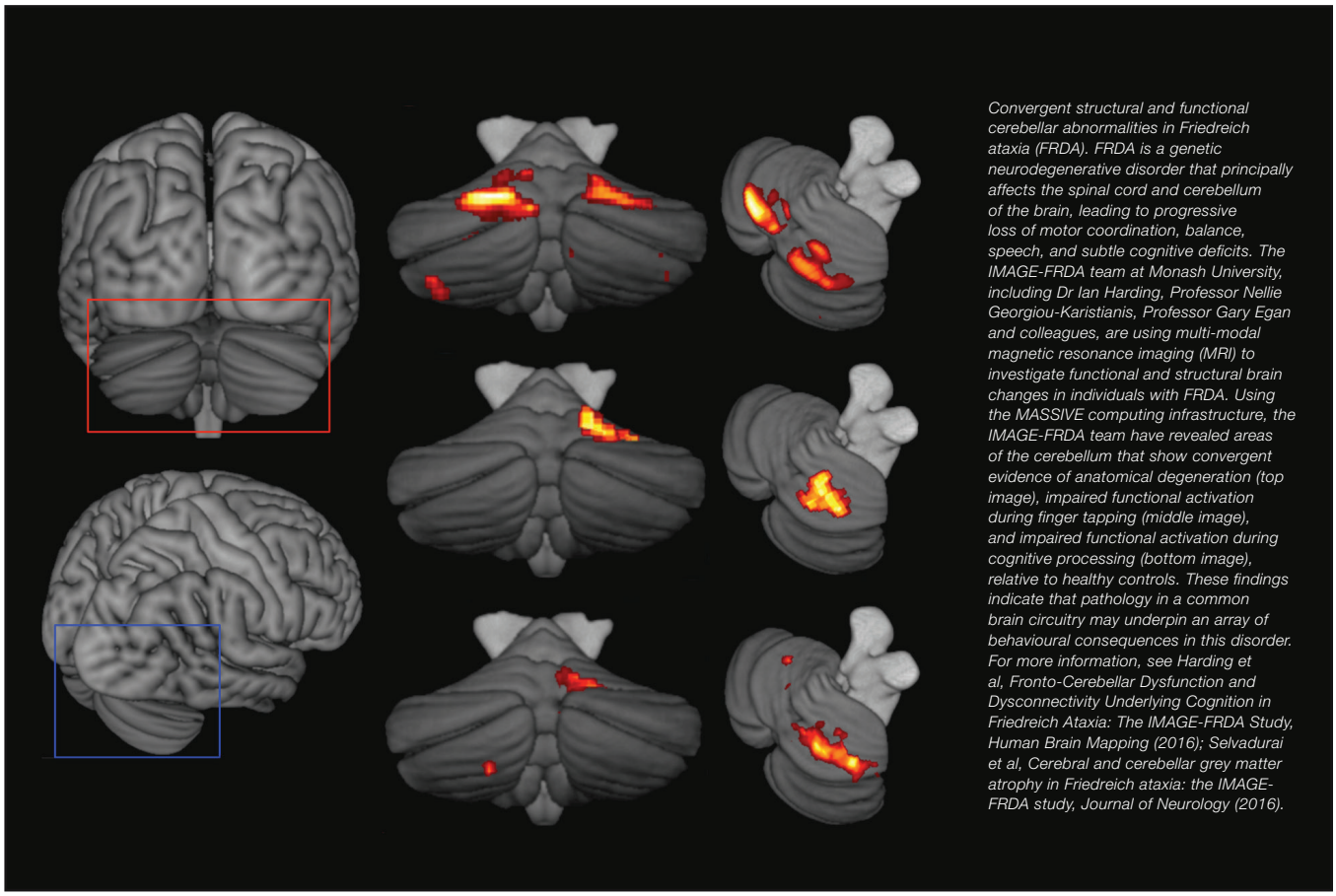
Digitally reconstructing the anatomy of extinct marsupials with high-resolution medical imaging. Co-registration of MRI and CT datasets from Monash Biomedical Imaging in MASSSIVE to selectively reconstruct the skeletal, chewing muscle, and surface anatomy of one of only ten pig-footed bandicoot wet specimens in the world.

Photo Credits: Alexander McDonald (Department Anatomy and Developmental Biology, Biomedical Discovery Institute), Alistair Evans (Department of Biological Sciences), Justin W. Adams (Department Anatomy and Developmental Biology, Biomedical Discovery Institute); specimen used with permission Museums Victoria.

