2016/17

ANNUAL REPORT

INNOVATING TO MEET AUSTRALIA'S BIG SCIENCE CHALLENGES

PAWSEY
supercomputing centre

CONTENTS

CHAIR'S REPORT

WELCOME TO THE PAWSEY SUPERCOMPUTING CENTRE 2016-17 ANNUAL REPORT.

As Pawsey Board Chairman, I have the great privilege of witnessing the outstanding achievements experienced by the Centre, and its continued evolution from a locally focussed computing centre into an internationally recognised high-performance computing facility.

Collaboration and engagement are important ingredients in meeting our strategic priorities, and Pawsey has made significant enhancements in responding to its stakeholders, to ensure that its focus continues to be on providing the highest level of service to enable Australian researchers to undertake ground-breaking science.

Indeed, Pawsey's relationship with NCI has, this year, been reinforced and will remain a focus for the year ahead, particularly in terms of the national investment plan into peak computing facilities. This essential collaboration allows our organisation to further advance and excel in supporting astonishing science outcomes.

Pawsey has doubled its user base through continual engagement with Australian researchers, while maintaining the high quality of service expected by the science community. The hallmark of Pawsey's approach is to provide strong support to its users. These principles are applied consistently across all areas of the organisation.

Enabling leading-edge and innovative science is the key to Pawsey's existence and we are honoured to be playing a pivotal role in improving health, extending scientific knowledge and advancing technology. Whether finding the origins of the universe, helping to reduce world hunger, or helping industry provide clean energy solutions to power the nation, Pawsey is providing the infrastructure to solve problems that were previously unimaginable.

Facilitating excellent science is also enabling Pawsey to assist in building a critical mass of advanced computing knowledge and expertise in the Western Australia and, furthermore, being at the forefront of the data analytics revolution will empower the State in leveraging this exciting new opportunity.

Finally, the dedicated Pawsey staff are always rising to the challenges of the constantly evolving high-performance computing environment and I would like to take this opportunity to express my sincere appreciation for their work and commitment.

John Langoulant AO,
CHAIRMAN OF THE BOARD

DIRECTOR'S REPORT

This past year has seen another excellent chapter in Pawsey's recent history, with the centre's expertise and infrastructure continuing to underpin wonderful science outcomes. In this report, you will be able to read some of these success stories.

In a year of consolidation, we were able to concentrate efforts on increasing engagement across the whole of Australia, establishing roadshows, training sessions and events to ensure that as wide an audience as possible would be able to appreciate the services on offer and gain maximum benefit from the capabilities available. As a national service funded significantly through the Australian government's NCRIS program, Pawsey places the highest possible emphasis on its duty to deliver impact in the whole national interest.

This year saw the development of a National Research Infrastructure Roadmap by a team led by the Chief Scientist of Australia, and a critical element of the roadmap was the highlighting of the urgent need to address a refresh of the high-performance computing facilities at NCI and the Pawsey Supercomputing Centre. Pawsey delivers services and infrastructure that underpin research in all nine of the national science priority areas, and in addition Pawsey provides the infrastructure and services to support the operations of the precursor telescopes of the Square Kilometre Array. The roadmap's highlighting of the need to provide refresh capability at NCI and Pawsey is a reflection of the core part that we play in the national research fabric, and the need for Australia to continue support for the most advanced compute and data intensive science.

Pawsey continued to reinforce our long-standing ties with NCI, and the strong partnership between our two facilities enabled an increase in the services and resources available to the Australian research community. Among the notable elements of this collaboration, Pawsey and NCI worked together on a national investment plan for tier-1 high-performance computing, centred around a staggered investment cycle across the two facilities for a clear path to future development of national high-performance computing and data capability. Furthermore, on a more visible front, NCI was able to increase its compute time commitment to the national merit allocation scheme NCMAS this year, joining Pawsey's ability to increase its commitment to this scheme in the previous year.

Pawsey continued to make commitments and investments in one of its core focus areas of radio astronomy, demonstrating Australia's overall commitment and capability in the build up towards the construction of the Square Kilometre Array (SKA) telescope. The Square Kilometre Array is one of the great scientific endeavours of our time, and ensuring we are able to deliver on our commitments to the operations of the SKA precursor telescopes is a key aspect of Pawsey's role in enabling the delivery of outstanding science in this field.

Supporting radio astronomy is however only one part of Pawsey's role in the Australian national fabric. In addition to the great science outcomes that we already see benefiting from Pawsey's infrastructure and services, the rapid growth in data intensive science at a large scale offers tantalising opportunities for new discoveries, and consequently Pawsey continues to evaluate the requirements for data science at scale in order to ensure Australia is well positioned in this area.

As Pawsey's Executive Director, I am proud of the achievements we have made this year, and I am delighted to see the continued success of the researchers whom we support. I would therefore like to offer my heartfelt thanks and congratulations to everyone for their effort and support this year, to our dedicated staff who work tirelessly to support the Australian research community, and to our partners and researchers. Pawsey owes its continuing development and success to everyone who works for, or constructively engages with, the Pawsey Supercomputing Centre, and we look forward with great confidence to continuing that development and success in the coming years.

Dr Neil Stringfellow
EXECUTIVE DIRECTOR

HIGHLIGHTS 2016/17

MORE THAN 300 PEOPLE
WELCOMED DURING THE OPEN DAY

As part of National Science Week, Pawsey hosted its first Open Day on Saturday 20 August 2016. More than 300 members of the Perth community learned about supercomputers and their importance to the advancement of science in the state and Australia.

$12 MILLION
FEDERAL GOVERNMENT CONTINUES TO INVEST IN AUSTRALIA'S FUTURE

Further NCRIS funding was announced in June 2017. Pawsey received $12 million over two years.

SUPPORTED OVER 1200 RESEARCHERS

In 2016 - 2017 Pawsey reported more than **1,200 active researchers** from more than **40 different institutions** across Australia and a number of collaborators overseas. These researchers are involved in **150 supercomputing projects** to deliver scientific outcomes.

THE INTEREST MULTIPLY

Visitors to the Centre rose from 593 in 2015-16 to **1332** in 2016-17

The number of Pawsey researchers doubled in two years, **from 693 in 2014-15 to over 1,200 in 2016-17.**

13.6 PB RESEARCH READY DATA STORED AT PAWSEY

Research ready data stored at Pawsey increased from 8.6PB in 2014-15 to 13.6PB this year.

OUTCOMES MULTIPLIED

Scientists published 35 percent more papers with findings derived from Pawsey systems in the 2016-17 financial year. Increased from 217 in the previous financial year to 293 publications.

ACTIVELY BUILDING THE KNOWLEDGE ECONOMY

440 people trained

132 UNDERGRADUATES HAVE GAINED SUPERCOMPUTING INSIGHT

Another 16 university undergraduates were trained and upskilled in the Pawsey Internship Programme.

PAWSEY OVERVIEW

The Pawsey Supercomputing Centre is a national, high-performance computing (HPC) facility, representing Australia's commitment to Big Science. Located in Perth, Western Australia, Pawsey is an unincorporated joint venture between CSIRO, Curtin University, Murdoch University, Edith Cowan University and The University of Western Australia - all contribute significantly in terms of operational support and financial support.

The Pawsey Supercomputing Centre is also funded by the State and Federal governments. Pawsey delivers cutting-edge computational support and services to key scientific areas such as radio astronomy, bioinformatics, energy, and resources.

The Western Australian Government is committed to developing Perth as a global centre of supercomputing and recognises the vital role science plays in the State's future prosperity. Coupled with Australia's robust national research infrastructure network, Pawsey plays a key part in ensuring Australian researchers have access to world-class computing facilities. The Centre supports research projects that require high levels of raw computing power, significant expertise, and data intensive services, bringing unique value to Australian and international researchers.

LOOKING BACKWARD

The Pawsey Supercomputing Centre, named in honour of the Australian radio astronomer, Dr Joseph Pawsey, is a federally funded purpose-built facility that was constructed in 2012.

Pawsey's flagship system, Magnus, was commissioned later the same year and it heralded a major step change in the Centre's supercomputing capabilities.

At the time, Pawsey experienced a transition from being a locally focused computing centre to a national facility, with a supercomputer ranked in the top 100 of the global Top500 list.