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Improving capabilities for tomographic reconstruction	CSIRO, Monash University	Darren Thompson, Fiona Chen, Gary Ruben, Nicola Scarlett, Robin Pearce, Sheridan Mayo	Partner Share	M1 / M2
Improving flood forecast skill using remote sensing data	Monash University	Ashley Wright, Valentijn Pauwels	Partner Share	M1 / M2
Immunity & Infection – Monash-Melbourne-LaTrobe CAP	Monash University	Stephanie Gras, Adam Shahine, Andrea Nguyen, Carine Farenc, Chris Hines, Christian Alexander Lobos, Christoper Szeto, Dimitra Chatzileontiadou, Elsa Marquez, Gabby Watson, Goodluck Onwukwe, Jan Petersen, Jerome Le Nours, Jesse Mobbs, Jia Jia Lim, Julian Vivian, Kerri Wait, Marcin Wegrecki, Phill Pymm, Praveena Thirunavukkarasu, Richard Berry, Wael Abdelhady, Yi Tian Ting, Yogesh Khandokar	Partner Share	M3
In-line phase-contrast mammographic CT at very low radiation doses	CSIRO, University of Melbourne, ANSTO	Andrew Stevenson, Anton Maksimenko, Christopher Hall, Daniel Hausermann, Darren Thompson, Jayde Livingstone, Matthew Dimmock, Patrycja Baran, Robert Acres, Sheridan Mayo, Timur Gureyev, Yakov Nesterets	Partner Share	M1 / M2
In-silico screening to identify new antimicrobials	Monash University	Anna Roujeinikova, Mohammad Khan, Philip Chan	Partner Share	M3
Infrared Image Analysis	Monash University	Bayden Wood, Dale Christensen, David Perez Guaita	Partner Share	M3
Integration of high-resolution DGT and planar optodes to investigate organism-induced modifications to contaminant biogeochemistry	ANSTO, University of Wollongong, University of South Australia, CSIRO, Griffith University	Daryl Howard, David Paterson, Dianne Jolley, Enzo Lombi, Martin de Jonge, Robbie Clarken, Timothy Remaili, William Bennett	Partner Share	M1 / M2
Investigating cytokine signalling pathways in proliferative disease	Monash University, Walter and Eliza Hall Institute of Medical Research	Adam Costin, Hariprasad Venugopal, Nicholas Liau	Partner Share	M1 / M2
Investigations of transitional and turbulent shear flows using direct numerical simulations (DNS), large eddy simulations (LES) and 3D Image Velcoimetry	Monash University, University of Minnesota, Polytechnic University of Madrid, University of Melbourne	Abel-John Buchner, Alex Kemp, Alice Martelletti, Atsushi Sekimoto, Daniel Edgington-Mitchell, Dinesh Bhatia, eric plancon, Graham Bell, Gregor Duerre, Joel Weightman, Jose Miguel Perez, Julio Soria, Marcus Fedrizzi, Michael Eisfelder, Muhammad Shehzad, Omid Amili, Paul McIntosh, Paul Stegeman, Phoebe Kuhn, Shahram Karami, Shevarjun Senthil, Shoaib Amjad, Shriram Ravikumar, Soledad Le Clainche Martinez, Tushar Sikroria, Vassili Kitsios, Zehuan Wu	National Merit Allocation	M1 / M2
Ion Channel Structural Studies	University of Queensland	Gavin Rice	Partner Share	M3
IRES	Monash University	Matthew Wilce	Partner Share	M3
IRz	Walter and Eliza Hall Institute of Medical Research	John Menting	Partner Share	M3
JAK	Monash University	Nicholas Liau	Partner Share	M3
JAP89	Monash University	Yi Tian Ting, Jesse Mobbs, Jia Jia Lim	Partner Share	M3
Kilosort	Monash University	Nicholas Price, Brian Oakley, Elizabeth Arsenault, Hersh Umesh Nevgi, Maureen Hagan, Yan Wong	Partner Share	M3
large scale 3D reconstruction for electron imaging	Monash University	Jing Fu, Shi Qiu, Shuo Zhang, Boyin Liu, Guangyi Zhou, Jialei Gong, VahidReza Adineh, Yeonuk Kim	Partner Share	M1 / M2, M3
Large scale registration of 2D and 3D brain histological data	Monash University, Nencki Institute of Experimental Biology	Blair Bethwaite, Kai Xi, Piotr Majka, Shi Bai, Sylwia Bednarek, Tristan Chaplin	Partner Share	M1 / M2
Lattice dynamics in thermoelectric materials	University of Wollongong	David Cortie	Discretionary	M3
Lattice Light Sheet Data Processing – Lieschke Lab	Monash University	Graham Lieschke, Harriet Manley, Lance Wilson	Partner Share	M3
Learning Algorithms for Computer Vision	Monash University	Andrew Paplinski, Kerri Wait, Md Anit Khan, Md Sazzad Hossain, Mohammad Ali Jan Ghasab, Varun Maithani, William Thomas Schmidt	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Learning Deep Semantics for Automatic Translation between Human Languages	Monash University, University of Melbourne	Gholamreza Haffari, Alexander Yuri Zenin, Chenyang Wang, Cong Hoang, Daniel Beck, Fahimeh Saleh, Islam Nassar, Ming Liu, Narjes Askarian, Omar Al Zeidi, Paulo Antunes Ventura Filho, Poorya Zaremoodi, Quan Tran, Sameen Maruf, Syed Najam Abbas Zaidi, Vu Thi Thuy Trang, Weiwei Lin, Xuanli He, Xuelin Situ	Partner Share	M1 / M2, M3
Learning Predictive SNP-SNP interaction Features from Genome-wide Association Studies	CSIRO, University of Melbourne	Cheng-soon Ong, Qiao Wang	Partner Share	M3
LENOURS laboratory	Monash University	Jerome Le Nours, Adam Shahine, Elsa Marquez, Marcin Wegrecki, Praveena Thirunavukkarasu, Yogesh Khandokar	Partner Share	M3
Lithgow Lab	Monash University	Matthew Belousoff, Iain Hay, Matthew Wilce, Mehdi Youssefi Matak	Partner Share	M3
LLSM Processing	Monash University	Keith Schulze, Lance Wilson	CVL	M3
Low dose mammography commissioning tests	CSIRO, University of Melbourne, ANSTO	Anton Maksimenko, Christopher Hall, Darren Thompson, Matthew Dimmock, Robert Acres, Robert Acres, Timur Gureyev, Yakov Nesterets	Partner Share	M1 / M2
Low-dose functional lung imaging	4Dx	Alex Winnett, David Wenger, Michael Curtis, Rajeev Samarage	Commercial	M1 / M2
Machine Learning	Monash University	Mohamed Hisham Jaward, Somayeh Ebrahimkhani	Partner Share	M3
Machine Learning in Games	Department of Defence, Monash University	Glennn Moy, Shuang Yu	Partner Share	M3
Macromolecular-ligand interaction discovery program III	Monash University	Jackie Wilce, Matthew Wilce, Lance Wilson	Partner Share	M3
Macromolecular-ligand interaction discovery program IV	Monash University	Jackie Wilce, Dene Littler, Julian Vivian, Marcin Wegrecki, Matthew Wilce	Partner Share	M3
Magnetic Properties of Tc Oxides and Tc Metal	ANSTO	Eugenia Kuo, Simon Middleburgh	Partner Share	M1 / M2
Magnetoreceptors in the pigeon inner ear: the elemental basis of biological nanomagnetism	Research Institute of Molecular Pathology, University of Western Australia, ANSTO	Daryl Howard, David Paterson, DavidAnthony Keays, Jeremy Shaw, Martin de Jonge, Pascal Malkemper, Robbie Clarken	Partner Share	M1 / M2
Mapping cement formation in synthetic beachrock: Implications for island stability in the Great Barrier Reef	ANSTO, University of Queensland, Monash University, Queensland University of Technology	Andreas Moll, Daryl Howard, David Paterson, Gordon Southam, Gregory Webb, Jenine McCutcheon, Jeremiah Shuster, Jessica Hamilton, Luke Nothdurft, Martin de Jonge	Partner Share	M1 / M2
MASSIVE High Performance Computing Project for ANSTO NSTLI Human Health	ANSTO, University of Wollongong, Curtin University	Keith Bambery, Abdella-mohammednur Ahmed, Andrew Chacon, Mitchell Klenner, Mitra Safavi-naeini	Partner Share	M3
Mathematical modelling and dynamics analysis of cancer signaling pathways	Monash University	Karina Islas Rios, Sungyoung Shin	Partner Share	M1 / M2
McGowan lab crystallography	Monash University	Sheena Mcgowan, Nyssa Drinkwater, Tess Rosalie Malcolm	Partner Share	M3
Mechanism of coal mass structure alterations subjected to different fluid saturation conditions during enhanced coalbed methane recovery process (ECBM	Monash University, ANSTO	Andrew Stevenson, Anton Maksimenko, Christopher Hall, Guanglei Zhang, Jayde Livingstone, Robert Acres, xiaogang zhang	Partner Share	M1 / M2
Mechanistic investigation into the role of corrosion-inhibition enhancer in mitigating carbon steel corrosion	Curtin University, ANSTO	Andreas Moll, Anton Maksimenko, Christopher Hall, Deepak Dwivedi, Katerina Lepkova, Robbie Clarken, Robert Acres	Partner Share	M1 / M2
Melbourne Brain Centre 7T MRI Protocol Development	University of Melbourne, University of Calgary, Murdoch Children's Research Institute	Amanda Ng, B Moffat, Chengchuan Wu, Emma Leeseberg, Hongfu Sun, Jon Cleary, Jordan Wright, Peter Yoo, Roger Ordidge, Scott Kolbe, Sila Genc, Warda Syeda, Yasmin Blunck, Yicheng Zhang	National Merit Allocation	M1 / M2, M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Memory in HD	Monash University, University of Sydney	Anna Carmichael, Bonnie Alexander, Emily-Clare Mercieca, Ian Harding, Muireann Irish, Richard Beare, Yifat Glikmann-Johnston	Partner Share	M1 / M2
MeRC AI initiatives	Monash University	Zongyuan Ge, Yunyan Xing	Partner Share	M3
Metagenomic Benchmarking	Hudson Institute	Sam Forster	Discretionary	M3
Metal-Semiconductor (MS) Contacts (Design House)	Monash University, RMIT University	Lance Wilson, Shan Don, Mohammad Saleh N Alnassar	CVL	M3
Micro CT scanning of cotton yarns	Deakin University University, CSIRO, ANSTO	Anton Maksimenko, Christopher Hall, Noman Haleem, Peter Tyson, Robert Acres, Stuart GORDON	Partner Share	M1 / M2
Micro-level respond of coal for Enhanced Coalbed Methane Recovery Process	ANSTO, Thailand Synchrotron, Monash University	Andrew Stevenson, Anton Maksimenko, Catleya Rojviriya, Christopher Hall, Guanglei Zhang, Jayde Livingstone, Robert Acres, zhaoyang ma	Partner Share	M1 / M2
Microstructural evolution of granular soils based on insitu X-Ray CT imaging	Monash University	Asadul Haque, Chanaka Senanayake Mudiyanselage, Ferdous Alam	Partner Share	M3
Mimivirus	Monash University	Daouda Traore	Partner Share	M3
Mitochondrial DNA in infection, autoimmunity and cancer	Monash University	Benjamin Kile, Genevieve Buckley, Kate Mcarthur, Lance Wilson, Tahnee Saunders	Partner Share	M3
MMI-LLSM	Monash University	David Potter, Genevieve Buckley, Lance Wilson	Partner Share	M3
Modelling and characterization of nanophotonic designs for nanoelectronics and nanobiotechnology	Monash University	Ashan Senevirathne, champi abeywickrama, Charith Kohomban Wickrama Jayasekara, Damien Leong, Dilusha Weeraddana, Harini Hapuarachchi, Kamani Gettapola, Lakshitha Kumarapperuma, Lelwala Lelwala Gamacharige, Malin Premaratne, Sudaraka Mallawa Arachchi, Tharindu Warnakula	Partner Share	M1 / M2
Modelling G protein-coupled receptors for drug discovery	Monash University	Amali Galappaththi Guruge, Billy Williams-Noonan, Chris MacRaild, Dallas Warren, David Chalmers, Estelle Suys, Mitchell Silk, Tamir Dingjan, Trayder Thomas	Partner Share	M1 / M2



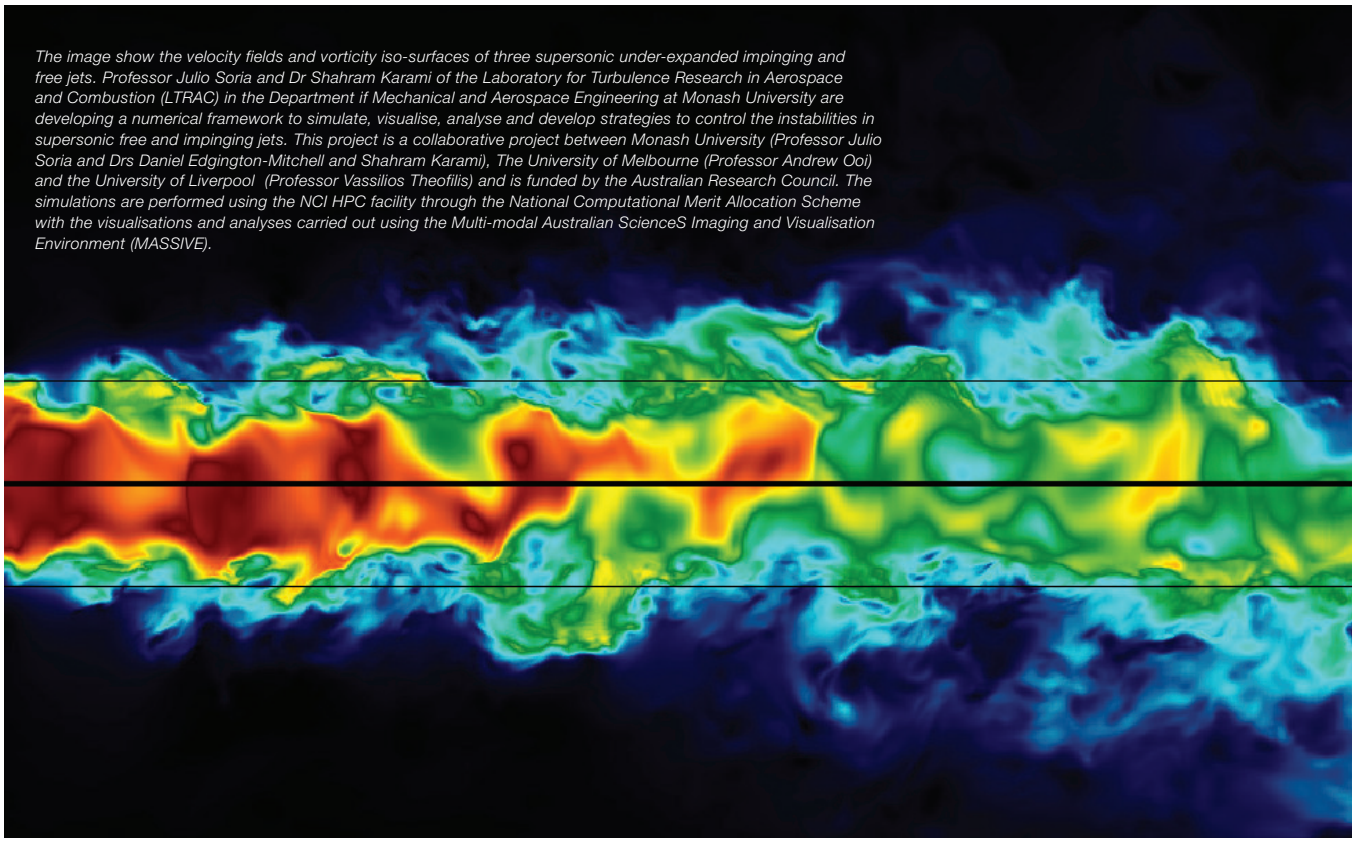
Convergent structural and functional cerebellar abnormalities in Friedreich ataxia (FRDA). FRDA is a genetic neurodegenerative disorder that principally affects the spinal cord and cerebellum of the brain, leading to progressive loss of motor coordination, balance, speech, and subtle cognitive deficits. The IMAGE-FRDA team at Monash University, including Dr Ian Harding, Professor Nellie Georgiou-Karistianis, Professor Gary Egan and colleagues, are using multi-modal magnetic resonance imaging (MRI) to investigate functional and structural brain changes in individuals with FRDA. Using the MASSIVE computing infrastructure, the IMAGE-FRDA team have revealed areas of the cerebellum that show convergent evidence of anatomical degeneration (top image), impaired functional activation during finger tapping (middle image), and impaired functional activation during cognitive processing (bottom image), relative to healthy controls. These findings indicate that pathology in a common brain circuitry may underpin an array of behavioural consequences in this disorder. For more information, see Harding et al, Fronto-Cerebellar Dysfunction and Dysconnectivity Underlying Cognition in Friedreich Ataxia: The IMAGE-FRDA Study, Human Brain Mapping (2016); Selvadurai et al, Cerebral and cerebellar grey matter atrophy in Friedreich ataxia: the IMAGE-FRDA study, Journal of Neurology (2016).