Currently, the Centre provides services to more than 1,200 researchers Australia-wide, a number that is ever-increasing, and it connects with other world-leading supercomputing centres in an exchange of knowledge and collaboration.

From the Centre's inception in 2012, Pawsey's compute capacity has grown by an order of magnitude and previous, now retired systems have informed the procurement of existing equipment.

Pawsey's key radio astronomy processing machine, Galaxy, processes large data sets from the MWA and ASKAP astronomy projects, and together with Magnus has played a pivotal role in the development of the Pawsey Supercomputing Centre. Both Galaxy and Magnus continue to function as vital assets of national scientific research infrastructure.

LOOKING FORWARD

Over the last four years the Pawsey Supercomputing Centre has developed significantly and now upholds its position as a key contributor to global high-performance computing services. Now in our fourth year of full operation, we have consolidated our advanced computer knowledge and expertise. Pawsey's cutting edge supercomputing facilities and services are supporting industry growth, and enabling Big Science outcomes for Australia. The past year, in particular, has been one of consolidation for Pawsey - in terms of usage, collaboration, recognition and relationships, research output, and improvements to infrastructure. The Western Australian Government has committed approximately $21 million to further develop Pawsey as a leading centre of supercomputing expertise. Over the next five years, Pawsey will strengthen its position by creating strategic links with peer centres and enhancing the visibility of its services.

Pawsey's focus over the next few years will be to work together with its sister organisation NCI, to ensure that both facilities are able to continue providing the highest quality of services to support Australian science. The necessity to upgrade systems at both facilities was highlighted through the National Research Infrastructure Roadmap (NRIR) which was a project commissioned in 2016 by the federal departments of Education and Training, and Industry, Innovation and Science to identify the focus areas for Australian Science. The Roadmap included high-performance computing as an area that requires funding and specifically, states that "Australia's Tier 1 facilities need upgrading at regular intervals to keep pace with research needs. These upgrades should be coordinated so Australia always has at least one facility operating at full capacity."

From its inception to becoming one of two established national supercomputing centres, Pawsey has generated a wide expansion and diversification of its user base. The Centre now moves forward with a focus of deeper engagement with its collaborator, Australian scientists and strategies for further growth of Pawsey researchers.

Through its collaboration, outreach, international presence and resources, the Pawsey Supercomputing Centre aims to continue showcasing Perth as a hub for science and technology. The Centre creates global awareness of the incredible minds of Australian scientists generating Big Science outcomes through the use of supercomputing. The long-term investment by both State and Federal governments is vital to continue enhancing the role that supercomputing plays in the future prosperity of Australia.

Pawsey looks forward to a consolidation of the Centre's position as a global supercomputing facility through strengthening alliances with international supercomputing centres. The consolidation of these relationships will not only showcase Pawsey's best practices but will provide opportunities to learn from the most advanced supercomputing facilities in the world.

THE CENTRE IS ADVANCING THE STATE AND NATIONAL SCIENCE PRIORITIES THROUGH:

- SUPPORT OF HIGH QUALITY RESEARCH
- CONNECTING AND ENGAGING WITH INDUSTRY, GOVERNMENTS AND OTHER PARTIES
- ONGOING SUPPORT FOR THE SQUARE KILOMETRE ARRAY (SKA)
- SHOWCASING PERTH AS A PLACE OF EXPERTISE FOR HPC

THE IMPACT

DHI IMPROVING AUSTRALIAN MARITIME SAFETY

PROJECT	Ship Grounding Risk Mitigation
PROJECT LEADER	Simon Brandi Mortensen
AREA OF SCIENCE	Hydrodynamics
SYSTEM	Magnus
TIME ALLOCATED	830,000 hours

Ship groundings account for one-third of the world's maritime accidents and can be catastrophic for maritime operations, people and the environment.

Pawsey Supercomputing Centre has assisted hydraulic specialist group DHI in the creation of a preventive strategy. A dedicated team, led by DHI award-winning hydraulic engineer Simon Brandi Mortensen, has developed a sophisticated numerical modelling system for predicting the fate of large drifting vessels.

The complex modelling system, developed in collaboration with the Australian Maritime Safety Authority, supports the improvement of emergency response strategies at sea.

CHALLENGE

Each year 35,000 vessels move through Australian waters, accounting for 10 per cent of the world's maritime traffic. With this number expected to grow by 80 per cent over the next 10 years, understanding how ships interact with the ocean is a priority for maritime safety.

Caroline Lai is one of the DHI team members responsible for developing a 3D ocean modelling forecast to feed into the large drift model.

"Water flow can vary hugely at different depths in the same area and it is not unusual to have water at the surface and sea floor flowing in opposite directions" Mrs Lai said.

"It is important to understand water flow conditions in the top 30 metres of open sea to provide a reliable forecast system. Therefore we built three-dimensional models."

The large domain size and fine spatial resolution necessities for the 3D modelling required the use of high-performance computing.

"Complexity of the three-dimensional solution and the large coverage area makes the model

very data-heavy and almost impossible for a normal computer to process," Mrs Lai said.

"For example, it might take 20 hours to complete a two-day simulation on a 12-core machine. This is too slow for emergency response teams to make rescue plans.

"To shorten the response time, we need an extremely fast and powerful machine."

SOLUTION

Using the state of the art infrastructure at Pawsey Supercomputing Centre, Mr Mortensen and his team were able to access the computing power required to complete the computer intensive tasks for 3D ocean modelling.

"We had been unable to build such a comprehensive and large 3D model in the past due to the limitation of computing power" Mrs Lai said. "But with the reliability of the Pawsey supercomputing resource, we are able to achieve something that previously seemed impossible."

OUTCOME

By utilising the cutting-edge supercomputing facilities at Pawsey, Mr Mortensen's team was able to create multiple numerical 3D current models. The models can simulate full hydrodynamic forces in vast areas of coastal waters and the individual responses of each ocean vessel.

As a result, Mr Mortensen and his team can use model outputs to accurately predict and reduce the risk of ships becoming grounded in Australian waters. To date, integrated wave and 3D flow models have been built for the North West and South West regions.

"This project aims to minimise the risk of vessel grounding, which might lead to oil spills, loss of vessels and in the worst cases, human casualties and permanent damage to our prestige marine environment" Mr Mortensen said.

"We see this model as an important step towards minimizing the likelihood of these types of events from taking place in the future."

IMAGE: *Instantaneous surface current patterns close to Dampier Port. DHI*

"FOR EXAMPLE, IT MIGHT TAKE 20 HOURS TO COMPLETE A TWO-DAY SIMULATION ON A 12-CORE MACHINE. THIS IS TOO SLOW FOR EMERGENCY RESPONSE TEAMS TO MAKE RESCUE PLANS".

MAKING WAVES IN CLEAN ENERGY
CURTIN UNIVERSITY/BOMBORA WAVE POWER

PROJECT	Characterisation and power prediction for a novel Wave Energy Converter
PROJECT LEADER	Dr Andrew King
AREA OF SCIENCE	Computational Fluid Dynamics
SYSTEM	Magnus
TIME ALLOCATED	925,000 hours

Wave power is a low-cost, sustainable energy that is generating international interest. It involves harnessing the power of the ocean's waves and converting it to electricity through a wave energy converter.

Dr Andrew King from Curtin University's School of Civil and Mechanical Engineering is working with Perth-based Bombora Wave Power to examine and optimise the performance of Bombora's mWave™ wave energy converter.

Using the supercomputing infrastructure at Pawsey, Dr King and his team can develop a series of mathematical models of water, air and membrane fluid mechanics to predict the volume of electricity that can be generated.

CHALLENGE

Bombora Wave Power's mWave wave energy converter must be capable of enduring storm conditions at sea while remaining cost effective for global market electricity production.

The complexity of ocean wave interaction with Bombora's wave energy converter and the lengthy timeframes that parametric studies require, presented a significant challenge for Dr King's research team.

"The mathematical models are non linear, tightly coupled and extremely challenging to solve," said Shawn Ryan, Executive Director of Bombora Wave Power.

Access to high-performance computing resources allowed Computational Fluid Dynamics (CFD) to lay the foundation for the accurate and complete understanding of the power capture process of the mWave™. The project called for computing infrastructure that was beyond the capability of standard computing facilities.

SOLUTION

Using Magnus, the peak system at the Pawsey Supercomputing Centre, Dr King and his team were able to refine the designs of mWave. Using fully coupled CFD models to understand and optimise the full potential of the innovative technology, the timeframe and cost of developing the mWave has been significantly reduced.

USING MAGNUS AND A FULLY COUPLED CFD MODEL TO UNDERSTAND AND OPTIMISE THE FULL POTENTIAL OF THE INNOVATIVE TECHNOLOGY, THE TIMEFRAME AND COST OF DEVELOPING THE MWAVE HAS BEEN SIGNIFICANTLY REDUCED.

IMAGES *Left: Mid-scale test site at Como Jetty, Western Australia. Right: mWave air flow*

"Developing wave energy technology is very complex and expensive, so using computer simulations for testing design proposals prior to building the full-scale device is essential, in order to minimise development costs and commercialisation time" Mr Ryan said.

OUTCOME

Following the mWave designs created through CFD techniques on Magnus, the wave energy converter prototype was constructed. The mid-scale prototype had a series of air-inflated rubber membranes covering a structure mounted to the seafloor and arranged at an angle to capture the power from the incoming waves.

In 2015, the mWave prototype was tested in the Swan River in Western Australia, with the tests confirming the energy capture process. Each full-scale mWave is rated at 1.5 Megawatts with the potential to supply sustainable electricity to 350 homes.

"The models and simulations have built real confidence in how mWave will perform when installed at full scale" Mr Ryan said. "Running multiple simulations simultaneously is a great way to compare different design iterations and configurations."

"Bombora is continuously researching and developing ways to optimise and refine the design and configuration of an mWave farm, which consists of multiple mWave devices, to get the maximum possible conversion of wave energy into electricity, at the lowest possible price."

"Without access to the Pawsey supercomputer, Bombora's confidence in the mWave's ability to generate competitively priced, high volumes of energy would be considerably less."

IMPROVING GAS TURBINES FOR A CLEANER PLANET
UNIVERSITY OF NEW SOUTH WALES

PROJECT	Direct Numerical Simulations of Turbulent Combustion
PROJECT LEADER	Evatt Hawkes
AREA OF SCIENCE	Turbulent Flows
SYSTEM	Magnus
TIME ALLOCATED	7,000,000 hours

Global trends of heightened fuel prices, clean air regulations, biofuels and greenhouse gas awareness are driving scientists to find answers to cleaner energy technologies.

The combined cycle gas turbine is the most efficient and lowest carbon emitting combustion-based power generation system currently available. Prof Hawkes, from the University of New South Wales, is leading a team of researchers to maximise gas turbine combustion efficiency using the world-class infrastructure at Pawsey Supercomputing Centre.

The gas turbine is a technology used in aviation and for power generation. When used for power generation, it is a technology that enables high penetration renewable energy due to its fast starting capability, providing rapid generation when renewables are not available. Despite this benefit and the already low CO_2 emissions, the technology needs to further reduce CO_2 while also limiting other harmful emissions, such as oxides of nitrogen (NOx). To achieve this, new combustion modes are of great interest to gas turbine manufacturers. The thrust of these new combustion modes is to achieve highly diluted, lower temperature combustion in intense mixing conditions, which improves combustion efficiency and radically reduces NOx emissions.

CHALLENGE

Achieving new combustion modes is a major challenge. Due to lower temperature flames being less stable; they can blow out completely, or be subject to unstable oscillations, which cause system damage. A key barrier in overcoming this challenge is a lack of knowledge of combustion in relevant high-turbulence conditions.

"There is very little understanding of what happens when small turbulent eddies are sufficiently intense that they can penetrate and disrupt the chemical reaction zone of the flame" said Prof Hawkes.

"This project sets out to resolve the lack of understanding using large-scale computational fluid dynamics models of the flame-turbulence interactions."

Turbulence is a classic example of a multi-scale process which can be thought of as composed of

UNSW AUSTRALIA

IMAGE: *Left Flame: Three-dimensional rendering of vorticity magnitude in a direct numerical simulation of a highly turbulent premixed jet flame. Simulation by Haiou Wang and Evatt Hawkes, University of New South Wales; rendering by Hongfeng Yu, University of Nebraska-Lincoln.*

Right Flame: Three-dimensional rendering of hydroxyl radical in a direct numerical simulation of a highly turbulent premixed jet flame. Simulation by Haiou Wang and Evatt Hawkes, University of New South Wales; rendering by Hongfeng Yu, University of Nebraska-Lincoln.

a multitude of vortices, or eddies, having different length-scales and time-scales. Direct numerical simulations (DNS) of combustion, which resolve all continuum scales of the flow, require very large numbers of grid points and time-steps to compute. In addition, combustion simulations need to compute the chemical reaction rates of many chemical species. As a result, these types of simulations are computationally very expensive.

SOLUTION

"Historically, due to of the computational expense, typical laboratory flames were long considered out of range for the DNS approach. However, the petascale computing era has changed this situation such that many laboratory flames are now accessible. In this project, we set out to compute a real laboratory flame, which had high turbulence levels such that small scales can penetrate and disrupt the chemical reaction zone of the flame, as they do in a real gas turbine" said Dr Hawkes.

Dr Haiou Wang, a postdoctoral research fellow in Prof Hawkes' group identified a candidate flame and carried out the DNS. Dr Wang noted: "This required a significant computational effort. Our simulations had 2 billion grid points, 150,000 time steps and 28 chemical species, resulting in around 1016 degrees of freedom. The simulations conducted ran on 19,200 cores on the Magnus supercomputer, using more than 10 million hours and generating around 100 TB of data.

OUTCOME

The massive task of data analysis in Prof Hawkes' project is ongoing and expected to be active for years. Already published work by Dr Wang and Hawkes included first-of-a-kind comparisons to experiment and used the DNS to propose new ways to experimentally measure the rate of heat release in the flame. Current submitted work looks at the stability of the flame, which is of great importance in gas turbines.

A completely new direction that this work is enabling is to directly use the data in industry. The research team has been approached by a major international gas turbine manufacturer to employ the DNS data as a validation database for models that are used in their combustor design process.

Direct use of these type of data by industry is a completely new direction for combustion DNS and one which can have significant future impact by providing engineers with the tools they need to design improved, lower emissions combustors.

DIRECT USE OF THESE TYPE OF DATA BY INDUSTRY CAN HAVE SIGNIFICANT FUTURE IMPACT BY PROVIDING ENGINEERS WITH THE TOOLS THEY NEED TO DESIGN IMPROVED, LOWER EMISSIONS COMBUSTORS.

MAKING THEIR MACH
UNIVERSITY OF QUEENSLAND

PROJECT	Performance Enhancement in Access-to-Space Scramjets
PROJECT LEADER	Dr Vincent Wheatley
AREA OF SCIENCE	Hypersonic Aerodynamics
SYSTEM	Magnus
TIME ALLOCATED	1,500,000 hours

MACH 12 scramjet engines produce thrust at 12 times the speed of sound, passing gas through the engine and combusting at supersonic speeds. The internal machinery of normal engines, such as jumbo jets, would melt in milliseconds if subjected to the same conditions.

Dr Vincent Wheatley, along with Dr Anand Veeravaganan, Professor Michael Smart and their team at the University of Queensland, is working to improve scramjet engines.

"We wanted to succeed in a way that would blow people away, not just make a little bit of progress," Dr Wheatley said.

Using Pawsey's Magnus supercomputer, Dr Wheatley and his team ran a series of sophisticated simulations to maximise combustion efficiency of Mach 12 scramjet engines. The team's ultimate goal is to design a reusable scramjet stage for a vehicle capable of reaching space.

CHALLENGE

Dr Wheatley and his team have found it extremely hard to improve efficiency of hypersonic engines.

"We can't rely on machinery for controlling everything, like you can at slow speeds" Dr Wheatley said.

"You can only use knowledge of fluid dynamics and combustion. Research has been going on for more than 50 years and we're only just having our first successful scramjet powered flights."

"Simulations to look at what is going on inside a scramjet engine require more than 1,000 gigabytes of RAM. Most desktop computers have around 16 gigabytes at most."

"Just fitting the simulations into a computer, never mind the time it takes to successfully run them, requires a machine the scale of Magnus."

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

SOLUTION

The Magnus system, the powerful supercomputer at the Pawsey Supercomputing Centre, provided Dr Wheatley and his team with the computing power to run and process the complex and extensive simulations required.