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Modelling Nanoscale Materials for Sensing and Device Applications	RMIT University	Dale Osborne, Edward Fernandez, Jonathan Clarke-Hannaford, Michelle Spencer, Patrick Taylor	National Merit Allocation	M1 / M2
Modelling the visual cortex with hierarchical neural networks	Monash University	Hsin-hao Yu, Declan Patrick Rowley	Partner Share	M3
Modelling trajectories of cognitive control in adolescents and young adults	Monash University	Sharna Jamadar	Partner Share	M3
Molecular dynamics simulation of high temperature-pressure geofluids	CSIRO, Monash University	Yuan Mei, Gan Duan, Qiushi Guan, Weihua Liu	Partner Share	M3
Molecular Dynamics Simultions on radiation damage of nuclear materials	ANSTO	Meng Jun Qin	Discretionary	M1 / M2
Molecular Immunology	Monash University	Julian Vivian, Jesse Mobbs, Phill Pymm	Partner Share	M3
Molecular simulations of proteins	Monash University	Ashley Buckle, Blake Riley, Cyril Reboul, Emily Wilson, James Fodor, Joseph Bloom, Peter Chandler, Thomas Weller	Partner Share	M1 / M2
Monash University, Biochemistry Department, MX Beam Time	Monash University	Anna Roujeinikova, Adam Quek, Andrew Ellisdon, Brad Spicer, Chris Hines, Daouda Traore, Guojie Wu, Hussain Bhukya, Mathias Hansen, Max Cryle, Natalie Borg, Paul Conroy, Ruby Law, Sarah Atkinson, Siew Pang, Thierry Izore	Partner Share	M3
Monash Bioinformatics Platform	Monash University	David Powell, Kirill Tsyganov, Kerri Wait, Adele Barugahare, Alison Anderson, Andrew Perry, Anup Shah, Moshe Olshansky, Nick Wong, Paul Harrison, Sarah Williams, Sonika Tyagi	Partner Share	M3
Monash Biomedical Imaging Small Projects	Monash University	Zhaolin Chen, Thomas Close, Gang Zheng, Jason Rigby, Kamlesh Pawar, Katrina Anne Chapman, Linden Parkes, Mohammed Alghamdi, Phil Ward, Shenjun Zhong, Tara Sepehrizadeh, Viswanath Pamulakanty Sudarshan, Winnie Orchard	Partner Share	M1 / M2, M3
Monash CAV	Monash University	Le Hai Vu, Cuong Nguyen, Neha Rajeev Wadhwa	Partner Share	M3
Monash CAVE2 rendering and data organisation	Monash University, University of Illinois at Chicago, University of California, San Diego	Andreas Hamacher, Arthur Nishimoto, Daniel Waghorn, David Barnes, Jurgen Schulze, Kai Sheng Keng, Kingsley Stephens, Lance Long, Luc Renambot, Michael Eager, Owen Kaluza, Philip Chan, Toan Nguyen Dinh	Partner Share	M1 / M2
Monash Collective for Crystallography of Medically Important Proteins	Monash University, La Trobe University	Sheena Mcgowan, Begona Heras, Fasseli Coulibaly, Nyssa Drinkwater, Olga Ilyichova, Tess Rosalie Malcolm	Partner Share	M3
Monash Micro Imaging Bio-image Analytics	Monash University, Hudson Institute	David Potter, Genevieve Buckley, Ian Harper, Keith Schulze, Chad Johnson, Jeshua Brennan, Juan Nunez-Iglesias, Kirstin Elgass, Owen Kaluza, Stephen Dubsky, Volker Hilsenstein	Partner Share	M3
Motion encoding in extrastriate cortex	Monash University	Maureen Hagan, Leo Lui, Nathan Huynh	Partner Share	M3
Movement and Exercise Neuroscience	Monash University	James Coxon, Claire Cadwallader, Dylan Jon Curtin, Eleanor May Taylor, Elizabeth Doery, Jaeger Andre Wongtrakun, James Coxon, Matthew David Wiseman, Robin Cash, Shou-han Zhou	Partner Share	M3
Multi-modal Visualisation of The Human Torso	Queensland University of Technology	Caroline Grant, Lance Wilson	National Merit Allocation	M1 / M2, M3
Multi-scale observations of plant response to drought	University of Tasmania, University of Western Sydney, ANSTO	Anton Maksimenko, Brendan Choat, Christopher Hall, Jennifer Peters, Madeline CarinsMurphy, Markus Nolf, Robbie Clarken, Robert Acres, Rosana Lpez, Tim Brodribb	Partner Share	M1 / M2
Multi-scale visualization of nano engineered construction materials	Monash University	Shujian Chen, Yanming Liu	Partner Share	M3
Multiple Sclerosis Genomics	Monash University	Vilija Jokubaitis, Jim Stankovich	Partner Share	M3
Nanoparticle structure determination	Monash University	Matus Krajnak	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Investigations of transitional and turbulent shear flows using direct numerical simulations (DNS), large eddy simulations (LES) and 3D Image Velcoimetry	Monash University	Julio Soria, Alex Do, Alice Martelletti, Atsushi Sekimoto, Dinesh Bhatia, Hamish Self, Joel Weightman, Julio Soria, Muhammad Shehzad, Sean Timothy Edward Lawrence, Seraj Alzhrani, Shahram Karami, Shevarjun Senthil, Tushar Sikroria, Zehuan Wu	National Merit Allocation	M3
NCIma5	Monash University	Shahram Karami	Discretionary	M3
NDS	Monash University	Daniel Griffiths	Partner Share	M3
Network Switching	CSIRO	Parnesh Raniga	Partner Share	M3
Neural and physiological correlates of somatic contagion: A multidimensional model of empathy for pain	Australian Catholic University, Monash University	Govinda Poudel, Juan Dominguez, Melita Giummarra, Shannon Driscoll	Partner Share	M1 / M2
Neural bases underlying individual differences in impulsivity and control	University of Queensland	Alexander Puckett, Georg Kerbler	National Merit Allocation	M1 / M2
Neural circuits for information processing in the brain	Monash University	Shaun Cloherty, Adam Morris, Jamie Mcfadyen	Partner Share	M3
Neural mechanisms of complex decision-making	University of Queensland	Dragan Rangelov, Luke Hearne	Partner Share	M3
Neuroanatomical correlates of injury severity and outcome following TBI	Monash University	Gershon Spitz	Partner Share	M1 / M2
Neuroimaging of human regional brain responses associated with control of physiology	Monash University	Michael Farrell, Abubakar Abubakar, Emma Liang, Pascal Saker, Suhel Singh, Tara Georgina Bautista, Thusharika Dissanayaka	Partner Share	M3
Neutron stars and their gravitational wave emission: extreme nuclear physics laboratories	University of Melbourne, Monash University	Andrew Melatos, Patrick Clearwater, Paul Lasky ,george Howitt, Lisa Drummond, Brynmor Haskell, Arthur Suvorov, Filippo Anzuini,	National Merit Allocation	M3
Neutron tomographic extraction of fertile plant fossils to reveal the source and function of the oldest known amber of southern Gondwana	Monash University	Chris Mays	Partner Share	M1 / M2
New Methods for Probabilistic Single-particle Cryo-EM 3D Reconstruction at Near-atomic Resolution	Monash University	Cyril Reboul, Dominika Elmlund, Hans Elmlund, Marion Boudes, Michael Eager, Qi Zhang, richard berry, Sarah Le, Simon Kiesewetter	Partner Share	M1 / M2
New Zealand gold and the great Australian link	ANSTO, Monash University, GNS Science	Andrew Tomkins, Christopher Voisey, Daryl Howard, David Paterson, Jerome Leveneur, Martin de Jonge, Patricia Durance, Simon Jowitt, Steven Micklethwaite	Partner Share	M1 / M2
No escape for mitochondrial iron the nexus of mitochondrial dysfunction and metal biology	ANSTO, Southern Innovation, Florey Institute of Neuroscience and Mental Health	Ben Garner, Daryl Howard, David Paterson, Erin McAllum, Gawain McColl, John Marcou, Martin de Jonge, Nir Drabkin, Robbie Clarken, Simon James	Partner Share	M1 / M2
Novel approaches to examine structural and functional connectivity in the brain	University of Melbourne	Fernando Calamante	Discretionary	M3
Numerical search of better radiotherapy protocols using genetic algorithms	Monash University	Simon Angus	Partner Share	M3
Numerical simulations of Shale gas extractions	Monash University	Ranjith Pathegama Gamage, Zhaoyang Ma, Aaqib Azhar, Avanthi Badulla Liyanage, Ayal Maneth Wanniarachchi, Dinesha Wanigarathna Jayasekara, Guanglei Zhang, K Mudiyanselage Adheesha Shashibhanu Bandara, Radhika Vidanage De Silva, Suresh Hewage, Xiaogang Zhang, Yuqi Song, Zhenlong Song	Partner Share	M1 / M2, M3
OCR on Large Monolithic Document Collections in Sanskrit	Monash University	Mark Carman, Rohit Saluja	Partner Share	M1 / M2
Optical Scanning Diffraction Microscopy	La Trobe University	Bo Chen, Guido Cadenazzi, Nicholas Anthony, Nick Phillips	Partner Share	M1 / M2
Ovarian reserve studies in the Spiny mouse model	Monash University, Hudson Institute	Peter Temple-Smith, Evgenia George	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
PACIA-GRIP Procter & Gamble Project	Monash University	Cordelia Selomulya	Partner Share	M1 / M2
Parallel Bioinspired Pattern Recognition	Monash University	Asad Khan, Yathindu Hettiarachchige	Partner Share	M1 / M2
Particle tracking of finite-size bodies in turbulent motion	Monash University	Catherine Meriaux	Partner Share	M3
Pediatric Brain Imaging correlates of long-term outcome	Monash University, Aston University, Murdoch Children's Research Institute	Amanda Wood, Adam Shephard, Jian Chen	Partner Share	M3
PFIB01	Monash University	Alex De Marco, Denis Korneev, Donna Merriner, Sergey Gorelick	Partner Share	M3
Polo Lab	Monash University	Jose Polo, Alexandra Grubman, Kirill Tsyganov	Partner Share	M3
Post-cranial reconstruction of Leaellynasaura amicagraphica – towards completing the digital puzzle	ANSTO, Museums Victoria, Monash University	Alistair Evans, Anton Maksimenko, Benjamin Francischelli, Christopher Hall, James Rule, Karen Siu, Lap Chieu, Les Kriesfeld, Lesley Kool, Lisa Nink, Mike Cleeland, Oliver Gore, Patricia Vickers-Rich, Qamariya Nasrullah, Robert Acres, Sally Davies, Thomas Rich, Tim Ziegler	Partner Share	M1 / M2
Preferential sorption of uranium with pyrite and OM within a quartz sand matrix: Characterisation by x-ray fluorescence microscopy	Monash University, ANSTO	Barbara Etschmann, Daryl Howard, David Paterson, Joel Brugger, Martin de Jonge, Sasha Wilson, Susan Cumberland	Partner Share	M1 / M2
Progressive development of soil arching in piled embankments	Deakin University, Monash University, ANSTO	Anton Maksimenko, Christopher Hall, Frazer Saunders, Louis King, Robert Acres, Will Gates	Partner Share	M1 / M2
Protein RNA complexes	Monash University	Matthew Wilce	Partner Share	M1 / M2
Provenancing chert artefacts from 3D imaging analysis of embedded fossil invertebrates	University of Western Australia, ANSTO	Andreas Moll, Anton Maksimenko, Christopher Hall, Ingrid Ward, Kane Ditchfield	Partner Share	M1 / M2
PTSD magnetic resonance spectroscopy	University of Newcastle	Scott Quadrelli	CVL	M3
Quantifying the effects of partially coherent X-rays in coherent diffractive imaging	Monash University	Giang Tran	Partner Share	M1 / M2
Question Generation from Text using Deep Learning	Monash University	Yuan-fang Li, Vishwajeet Kumar	Partner Share	M3
Rapid information processing in subcortical amygdala pathways	University of Queensland	Jessica McFadyen, Marta Garrido	Partner Share	M1 / M2
Re-Action: innovations in motor and cognitive rehabilitation	Australian Catholic University, Ghent University, Monash University	Adam Clemente, Juan Dominguez, Karen Caeyenberghs, Kerri Wait, Mireille Augustijn, Phoebe Imms	Partner Share	M1 / M2
Real-time lung imaging in preterm lambs to examine the impact of ante-natal steroids on the lung function	Monash University, Hudson Institute of Medical Research, ANSTO	Anton Maksimenko, Christopher Hall, Daniel Hausermann, Emma Brouwer, Erin McGillick, Genevieve Buckley, Karyn Rodgers, Katie Lee, Kelly Crossley, Linda Croton, Marcus Kitchen, Megan Wallace, Philip DeKoninck, Robert Acres, Shigeo Yamaoka, Stuart Hooper, Valerie Zahra	Partner Share	M1 / M2
Replication proteins	University of Wollongong	Nicholas Dixon, Gokhan Tolun, Zhi-qiang Xu	Partner Share	M3
Resonant Mie Scatter Correction for FTIR Microspectroscopy – IR Beamline Users	Monash University, La Trobe University, James Cook University, University of Otago, Deakin University University, University of Technology Sydney, Baker Heart and Diabetes Institute, University of Cambridge, Department of Primary Industries (Victoria), University of South Australia, ANSTO	Bayden Wood, Benjamin Gordon, Danielle Martin, David PErez-Guaita, Ewen Silvester, Finlay Shanks, Gregory Giles, Jitraporn (Pimm) Vongsvivut, Johanna Howes, Keith Bambery, Li-Jeen Mah, Marie Bongiovanni, Matt Kitching, Olivia Sackett, Phil Heraud, Qinfen Gu, Ryo Sekine	Partner Share	M1 / M2