Dr Wheatley says recent advancements in hypersonics research owe much to systems like Magnus.

"After decades of research, the reason why scramjet technology is finally leaping ahead is because we've now got the capability thanks to resources such as Pawsey" he said.

"We can now look at what's going on inside the engines and diagnose where the losses are and what we can improve."

"Without Magnus, we simply wouldn't be able to do this work."

OUTCOME

Dr Wheatley and his team were able to improve combustion efficiency in a Mach 12 engine by 20 per cent.

"We set ourselves this Mach 12 challenge; we could have picked something easier" he said.

"The highest Mach number at which a scramjet engine has demonstrated it can balance drag is Mach 9.6."

Given the recent interest from aerospace giants SpaceX and Blue Origin in developing reusable access-to-space systems, Dr Wheatley is unequivocal about the potential of hypersonics research.

"We've got billionaires around the world looking at reusable access to space and air-breathing technology is perfect for that" he said.

"The weight saved by not carrying oxidisers allows you to have the thermal protection and flight systems required for reusability.

"Reusable access-to-space systems could transform the world economy.

"For decades, Australia has been a world leader in this area. We now need to leverage that position and participate in the development of something which could completely transform access to space."

"AFTER DECADES OF RESEARCH, THE REASON WHY SCRAMJET TECHNOLOGY IS FINALLY LEAPING AHEAD IS BECAUSE WE'VE NOW GOT THE CAPABILITY THANKS TO RESOURCES SUCH AS PAWSEY,"

TOP IMAGE *The image shows the mixing and combustion process in a planar scramjet. This visualizes the vortices in the engine, coloured by the mass fraction of hydroxyl, which shows where combustion is occurring. Credit Rolf Gehre*

BOTTOM IMAGE *The latest scramjet design from the Hypersonic Propulsion team at the University of Queensland. Credit Dawid Preller*

ICRAR LET THERE BE LIGHT

PROJECT	Detection of the Epoch of Reionisation Using the Murchison Widefield Array
PROJECT LEADER	Dr Cathryn Trott
AREA OF SCIENCE	Radio Astronomy
SYSTEM	Galaxy
TIME ALLOCATED	350,000 hours

After the Big Bang, there was a period of darkness in the universe lasting hundreds of millions of years.

During these cosmic dark ages, the first stars and galaxies began to form, leading to the Epoch of Reionisation, when these first sources of light ignited and the universe was illuminated.

However, little is known about the Epoch, which occurred around 13 billion years ago. The Curtin Institute of Radio Astronomy's Dr Cathryn Trott and her team are using the Pawsey Supercomputer's Galaxy system to assist with their research into the Epoch of Reionisation.

Dr Trott says that over the past 20 years, there has been a realisation that the Epoch could potentially be observable but because it emitted such a weak signal, we've never had the telescope to be able to detect it.

But using the Murchison Widefield Array (MWA) – a low-frequency radio telescope in the Murchison Desert, 10 hours north east of Perth – Dr Trott and her team are detecting when reionisation began.

"The Epoch is in the very distant universe and from an observational point of view, the best way to measure this is by looking at the hydrogen because hydrogen is what has changed in that period," Dr Trott said.

CHALLENGE

Dr Trott's research involves the MWA collecting 24 gigabytes of data every two minutes. And it requires more than 1,000 hours of observation.

"There's a lot of information we need to process simultaneously, otherwise it would take us decades to process enough data to enable us to conduct the experiment" Dr Trott said.

Dr Trott said her experience in medical imaging physics has been helpful in detecting weak signals in complex data.

"For me, that meant I had the skill to be able to understand how we might actually go about detecting this needle-in-a-haystack hydrogen signal" she said.

USING THE MURCHISON WIDEFIELD ARRAY, DR TROTT AND HER TEAM ARE DETECTING WHEN REIONISATION BEGAN

SOLUTION

"We have to distil 720 petabytes of data" Dr Trott said. "We use Galaxy to distil that by a factor of 12, down to about 60 petabytes and then through the final processing step, which also happens on Galaxy, the final outputs go from a terabyte to a gigabyte."

Dr Trott said the Galaxy system's ability to process such a volume of raw data has been critical to her project's success.

"For us, being in Perth and having the Pawsey Centre available to us is absolutely crucial to the science we're doing because it's so much data that we have to distil down" she said.

OUTCOME

Dr Trott's research is informing the development of the low-frequency component of the Square Kilometre Array (SKA), another Murchison-based radio telescope, which will be 50 times more sensitive and 10,000 times faster than the world's most advanced telescope.

"With the MWA and those telescopes that exist at the moment, we want to detect the Epoch, so we get a glimpse of that period," Dr Trott said.

"With the SKA, we'll be able to explore it and really understand how the universe evolved over that period of a billion years."

Dr Trott said continued research into the Epoch of Reionisation could provide revelatory information about the evolution of the universe.

"It's not that we can just explore this Epoch and move on," she said. "This is a gateway to really understanding some of the astrophysics rather than just the cosmology, such as the formation and evolution of stars and the evolution of elements.

"The Big Bang gave us hydrogen and helium, now we have everything else. We're made of carbon, we breathe oxygen – where did that come from?"

"This really is a gateway to all of that science."

IMAGE: *Outrigger tile at night (30 sec exposure , full moon) credit Peter Wheeler, ICRAR.*

UNDERSTANDING THE OCEAN TO IMPROVE OFFSHORE DESIGN
THE UNIVERSITY OF WESTERN AUSTRALIA

PROJECT	Understanding the Ocean to Improve Offshore Design
PROJECT LEADER	Professor Liang Cheng
AREA OF SCIENCE	Computational Fluid Dynamics
SYSTEM	Magnus
TIME ALLOCATED	4,000,000 hours

Pipelines and subsea structures used in offshore construction and engineering involve complex designs based on predicting oceanic behaviour.

Professor Liang Cheng from the School of Civil, Environmental and Mining Engineering at the University of Western Australia is leading a team of researchers to pave the way for improved structure designs, minimising costs and project risks in marine infrastructure.

The research involves studying hydrodynamic forces and the subsequent impact on offshore structures.

Through the use of the Pawsey Supercomputing Centre, Prof Cheng and his research team are able to conduct advanced computational fluid dynamics (CFD) simulations to make significant progress in accurately predicting hydrodynamic forces.

CHALLENGE

The design and construction of offshore infrastructure is an exceptionally challenging task for marine engineers.

Hydrodynamic forces make design practice complicated due to the unpredictability of the ocean environment and its interactions with infrastructure.

Engineers must consider and plan for a host of hydrodynamic influences such as infrastructure instability, seabed scour, green water loading and ocean turbulence around structures.

"From an engineering application point of view, we aim to provide accurate and reliable estimates of extreme hydrodynamic loadings and hydrodynamic responses of offshore structures" Prof Cheng said.

"That ranges from oil and gas pipelines laid on the natural seabed to large-scale floating structures that host storage and processing facilities, requiring advanced CFD techniques."

The process of CFD techniques, however, requires computationally intensive tasks that call for a sophisticated system beyond the capacity of standard computing facilities.

"The major challenge in our applications is to

resolve all scales of flow structures involved in engineering flows" said Prof Cheng. "This involves significant computational power that can only be provided by a supercomputer."

SOLUTION

The world-class facilities at the Pawsey Supercomputing Centre provided the high-performance computing required for processing algorithms and numerical analysis of CFD practice.

"The solution was to use a supercomputer where large scale problems are divided into a number of small jobs that can be processed in parallel by multiprocessors" Prof Cheng said.

"The supercomputer allowed us to solve many problems in a tolerable time frame which was not previously possible."

Prof Cheng said the use of CFD techniques removed the need for conducting costly and time-consuming physical model testing.

"Accurate and reliable estimates of hydrodynamic loadings and hydrodynamic responses of offshore structures reduces the risks associated with over or under design of the structures, leading to reduced project costs and far less probability of project failures."

OUTCOME

The powerful supercomputer Magnus allowed Prof Cheng and his research team to make significant progress in predicting marine flow and structure interactions.

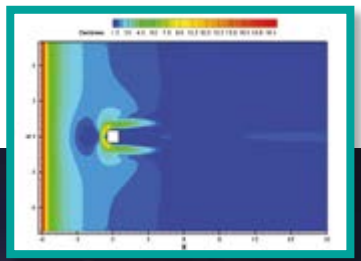
"The results from this project have already been used in large scale projects, upgrading the pipeline design guidelines and being applied directly in engineering designs such as the STABLEpipe Joint Industry Project" Prof Cheng said.