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Resource of genetics and epigenetics data for elucidating the underlying mechanisms of cancer predisposition and progression	Monash University	Tu Nguyen-Dumont, David Powell, Derrick Theys, Ee Ming Wong, Jared Burke, Jason Steen, Nick Wong, Sonika Tyagi	Partner Share	M3
Revealing nickel biopathways in the roots of hyperaccumulating and non-hyperaccumulating genotypes of Senecio coronatus with XRF tomography and confocal XAS	ANSTO, University of Queensland, University of Adelaide, iThemba LABS, University of Sydney	Antony vanderEnt, Daryl Howard, David Paterson, Hugh Harris, Jolanta MesjaszPrzybylowicz, Martin de Jonge, Peter Erskine, Rachel Mak, Wojciech Przybylowicz	Partner Share	M1 / M2
Revealing the cranial structure of Leaellynasaura amicagraphica using synchrotron computed tomography	Monash University	Alana Sharp	Partner Share	M1 / M2
RNA Polymerase	University of Newcastle	Peter Lewis	Partner Share	M3
Role of epigenetic regulators in embryonic stem cells	Monash University	Partha Das, Stuart Archer, Yogesh Kumar	Partner Share	M3
Rossjohn Lab	Monash University	Richard Berry, Ben Gully, Dene Littler	Partner Share	M3
Scalable Probabilistic Models for learning complex relational data with rich side information	Monash University	Lan Du	Partner Share	M3
Scene Text Recognition	Monash University	Mark Carman, Rohit Saluja	Partner Share	M3
Seeking the First Treatment for Neonatal Pulmonary Arterial Hypertension: Studies at the Imaging and Medical Beamline (Submission 2)	ANSTO, Monash University, University of Otago, National Cerebral and Cardiovascular Center (Japan), La Trobe University	Anton Maksimenko, Christine Bui, Christopher Hall, Claudia A Nold, Daryl Schwenke, Ina Rudloff, James Pearson, Kirstin Elgass, Megan Wallace, Philip Berger, Robert Acres, Steven Shian Chin Cho	Partner Share	M1 / M2
Semi-automated processing of Magnetic Resonance Imaging data	Monash University	Ian Harding, Hiba Bilal, Meghna Goveas, Sid Chopra, Stephanie Teh, Thomas Wykeham Biczok	Partner Share	M3
Sexton Lab	Monash University	Patrick Sexton, Lynn Liang, Alisa Glukhova	Partner Share	M3
Short range order analysis on HEAs	University of Sydney	Anna Vallarta Ceguerra, Lena-Pia Frommeyer	CVL	M3
SIMPAS research on particle science and technology	Monash University	Jieqing Gan, Jieqing Gan, Lulu Jiao, Sida Liu, Siyuan He, Tengfang Zhang, Xuejiao Liu, Zheng Qi	Partner Share	M1 / M2
Simulation & Visualisation of Supernovae in 3D	Monash University	Bernhard Mueller	Partner Share	M3
Simulation and Modelling of Particulate Systems	Monash University	Aibing Yu, Jieqing Gan, Lulu Jiao, Siddhartha Shrestha, Siyuan He, Wenhuan Zhang, Xin Li, Zheng Qi	Partner Share	M1 / M2, M3
Simulation of many-body quantum systems	University of Queensland	Ian Mcculloch	Discretionary	M3
Simulations and visualisation of star and planet formation	Monash University	Alex Rothwell, Ben Ayliffe, Daniel Price, Guillaume Laibe, Hayley Macpherson, James Wurster, Marthinus Jacobs, Michelle Strumila, Paul Lasky, Rebecca Nealon, Terrence Tricco	Partner Share	M1 / M2
Single projection and tomographic x-ray imaging with the Australian Synchrotron's Imaging and Medical Beamline	CERN, Monash University	Jeremy Brown, Jian Yen	Partner Share	M1 / M2
Small Angle Neutron Scattering	ANSTO, Monash University	Nick Hauser, Anna Sokolova, Manish Kumar	Partner Share	M3
Small projects at BMRI	University of Sydney	Daniel Brown, John Gillam, Mahendra Samarawickrama, Sandra Fok, Steven Meikle, William Ryder	Discretionary	M1 / M2
Smart Antenna for Soil Moisture Radiometer	Monash University	Muhsiul Hassan, Shahriar Hasan Shehab	Partner Share	M1 / M2
snlab2	Monash University, Leiden University	Farid Zaid, Felice van Nunspeet, Guy Prochilo, Halina Porecki, Juan Dominguez, Pascal Molenberghs, Robert Eres	Partner Share	M1 / M2
Social Neuroscience Lab	Australian Catholic University	Juan Dominquez Duque	Partner Share	M3



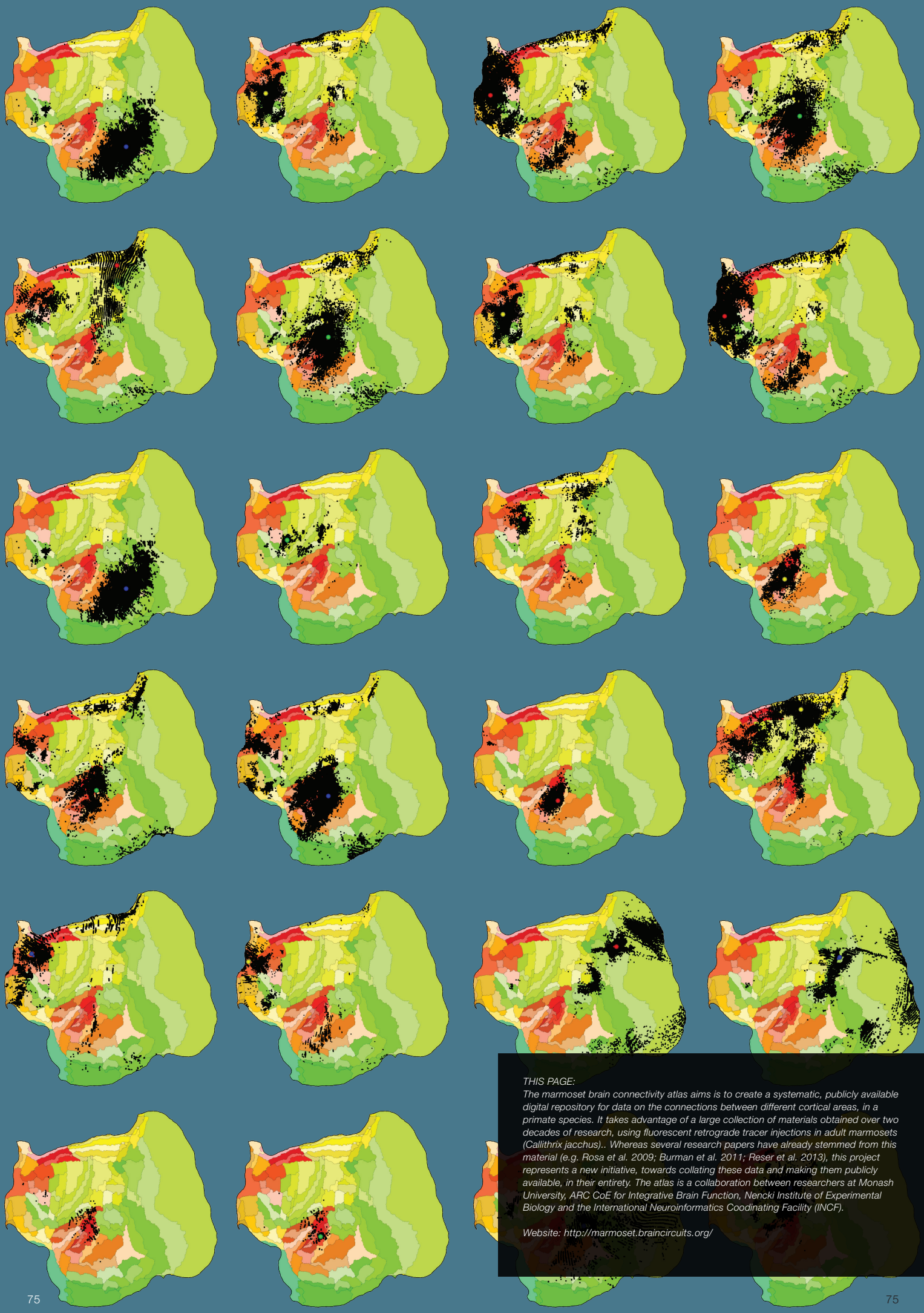
The image show the velocity fields and vorticity iso-surfaces of three supersonic under-expanded impinging and free jets. Professor Julio Soria and Dr Shahram Karami of the Laboratory for Turbulence Research in Aerospace and Combustion (LTRAC) in the Department if Mechanical and Aerospace Engineering at Monash University are developing a numerical framework to simulate, visualise, analyse and develop strategies to control the instabilities in supersonic free and impinging jets. This project is a collaborative project between Monash University (Professor Julio Soria and Drs Daniel Edgington-Mitchell and Shahram Karami), The University of Melbourne (Professor Andrew Ooi) and the University of Liverpool (Professor Vassilios Theofilis) and is funded by the Australian Research Council. The simulations are performed using the NCI HPC facility through the National Computational Merit Allocation Scheme with the visualisations and analyses carried out using the Multi-modal Australian ScienceS Imaging and Visualisation Environment (MASSIVE).

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
SOI Characterisation – DHVL	University of Wollongong	Jeremy Davis, Andrew Dipuglia, Giordano Biasi, Matthew-john Cameron	CVL	M3
Spectral CT for pre-clinical brain cancer treatment research	ANSTO, Barwon Health, University of Otago	Alex Merchant, Anton Maksimenko, Christopher Hall, Marzieh Anjomrouz, Nanette Schleich, Robert Acres, Stewart Midgley	Partner Share	M1 / M2
SRO of Mg alloys	University of Sydney, University of Queensland	Ingrid Ellen Mccarroll, Ning Mo	CVL	M3
Stability and Control of Insect Flight	Australian Defence Force Academy	Di Wu, John Young	Discretionary	M1 / M2
STARImaging	Murdoch Children's Research Institute, Monash University, University of Melbourne	Richard Beare, Joseph Yuan-Mou Yang, Michele Callisaya, Amanda Wood, Jian Chen, Sally Richmond	Partner Share	M3
Stroke and normative connectomes	University of Queensland	Jason B Mattingley, Julia Fellrath, Luke Hearne	Partner Share	M3
Structural Biology	Monash University	Chen Davidovich, Emma Gail, Qi Zhang	Partner Share	M3
Structural determination of IGF1R	Walter and Eliza Hall Institute of Medical Research, Monash University	Yibin Xu, Hari Venugopal, Lance Wilson	Partner Share	M3
Structural neuroplasticity in brain injured patients	Australian Catholic University	Karen Caeyenberghs, Adam Clemente, Hannah Richards, Juan Dominquez Duque, Kerri Wait, Phoebe Imms	Partner Share	M3
Structural studies of G protein-coupled receptors	Monash University	David Thal, Alisa Glukhova, Michele Kattke, Ziva Vuckovic Mueller	Partner Share	M3
Structure-property relationship of carbon composite parts fabricated from cellulose powder by 3D printing	Deakin University University, CSIRO, ANSTO	Anton Maksimenko, Azam Oroumei, Christopher Hall, Darren Thompson, Jun Zhang, Robert Acres, Saeed Dadvar	Partner Share	M1 / M2
Structure, dynamics and interactions of malaria surface proteins as vaccine candidates and drug targets	Monash University	Amali Galappaththi Guruge, Billy Williams-Noonan, Chris MacRaild, Dallas Warren, David Chalmers, Estelle Suys, Trayder Thomas	National Merit Allocation	M1 / M2
Study of plasmonic devices	La Trobe University	Damien Leong, Eugeniu Balaur, Muhammad Salman Maqbool	Partner Share	M1 / M2

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Super-critical carbon dioxide as a fracturing fluid for deep coal seam gas reservoirs	ANSTO, Synchrotron Light Research Institute (Thailand), University of Melbourne	Andrew Stevenson, Anton Maksimenko, Catleya Rojviriya, Chengpeng Zhang, Christopher Hall, Jayde Livingstone, Robert Acres, SureshMadushanSampath KadinappuliHewage	Partner Share	M1 / M2
Synchrotron beam-line optimisation	Monash University	Matthew Dimmock	Partner Share	M3
Synchrotron Cretaceous Mammals	Monash University, CSIRO, ANSTO	Alex Barber, Alexander McDonald, Alexander McDonald, Alistair Evans, Angela Olah, Anton Maksimenko, Darren Thompson, David Hocking, Hazel Richards, Karen Siu, Karina Sorrell, Lap Chieu, Lap Chieu, Laura Murphy, Mark Nikolic, Qamariya Nasrullah, Roger Close, Tahlia Pollock, Travis Park	Partner Share	M1 / M2
Synchrotron radiation tomography of additively manufactured Ti6Al4V microlattice structure	CSIRO, ANSTO	Andreas Moll, Anton Maksimenko, Christopher Hall, Darren Fraser, Nicola Scarlett, Robert Acres	Partner Share	M1 / M2
Synchrotron-based phase contrast x-ray imaging of the lungs	Monash University	Florian Schaff, Gary Ruben, Genevieve Buckley, Jessica Crawshaw, Katie Lee, Linda Croton, Marcus Kitchen, Michelle Croughan	Partner Share	M1 / M2, M3
Tandem Maia-Geopixe real-time fluorescence analysis	ANSTO, CSIRO, Monash University, Deutsches Elektronen-Synchrotron, Queensland University of Technology, Florey Institute of Neuroscience and Mental Health	Cameron Kewish, Chris Ryan, Daryl Howard, David Paterson, Gary Ruben, Geopixe Zero, Kathryn Spiers, Lenneke Jong, Martin de Jonge, Michael Jones, Murray Jensen, Peter Kappen, Simon James	Partner Share	M1 / M2
Task related motion	QIMR Berghofer	Michael Breakspear, Johan Van Der Meer, Matthew Aburn	Partner Share	M3
TCAD for RMIT	Monash University, RMIT University	Lance Wilson, Tuan Bui Anh	CVL	M3
TCAD at UOW	University of Wollongong	Jeremy Davis, Giordano Biasi	CVL	M3
Test of 3D printed refractive x-ray lenses for long distance beam refocusing at IMBL	ANSTO, RMIT University, Elettra	Andreas Moll, Anton Maksimenko, Christopher Hall, Daniele Pelliccia, Robert Acres, Serena Pacile	Partner Share	M1 / M2
Testing the metabolic theory of ecology using high throughput CT imaging	Monash University, ANSTO	Anton Maksimenko, Ben Wegener, Bernard Coetzee, Christopher Hall, Grant Duffy, Guillaume Latombe, Ian Aitkenhead, Jessica Hoskins, Katherine Moon, Rebecca Hallas, Robert Acres, Steven Chown	Partner Share	M1 / M2
The acoustic function of airspaces in echolocating bat heads	University of Adelaide, ANSTO	Anton Maksimenko, Christopher Hall, Jiayuan Liang, Kyle Armstrong, Robert Acres, Yongkang Lin	Partner Share	M1 / M2
The ageing behavior of Aluminum alloy	University of Sydney	Anna Vallarta Ceguerra, Li Liu	CVL	M3
The association between neuroanatomical correlates of attention and working memory, and response to methylphenidate in traumatic brain injury rehabilitation	Monash University	Catherine Willmott, Gershon Spitz, Jacqueline Owens	Partner Share	M1 / M2
The Blurry Bees Project: Voxel-shift compensation during tomographic image acquisition of live bees using synchrotron radiation	CSU, ANSTO	Andreas Moll, Anton Maksimenko, Christopher Hall, Mark Greco, Robert Acres, Tim Wess	Partner Share	M1 / M2
The Change Your Life Training Program	Australian Catholic University, Monash University	Juan Dominquez Duque, Guy Anthony Prochilo, Halina Porecki	Partner Share	M3
The Characterisation Virtual Laboratory Test and Development	University of Sydney, Monash University, University of Queensland,	Anitha Kannan, Anna Ceguerra, Carlo Hamalainen, Chris Hines, Harald Waxenegger, James Wettenhall, Jupiter Hu, King Chiu, Steve Androulakis, Wojtek Goscinski	Discretionary	M1 / M2
The comparative physiology of oxygen delivery to the kidney	Monash University, University of Western Australia, University of South Australia	Bianca Le, Harry Smallbone, Jennifer Ngo, Mayer Melhem, Roger Evans, Zohaib Khan	Partner Share	M1 / M2
The dynamics of drug behaviour in the human body	Monash University	David Chalmers, Amali Galappaththi Guruge, Billy Williams-Noonan, Estelle Suys, Trayder Thomas	Partner Share	M3