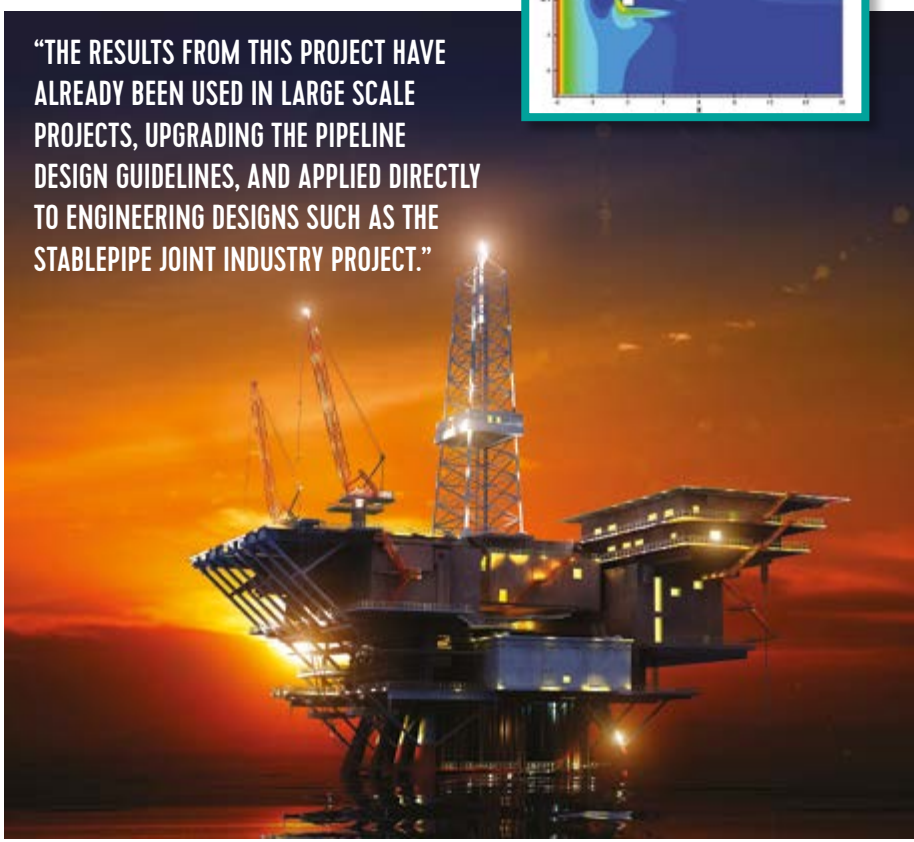
Research findings will continue to be a resource for engineering designs of subsea infrastructure and offshore cyclone evasion strategies. This will significantly improve future designs and planning for marine engineers and reduce costs for oil and gas companies.

"Supercomputing facilities allow us to gain significant insights into fundamental behaviours of engineering flows and physics responsible for those behaviours" Prof Cheng said.

"We can develop reliable and affordable solutions to engineering problems that could not be achieved prior to the supercomputing era."

IMAGES: *Oil platform at night. Top below: Time-averaged flow features of a square pile in steady flow. Bed-shear-stress on the a horizontal plane (z/d = 0.002, where z is the height to the seabed and d is the size of the square).*





UNLOCKING THE GENETIC CODE
THE UNIVERSITY OF WESTERN AUSTRALIA

PROJECT	Relative Importance of Genetic and Epigenetic Factors in the Aetiology of Common Complex Disease
PROJECT LEADER	Associate Professor Scott G. Wilson
AREA OF SCIENCE	Genetic Epidemiology
SYSTEM	Magnus and Nectar Cloud
TIME ALLOCATED	40,000 hours

Susceptibility to human disease has been a cornerstone of genetic research for several decades.

Adjunct Associate Professor Scott G. Wilson, from the University of Western Australia's School of Medicine and Pharmacology, is leading a team of researchers to identify which factors govern a predisposition to specific complex diseases.

Using the Magnus system at the Pawsey Supercomputing Centre, Professor Wilson and his team can focus on genetic determinants of diseases such as osteoporosis, polycystic ovarian syndrome, autoimmune disease, thyroid metabolism and cancer and muscle and liver disease.

CHALLENGE

In collaboration with other researchers, Prof Wilson has undertaken numerous genome-wide association studies on thousands of individuals.

Researchers investigated various gene characteristics of endocrine, bone, liver and muscle phenotypes. In examining these characteristics, Prof Wilson aims to uncover the key role that certain genes play in the onset of complex diseases. Such extensive studies, however, generate vast amounts of data for researchers to analyse.

The project called for complex mathematical procedures that exceeded the capability of standard computing facilities. Large-scale genetic analyses were needed.

"It's often difficult for people to comprehend just how much data is generated from whole genome sequencing," Prof Wilson said.

"For example, while the entire genome of each person fits inside each cell of the body, the DNA code contains approximately 3 billion nucleotide base pairs, which amounts to about 300 gigabytes. You could only fit data for one or two individuals on an average computer but even then you wouldn't have enough RAM to manipulate the data."

"While we have whole genome sequence data from thousands of people available to study, it's not practical to network thousands of PCs together."

SOLUTION

The Magnus system, the powerful supercomputer at the Pawsey Supercomputing Centre, enabled the research team to manage the project's large dataset. As a result, proficient data analyses on genetic disease susceptibility were made possible.

"Access to the Pawsey Supercomputing Centre infrastructure was a key element of our research program because of the profound increase in volume and complexity of data" Prof Wilson said.

"We have access to a number of other international supercomputing facilities but I believe the resources available at the Pawsey Supercomputing Centre are state of the art.

"I can't overstate the importance of the assistance we received from the local technical and support staff in getting our analyses running and data processed efficiently."

"WHILE THE ENTIRE GENOME OF EACH PERSON FITS INSIDE EACH CELL OF THE BODY, THE DNA CODE CONTAINS APPROXIMATELY 3 BILLION NUCLEOTIDE BASE PAIRS, WHICH AMOUNTS TO ABOUT 300 GIGABYTES"

OUTCOME

Using the Pawsey supercomputing facilities, Prof Wilson and his team were able to process immense amounts of data, streamlining the task of pinpointing relevant genetic information.

Knowledge of hereditary prone diseases such as thyroid cancer, polycystic ovarian syndrome and osteoporosis can be recognised and utilised for future medical applications.

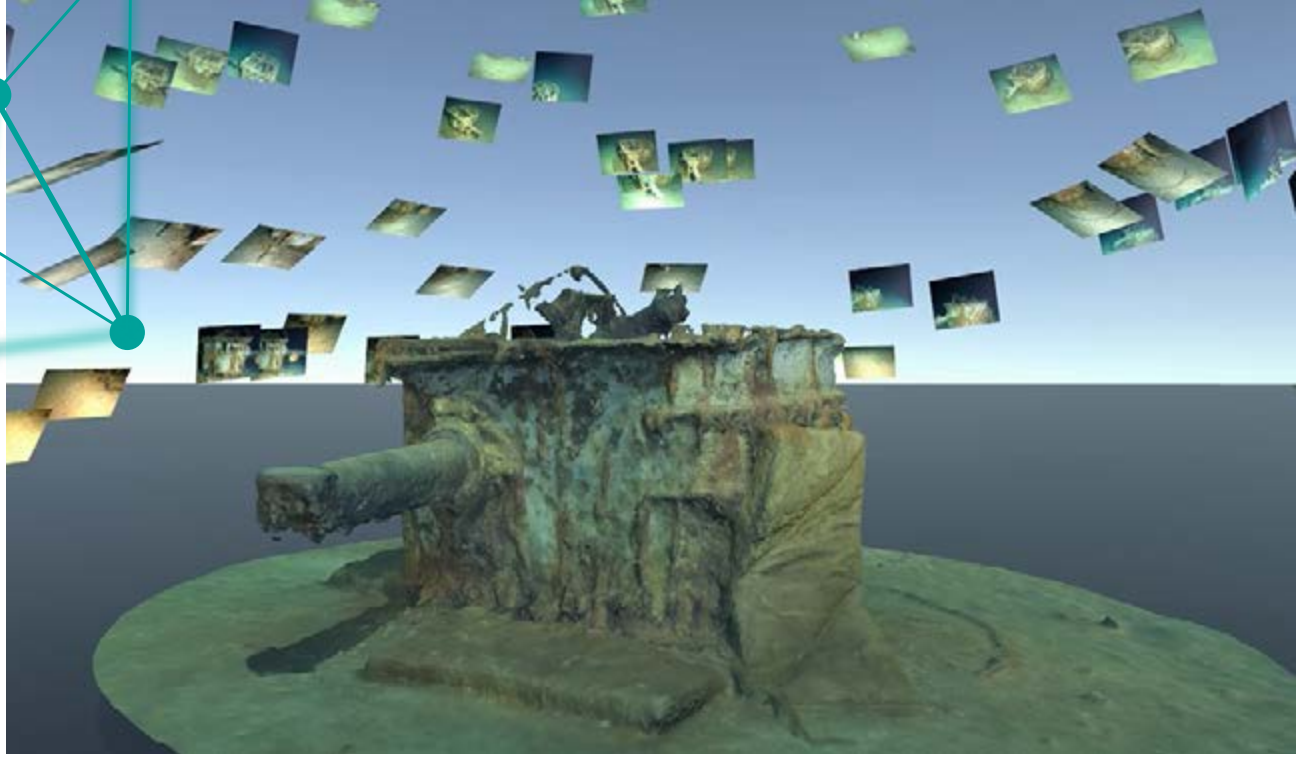
Unlocking the genetic code underlying complex diseases may help researchers predict familial patterns of illnesses and lead to the processes for disease minimisation and effective treatment.