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
The Dynamics of Protein-Ligand Interactions and Computational Drug Formulation	Monash University	David Chalmers, John Mansour	Partner Share	M3
The Internet as Quantitative Social Science Platform	Monash University	Simon Angus, Klaus Ackermann	Partner Share	M3
The neural correlates of attention and prediction	University of Queensland	Matthew Tang	Partner Share	M3
The Neuroscience of Morality	Monash University, Leiden University	Ayushi Gupta, Felice van Nunspeet, Juan Dominguez, Pascal Molenberghs, Robert Eres, Stefanie Roberts	Partner Share	M1 / M2
Thermoelastic properties of hydrated sulphates	ANSTO	Helen Brand, Qinfen Gu	Partner Share	M1 / M2
Three-dimensional displacement and strain fields from synchrotron x-ray tomography of piled embankments	Golder Associates, Monash University, Deakin University University, ANSTO	Andrew Stevenson, Anton Maksimenko, Christopher Hall, Jayde Livingstone, Louis King, Michael vontSteen, Mohammed Faizal, Robert Acres, Will Gates	Partner Share	M1 / M2
Thrombus Reconstruction	Monash University	Isaac Pinar, Freya Rudawski, Mark Zander	Partner Share	M3
Titan Krios Core Facility	Monash University, Max Planck Institute of Biochemistry	Adam Costin, Georg Ramm, Hariprasad Venugopal, James Wettenhall, Maryam Khoshouei, Matthew Belousoff, Mazdak Radjainia	Partner Share	M1 / M2
Towards in-vivo longitudinal in-line phase contrast CT for canine orthopaedic surgical outcome assessment	Monash University, ANSTO	Andrew Stevenson, Anton Maksimenko, Carlos Pena, Chris Harris, Christopher Hall, David Albrecht, Jayde Livingstone, Matthew Dimmock, Michael Farrell, Mitzi Klein, Robert Acres	Partner Share	M1 / M2
Towards large-scale calculations of ionic liquids	Monash University, Ames Laboratory	Alireza Heidari, andrey asadchev, Ekaterina Pas, Jason Rigby, Jennifer Hodgson, Kai Xi, Samuel Tan, Santiago Barrera Acevedo, Su Chen, Torsten John, Zoe Seeger	Partner Share	M1 / M2
Trace elements concentration in coralloid speleothems associated with Neanderthal skeleton in Altamura cave (Southern Italy): paleoenvironmental constrain and paleoclimate significance	University of Newcastle, ANSTO	Andrea Borsato, Daryl Howard, David Paterson, Martin de Jonge, Silvia Frisia, Valentina Vanghi	Partner Share	M1 / M2
Trace-element and oxidation state variations in pophyry copper systems: the story according to epidote	University of Tasmania, CSIRO, ANSTO	Angela Escolme, Ayesha Ahmed, Daryl Howard, David Paterson, Louise Fisher, Mark Pearce, Martin de Jonge, Robbie Clarken	Partner Share	M1 / M2
Tracing melt transfer zones in the lower crust: A microchemical perspective	Macquarie University, University of Sydney, ANSTO	Daryl Howard, David Paterson, Kim Jessop, Martin de Jonge, Nathan Daczko, Timothy Chapman	Partner Share	M1 / M2
Transition, stability and control of bluff body flows	Monash University	Mark Thompson	National Merit Allocation	M3
Trials for Monash Clinical & Imaging Neuroscience	Monash University, GGZ inGeest	Alex Fornito, Ari Pinar, Beth Johnson, Chao Suo, Chao Suo, Fernanda Mata, Lianne Schmaal, Linden Parkes, Maria Soloveva, Melissa Hughes, Michelle Lamblin, Murat Yucel, Nigel Rogasch, Orwa Dandash, Paul Klauser, Simon Baker, Stuart Oldham, Valentina Lorenzetti	Partner Share	M1 / M2
Understanding virus replication by Cryo-Em	Monash University	Adam Costin, Alex de marco, DAMIA GARRIGA, Fasseli Coulibaly, Georg Ramm, Hans Elmlund, Hariprasad Venugopal, James Wettenhall, Joshua Hardy, Mazdak Radjainia	Partner Share	M1 / M2
UOW CryoEM PoC	University of Wollongong, Monash University	James Bouwer, Carus Lau, Claudia Sybille Kielkopf, Jafaruddin Lie, Jason Andrade, Lance Wilson, Simon Brown	Partner Share	M3
Use of micro-XANES to clarify the local structure of corroded tube surface and scale during Victorian brown coal oxy-fuel combustion	Monash University, ANSTO	Andreas Moll, Barbara Etschmann, Daryl Howard, David Paterson, Iman Jabaz, Lian Zhang, Martin de Jonge, Song Zhou	Partner Share	M1 / M2
Validation of Silicon on Diamond detectors for quality assurance in MRT	University of Wollongong	Andrew Dipuglia, Elette Engels, Jeremy Davis, Matthew Cameron, Michael Lerch	Partner Share	M1 / M2

Title	Organisations	Researchers	Allocation Mechanism	M1/M2/M3
Vibrational spectroscopy using neutrons and photons	ANSTO	Anton Stampfl	Partner Share	M3
Vijay Biomedicine Discovery Group	Monash University	Vijay Dhanasekaran, Almaz Bailey, Celeste Donato, Don Teng, Kerri Wait, Laura Perlaza-Jimenez, Miguel Grau Lopez	Partner Share	M3
Visual analysis of snail and slug movement in an open field	University of South Australia	Ivan Lee	National Merit Allocation	M3
Visualising water transport in plants: why are some species more drought resistant than others?	ANSTO, Western Sydney University, University of Tasmania	Anton Maksimenko, Brendan Choat, Christopher Hall, Danielle Creek, Jennifer Peters, Markus Nolf, Rob Skelton, Robert Acres, Rosana Lpez, Tim Brodribb	Partner Share	M1 / M2
Visualization of soft tissue from synchrotron x-ray phase contrast tomography	Monash University	Daniele Pelliccia	Partner Share	M1 / M2
Vocal cord movements in Parkinson's disease	Eastern Health, University of Melbourne, Monash University	Dominic Thyagarajan, Jayavardhana Gubbi, Laura Perju Dumbrava, Richard Beare, Yannick Planche	Partner Share	M1 / M2
Volume electron microscopy by FIB-SEM	RMIT University	Chaitali Dekiwadia	CVL	M3
Volume reconstruction from sparse CT and MRI measurements	Monash University	Preeti Gopal	Partner Share	M3
Whisstock Lab CryoEM	Monash University	Lance Wilson, Ruby Law, Brad Spicer, Charles Bayly-Jones, Chris Lupton, Christina Lucato, Hari Venugopal, Siew Pang	Partner Share	M3
Whisstock Lab MX	Monash University	Ruby Law, Adam Quek, Andrew Ellisdon, Brad Spicer, Chris Lupton, Christina Lucato, Daouda Traore, Guojie Wu, Laura D'andrea, Paul Conroy, Siew Pang	Partner Share	M3
Whole-brain cellular-resolution connectomic analysis of the primate cortex	Monash University	Piotr Majka, Shi Bai	Partner Share	M3
X-Ray computed tomography imaging and modelling the microstructure of artificially cemented acid sulphate soils	Monash University	Asadul Haque, Asheque al Mahbub, Chanaka Senanayake, Md Ferdous	Partner Share	M1 / M2
X-ray diffraction of protein crystals	ANSTO, Monash University	Ruby Law, Caradoc-Davies	Partner Share	M3
X-ray Lung PIV	Monash University	Kaye Morgan, Freda Werdiger	Partner Share	M3
XANES investigation of the redox state of iron in basalts as a function of protolith water content	Curtin University, Monash University, ANSTO	Andrew Tomkins, Daryl Howard, David Paterson, Jeremy Wykes, Katy Evans, Martin de Jonge, Prokopiy Vasilyev	Partner Share	M1 / M2
XFM commissioning and experiments: proposal and shift requirements for round 1, 2017	ANSTO	Cameron Kewish, Daryl Howard, David Paterson, Martin de Jonge, Robbie Clarken	Partner Share	M1 / M2
XFM Elemental mapping and Micro-XANES spectroscopy of cancer cells and spheroids treated with cobalt and platinum anti-cancer drugs	University of Sydney, ANSTO	Alexandra Glenister, Anna Renfrew, Catherine Chen, Daryl Howard, David Paterson, Elisabeth Tondl, Martin de Jonge, Trevor Hambley	Partner Share	M1 / M2
XFM studies of iron-rich mineral	ANSTO	Andreas Moll, Daryl Howard, David Cookson, David Paterson, Martin de Jonge	Partner Share	M1 / M2
XFM Tomography of Cancer Spheroids Treated with Gallium and Platinum Anti-Cancer Drugs	ANSTO, University of Sydney	Aviva Levina, Catherine Chen, Daryl Howard, David Paterson, Martin de Jonge, Peter Lay, Rachel Mak, Rachel Mak, Trevor Hambley	Partner Share	M1 / M2
XRF investigation of annually laminated stalagmites from Australia and the South Pacific: paleoclimate significance and crystal control on trace elements incorporation	University of Newcastle, ANSTO	Andrea Borsato, Daryl Howard, David Paterson, Ebony Anderson, Martin de Jonge, Pauline Treble, Valentina Vanghi	Partner Share	M1 / M2



THIS PAGE:
The marmoset brain connectivity atlas aims is to create a systematic, publicly available digital repository for data on the connections between different cortical areas, in a primate species. It takes advantage of a large collection of materials obtained over two decades of research, using fluorescent retrograde tracer injections in adult marmosets (Callithrix jacchus).. Whereas several research papers have already stemmed from this material (e.g. Rosa et al. 2009; Burman et al. 2011; Reser et al. 2013), this project represents a new initiative, towards collating these data and making them publicly available, in their entirety. The atlas is a collaboration between researchers at Monash University, ARC CoE for Integrative Brain Function, Nencki Institute of Experimental Biology and the International Neuroinformatics Coodinating Facility (INCF).

Website: http://marmoset.braincircuits.org/

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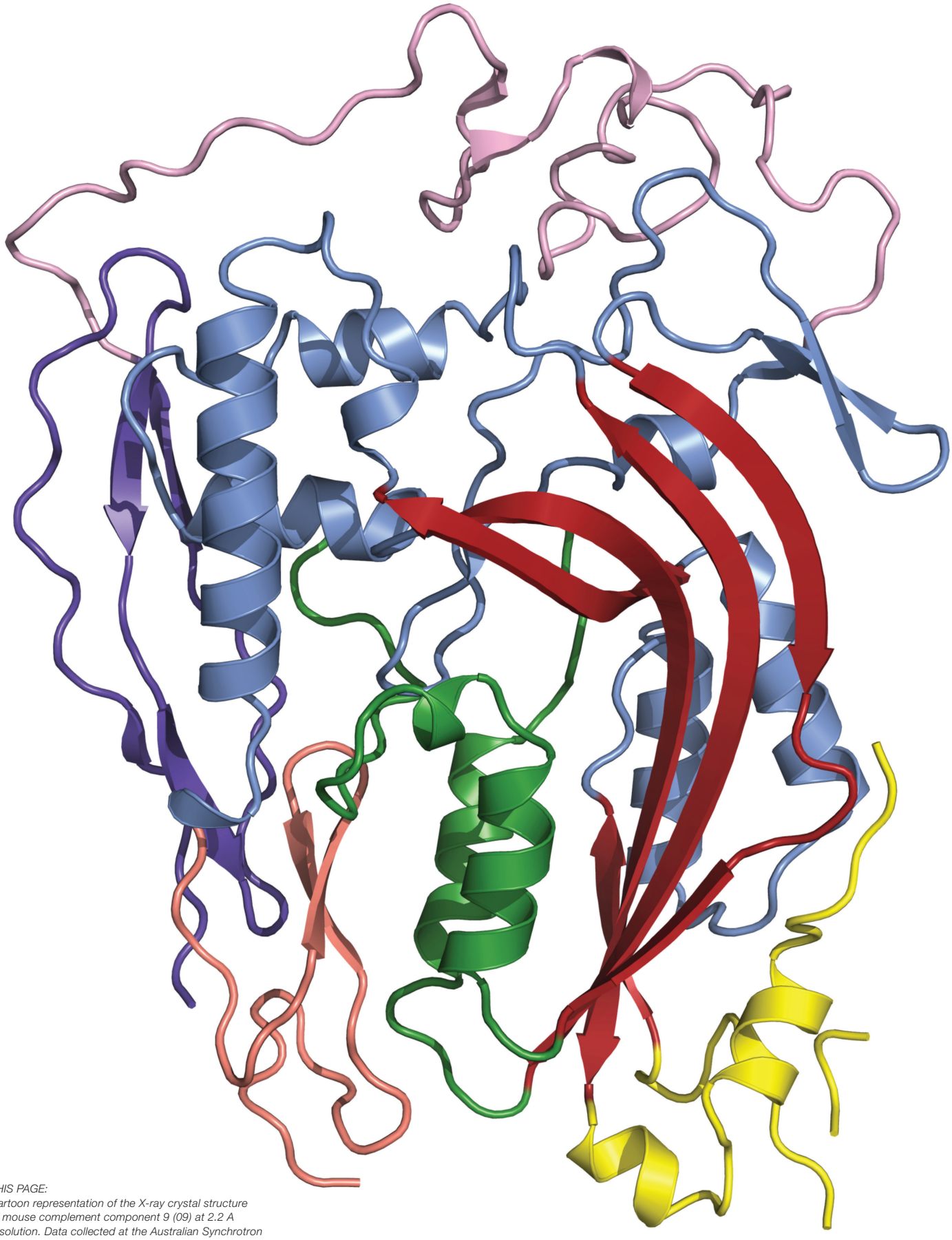


THIS PAGE:
Cartoon representation of the X-ray crystal structure of mouse complement component 9 (09) at 2.2 A resolution. Data collected at the Australian Synchrotron MX2 beamline. This was the second X-ray crystal structure determined via experimentally phasing since the installation of the ACRF Eiger detector (2017). The data was processed using MASSIVE M3. The crystal structure unveiled a mechanism that prevents polymerization and pore formation of 09 on host cells. This work is published in Nature Communications (2018) by Spicer and Law et al.

Financial Statement

			2017 $	2018 $
BROUGHT FORWARD			**100,765**	**(268,373)**
Income				
	Partner	Monash	500,000	500,000
		CSIRO	400,000	400,000
		ANSTO-Australian Synchrotron	225,000	70,000
		ARC CoE for Integrative Brain Function		150,000
		ARC CoE Molecular Imaging		150,000
		University of Wollongong		67,500
	Capital Investor	Monash	2,000,000	1,520,000
		Monash Institute / Faculty		180,000
	Projects	Characterisation VL and associated initiatives	506,477	335,915
	Other Income			20,482
	TOTAL INCOME		**3,631,477**	**3,393,897**
Expenses				
	Project	Characterisation VL and associated initiatives	590,159	265,000
	Facility	Management and Operations	720,397	876,516
		Hardware	2,365,260	1,400,805
		Utilities and Maintenance	104,260	119,435
		Software and Licenses	56,536	50,000
		Training and Outreach	104,027	159,929
		Other	59,977	6,059
	TOTAL EXPENSES		**4,000,616**	**2,877,744**
CARRIED FORWARD			**(268,373)**	**247,780**

Note: 2018 figures include actuals to 30st June 2018, and forecasts to 31st Dec 2018

Featured Scientists

Optical microscopy: connecting the data

Pg. 15

Prof Antoine van Oijen,
ARC Laureate Fellow and Director of Molecular Horizons, University of Wollongong

Electron microscopy: Assembling a biological puzzle.

Pg. 16

Dr Gökhan Tolun,
University of Wollongong

MyTARDIS at University of Newcastle

Pg. 19

Dr William Palmer
University of Newcastle

Dr Jamie Flynn
University of Newcastle

Dr Antony Martin
University of Newcastle

The Design House Virtual Laboratory

Pg. 25

Dr Sean Langlier
Melbourne Centre for Nanofabrication

AI in Focus: Robotic Vision

Pg. 30

Prof. Tom Drummond
Monash University

AI in Focus: Improving Magnetic Resonance Imaging

Pg. 32

Dr Zhaolin Chen
Monash University

Dr Kamlesh Pawar,
Monash University

Prof Gary Egan
Monash University, Director of the ARC CoE in Integrative Brain Function

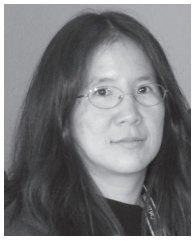
Gravitational waves and neutron stars

Pg. 34

Prof. Andrew Melatos
University of Melbourne

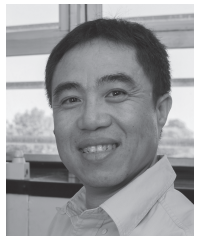
Materials modelling: a mathematical study of nuclear materials

Pg. 36



Dr Eugenia Kuo
ANSTO

Dr Greg Lumpkin
ANSTO



Dr Meng Jun Qin
ANSTO

Bioinformatics: finding the needle in the data haystack

Pg. 38

Dr Sonika Tyagi
Monash University

AProf David Powell
Monash University

Underpinning Instruments: Australia's First Cryogenic Focused Ion Beam-Scanning Electron Microscope

Pg. 40

Dr Georg Ramm
Monash University

Prof Kat Gauss
University of New South Wales, Deputy Director of the ARC CoE in Advanced Molecular Imaging

Prof James Whisstock
Monash University, Director of the ARC CoE in Advanced Molecular Imaging and ARC Laureate Fellow

A "super" receptor that helps kill HIV infected cells

Pg. 44

AProf Stephanie Gras
Monash University

A.I. in Focus: Translating Natural Language

Pg. 46

Dr Reza Haffari
Monash University

Notes

Notes