Supercomputers now play a fundamental role in large-scale analyses for projects such as these.

"Supercomputers are an essential tool for medical researchers and I feel privileged to have access to this highly sophisticated data processing infrastructure" Prof Wilson said.

Prof Wilson said medical research was able to reap the rewards of the visionary groups behind the establishment of the facility.

"I'm very grateful to the information technology leaders and politicians who had the foresight to establish this important facility" he said.



VIRTUAL ARCHAEOLOGY UNRAVELS HISTORIC SHIPWRECK MYSTERY CURTIN UNIVERSITY

PROJECT	3D Reconstruction Processing for the HMAS Sydney (II) and HSK Kormoran 3D Imaging
PROJECT TEAM	Dr Andrew Woods, Dr Andrew Hutchison, Mr Joshua Hollick
AREA OF SCIENCE	3D Imaging and 3D reconstruction
SYSTEM	Magnus
TIME ALLOCATED	1,000,000 hours

Curtin University

During World War II, the Australian ship HMAS Sydney (II) encountered the German raider HSK Kormoran and after a short but fierce battle, both ships sank, taking with them all 645 crew from the Sydney and almost 100 crew from the Kormoran. The exact resting place of these wrecks was unknown until their discovery in 2008, when they were located 200 kilometres off the coast of Western Australia at a depth of 2.5 kilometres below the ocean's surface. These ships are historically very significant but until now they have been inaccessible due to their isolated location. Using remotely operated vehicles (ROVs) fitted with digital still and video cameras and the power of the Pawsey Supercomputing Centre's Magnus supercomputer, a team of researchers from Curtin University are recreating the wreck sites in 3D to make this important piece of Australian history available to the general public.

CHALLENGE

"The project has been huge and has involved a lot of people, a lot of partners, a lot of hard work and a lot of technology," Dr Woods says. "Some of the project challenges were budget (how on earth were we going to complete such an ambitious project with a limited budget), logistical (reaching the two most isolated sites on the Australian Heritage Register), and technical (we had a huge amount of camera and lighting equipment to connect to two underwater vehicles and it all had to work at considerable water depth)."

USING CONVENTIONAL METHODS, IT WOULD HAVE TAKEN 1,000 YEARS TO PROCESS THIS VAST AMOUNT OF DATA.

To access these remote wrecks, Dr Andrew Woods, Dr Andrew Hutchison and Mr Joshua Hollick worked with the WA Museum to use two ROVs from offshore services company DOF Subsea fitted with new-to-market cameras capable of cataloguing such a large site and operating successfully at 2.5 kilometres underwater.

The team collected half a million photographs and 300 hours of high definition video footage – in total some 50 terabytes worth of data. Using conventional methods, it would have taken 1,000 years to process this vast amount of data. The team needed to find a way to reduce this time to something achievable.

SOLUTION

The researchers are utilising the computing power of Pawsey's Magnus supercomputer to feature match the images and build their 3D models – using a complex process known as photogrammetric 3D reconstruction.

"The wreck sites are expansive and detailed, which causes a problem for conventional 3D reconstruction processing techniques. We are therefore developing custom software to run on Magnus to perform our 3D reconstruction processing," Dr Woods says.

The method being used by the team is a multi-stage process – after identifying common features between images, Magnus builds a cloud of points (representing the common features) in 3D space, over which a 3D mesh is fitted and the original images are placed to form the final 3D model.

"Fortunately the 3D reconstruction process is highly parallel in nature and very suitable for running on Magnus which allows thousands of operations to be performed in parallel which speeds up the process considerably."

OUTCOME

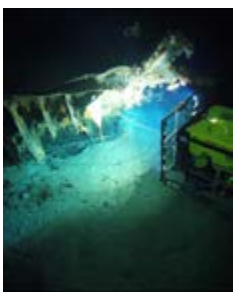
The completed reconstructions could be available to the general public in two to three years and will form part of a new exhibition in several Western Australian Museum sites to commemorate the Sydney, the Kormoran and their lost crew.

The team could potentially also print 3D models of the ships and related artefacts. The site is protected by the Historic Shipwrecks Act which prevents the removal of artefacts from the wreck sites, so 3D printed physical reproductions could be used in future exhibits in place of the real thing.

Of the photogrammetric 3D reconstruction method they're using, Dr Woods says, "The process could be applied to other underwater sites such as tropical coral reefs or oil and gas infrastructure and other shipwrecks but the process could also be used in land-based environments such as complex rock-art fields, or underground mines."

IMAGES:
LEFT PAGE: *Sydney-Kormoran Project 3D Reconstruction of the HMAS Sydney II High Altitude Control System (HACS). Image courtesy of Curtin University and WA Museum. © WA Museum.*

BELOW: *Sydney Kormoran expedition 2015. DOF Subsea ROV inspecting Kormoran engine room. Image courtesy of Curtin University and WA Museum. © WA Museum.*



REVEALING THE HIDDEN BACTERIAL WORLD IN TICKS
MURDOCH UNIVERSITY

PROJECT	Uncovering the microbiome of Australian ticks
PROJECT LEADER	Dr Charlotte Oskam
AREA OF SCIENCE	Bacteriology
SYSTEM	Magnus and Galaxy
TIME ALLOCATED	150,000 hours

"STANDARD DESKTOP COMPUTERS TAKE DAYS TO WEEKS TO ANALYSE OUR LARGE DATA SETS, HOWEVER USING MAGNUS, OUR DATA SETS ARE USUALLY ANALYSED WITHIN HOURS"

Ticks are one of the most important vectors (organisms that transmit pathogens and parasites) of disease affecting humans and animals.

A quarter of worldwide pandemics over the past decade have been attributed to vector-borne disease and controlling these emerging infectious diseases is one of the most important objectives of global economies.

Despite this, little is known about the pathogens transmitted by ticks to people and animals in Australia.

The Vector and Waterborne Pathogen Research Group (VWBPRG) at Murdoch University is led by Professors Peter Irwin and Una Ryan, with Dr Charlotte Oskam, Dr Andrea Paparini and their postgraduate students.

The group is utilising the processing power of the Pawsey Supercomputing systems to analyse tick bacterial community profiles and identify tick-borne bacterial species that may be associated with illness.

CHALLENGE

Understanding the source of emerging infectious diseases in humans and animals is important for public health. Ticks are known to transmit a greater variety of pathogenic microorganisms than any other arthropod group.

Outside Australia, ticks are recognised transmitters of the bacteria that cause Lyme disease. Although these bacteria have not been found in Australian ticks, the growing presence of Lyme disease-like illness in Australia highlighted the need for research into possible causes.

The VWBPRG is using advanced DNA sequencing platforms and a recently developed molecular toolkit to detect microorganisms in Australian ticks.

"Assigning taxonomy to millions of DNA sequences is a crucial step but is often labour-intensive and time consuming," Dr Oskam said.

The VWBPRG's own computer systems lacked the power to process the increased genetic information available and the team required

higher-powered computers to identify and characterise the zoonotic microorganisms carried by ticks.

SOLUTION

Dr Oskam utilised Pawsey's Magnus supercomputer to analyse more than 450 tick bacterial communities carried by four native tick species.

"Standard desktop computers take days to weeks to analyse our large data sets. However using Magnus, our data sets are usually analysed within hours" she said.

The use of next generation sequencing technology and Pawsey's supercomputers has enabled Dr Oskam's team to detect and identify bacteria that have previously gone undetected using traditional methods.

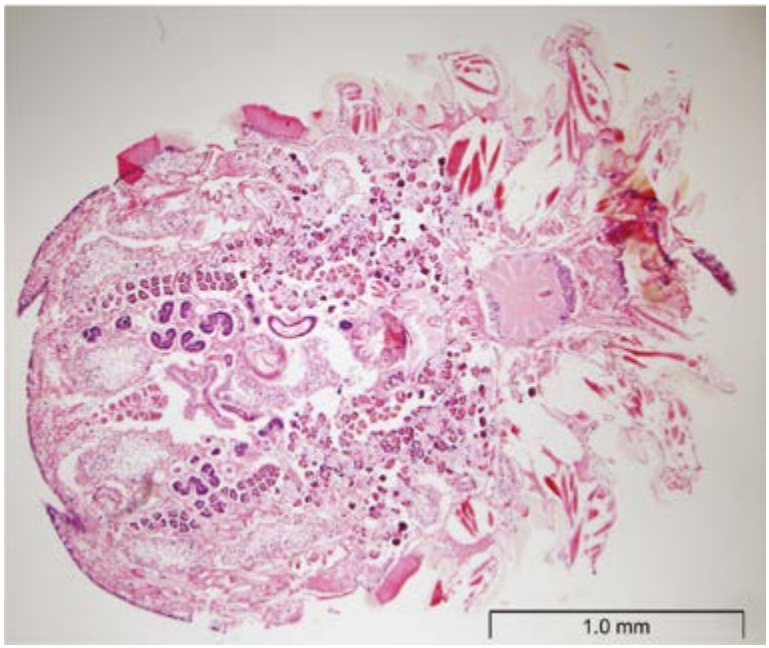
"With increasing genetic information, as a result of advanced DNA sequencing platforms, the scale of the data analysis required by this research necessitated access to high-performance computing" she said.

OUTCOME

Dr Oskam and her team have identified five tick-borne bacterial species, prompting them to begin developing new molecular tools to investigate these species further.

"While we are yet to identify their zoonotic and pathogenic potential, what we do know is that these new 'bugs' have previously gone undetected with traditional methods" she said.

Dr Oskam's research will contribute to the National Science and Research priority Health by expanding knowledge of microorganisms that may negatively impact on the health and welfare of humans and animals in Australia.



"This research is providing the science to help improve the accuracy of current disease diagnoses for microorganisms responsible for locally acquired tick-borne infections in Australia," Dr Oskam said.

The next step for the VWBPRG team is to understand the lifecycle of the five bacterial species identified, as well as identifying wildlife reservoir hosts, to improve on diagnostic tests and methods of control for tick-borne diseases.

The Australian Research Council currently funds this research with industry partners Bayer HealthCare, Bayer Australia and Queensland Health.

IMAGES *Top: Female paralysis tick, Ixodes holocyclus, sectioned and stained with H&E. Imaged by PhD student Alex Gofton. Bottom left: the bacterial microbiome within Australian ticks is comprised of endosymbionts, environmental and commensals, known pathogens and novel bacterial species. Bottom left: Paralysis tick, Ixodes holocyclus, commonly found on the eastern seaboard of Australia (dorsal view). Imaged by PhD student Telleasha Greay.*

CSIRO HUNTING FOR A SOLUTION

PROJECT	Random positioning code for large data sets
PROJECT LEADER	Dr Amanda Barnard
AREA OF SCIENCE	Nanotechnology
SYSTEM	Magnus
TIME ALLOCATED	20,000,000 hours

"IT'S WHEN YOU NEED TO DO 100,000 CONFIGURATIONS INSTEAD OF 10."

This is how CSIRO Office of the Chief Executive Science Leader Dr Amanda Barnard describes the random positioning code she and her team of 12 are developing using the Pawsey Magnus system.

The code – used by Dr Barnard's team to develop the molecular design of next-generation molecular interfaces such as surface coatings – is part of the 'Hunt and Gather' software platform, a high-throughput simulation engine which will be made available globally for researchers looking to generate and analyse large sets of data.

"We want to use these big data sets to try to work out more detailed correlations between the structural features of entire ensembles – or entire samples – of particles, rather than individual ones, with properties and ultimately performance," Dr Barnard said.

CHALLENGE

Dr Barnard's research involves running multiple simulations, something she describes as 'computationally demanding', with sophisticated quantum mechanical simulations which can be incompatible with cloud-based computing.

Her team's work requires the use of High-Performance Computing (HPC) systems such as Magnus to succeed.

"Some of the research could not be done by other means," Dr Barnard said. "There are certain types of simulation methods that just don't scale and you can't break them up into smaller jobs, so we have to have a system that's parallel, to handle that.

"Magnus has faster interconnects than some other supercomputers that are available in Australia, so some of the codes we use perform better on Magnus."

SOLUTION

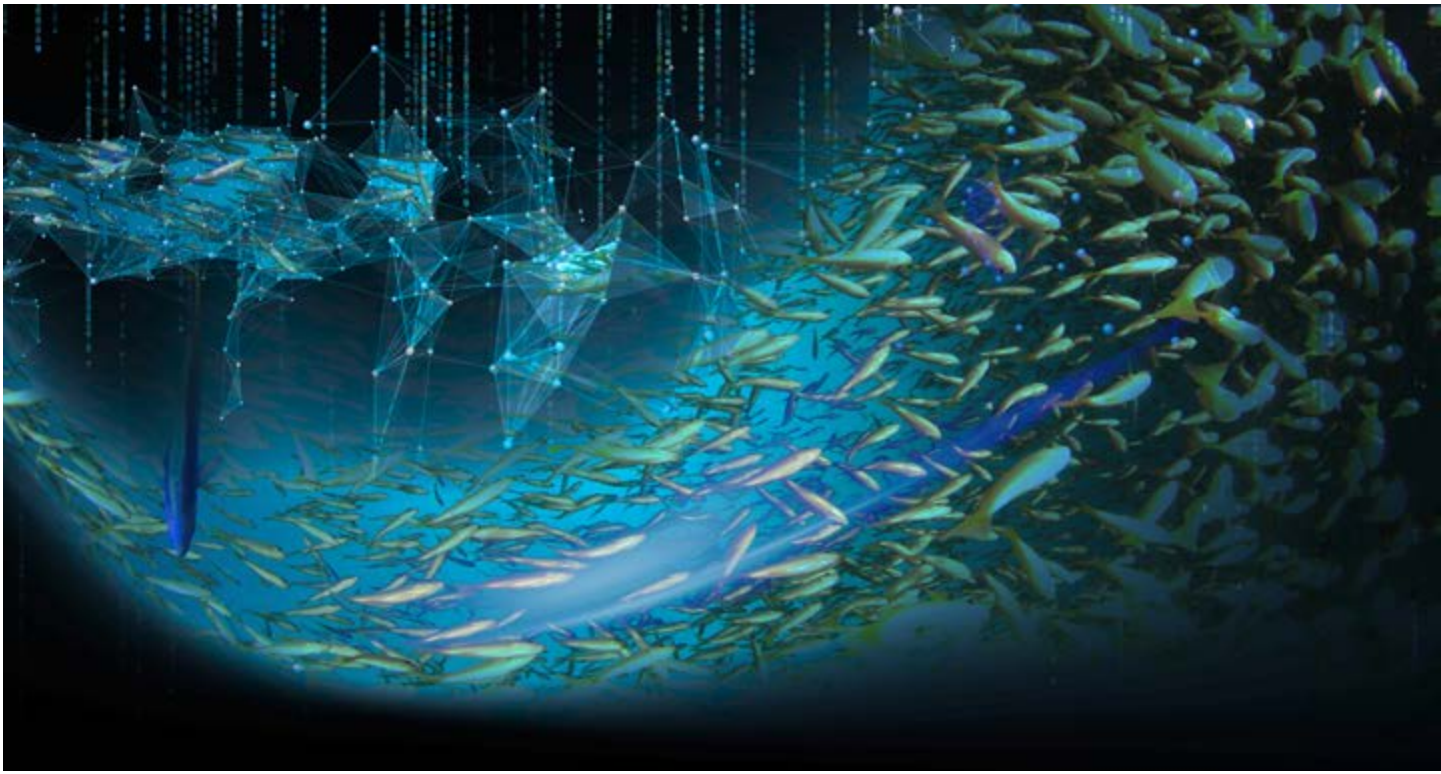
Dr Barnard says strong collaboration between her team and the Pawsey team has been a great benefit to the project.

"Very early on, when we were setting up and getting our codes running, we drew on the expertise of the Pawsey staff very heavily to get everything up and running," she says.

"We were able to work out technically how the code worked and it worked really well."

Dr Barnard and her team are developing the random positioning code to provide greater clarity on how and where molecules interact with surfaces.

Her team is taking a data analytics approach to the problem and is studying statistical outputs in combination with the thermodynamics.



"We calculate a lot of random positions, then look at the statistical distribution, rather than trying to seek just the ground state energy configuration, which is what other people are generally doing" she said.

"It's a different approach – it won't give us the same answer – but we can more rapidly get guidance as to what kind of areas require further work and what areas of the problem are unimportant.

"You can never tell in advance what areas might be a waste of time if you take a more systematic approach, as we've been doing for years."

OUTCOME

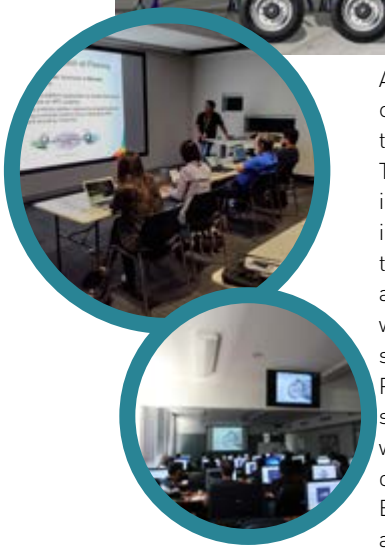
Dr Barnard says the code, and the Hunt and Gather platform, will ultimately be used to benefit researchers around the world.

"In the past, we've expended a lot of computing power calculating very accurately 10 configurations," she said. "Now we want to do 100,000 or more without giving up all the advantages we are accustomed to."

"In the future, Hunt and Gather will be a complete platform that will run the random positioning. It will run systematic searches as well and help us manage all kinds of big data exercises. It will be available to the global research community."

TRAINING

SKILLS DEVELOPMENT



Pawsey training is held every month. Through the year special sessions with international experts specially designed for Pawsey researchers are also run, such as OpenFOAM training that took place in December 2016 (Image above)

As a full-service centre, Pawsey implements comprehensive training packages for researchers to best optimise the resources available.
The Centre has not only continued to deliver internal courses to capacity audiences but has introduced Pawsey Roadshows to take Pawsey training on the road. The roadshows are part of a major strategy to reach researchers nationally with information of how supercomputing can significantly improve projects, how to access Pawsey services, or even help solve current supercomputing challenges. The first roadshow was held in Melbourne in October 2016 with outreach staff then visiting Hobart, Adelaide, Brisbane and Sydney in March 2017. Staff toured across Australia to deliver introductory training and information sessions to researchers.
These events also provided researchers with an opportunity to present their experience using high-performance computing (HPC) facilities to illustrate how their research has been supported by Pawsey's services and expertise.

Pawsey also coordinated its annual Internship Program, a highly-anticipated event that develops the knowledge and computational skills of Australia's future scientists.

User drop-in clinics at Pawsey Partner institutions have provided a valuable mechanism to assist researchers with diverse spheres of learning such as code optimisation, data transfer, workflows, and resource applications. The growth of the Centre's programs has progressed to the planning of online training which will further expand Pawsey services to national users and also give access to training content to the international HPC community.

Pawsey is evolving its training programs to build a critical mass of advanced computing knowledge in the research community. It will continue to engage in activities such as its internship program to further grow the expertise of the next generation of supercomputing specialists and create a skilled workforce in Australia.

ADDITIONAL TRAINING COURSES

Additional courses have been included in the Centre's training calendar, including Remote Visualisation and Optimising Serial Code. Remote visualisation is a course that helps researchers understand the most efficient ways to interact with Pawsey data systems from offsite locations. Remote visualisation enables local and national users to visualise large complex datasets onto inexpensive devices, such as laptops, without needing to transfer large data sets or run costly workstations; expanding methods of access to Pawsey systems.

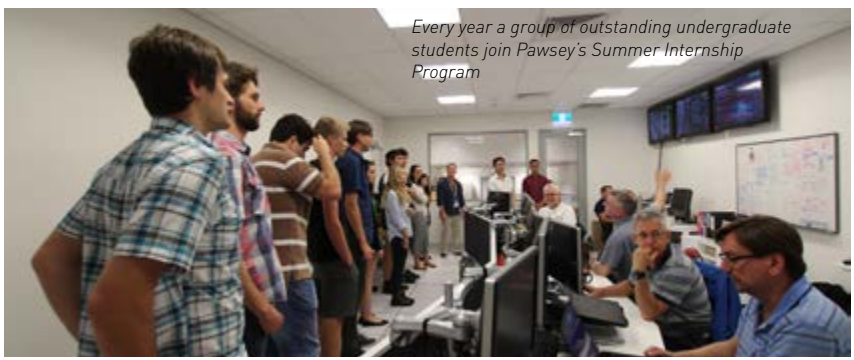
Optimising Serial Code is a training module which recognises that software needs single-core performance in addition to parallel performance, applicable to both cloud computing and supercomputing. The course recognises that Pawsey users are generally not expert software developers, hence there is a need for introductory development courses in preparation for more advanced supercomputing developer modules.

NIMBUS TRAINING

To facilitate uptake of the Nimbus Cloud service, Pawsey has offered a variety of training options to research users. Nimbus training sessions were run (11 clinics and training sessions) in June 2017 at each partner institution. Nimbus-related training was provided in two streams during the period. In the second stream Pawsey staff worked with a research group at Murdoch to test the viability and usefulness of intensive training around introductory computing training. Informal feedback and a high rate of attendance suggested a high demand for further training.

ADACS

Pawsey staff codirect the Astronomy Data and Computing Services (ADACS). This is a national collaboration with Swinburne and Curtin Universities to provide computation and data services to astronomy researchers. This project is funded by Astronomy Australia Ltd and it was the result of a national competitive process. This initiative will provide expert support, training and services tailored specifically to astronomy.



Every year a group of outstanding undergraduate students join Pawsey's Summer Internship Program

SUMMER STUDENT INTERNSHIP

Pawsey recognises that students are the next generation of computational scientists. The Pawsey Summer Internship Program pairs academically gifted undergraduate students with Pawsey researchers to work on challenging computational projects to build students' computational expertise.

The internship program is an effective means of demonstrating the benefits of high-performance computing to the next generation. More than 130 placements have been awarded since its inception, involving large-scale engagement of students, supervisors and Pawsey staff. It is increasingly competitive to win a placement at Pawsey, with less than 30 percent of applicants being accepted due to the high quality of proposals and the limited places available.

IN THE 2016-2017 REPORTING PERIOD, PAWSEY ACCEPTED 15 INTERNS FROM A POOL OF 51 APPLICANTS FROM MURDOCH, UWA AND CURTIN UNIVERSITY FOR THE SUMMER INTERNSHIP PROGRAM.

Student and supervisor surveys highlight the numerous benefits of the internship program, including the progression of science, the nurturing of new researchers, the maintenance of Pawsey's visibility and the cross-fertilisation of research across Pawsey partners.

BUILDING STAKEHOLDER RELATIONSHIPS

IMAGES:
Sharing their passion with kids and adults, Pawsey staff welcomed people from the community during the open day. Staff called this the best team building exercise they have been part of.

PAWSEY ENGAGEMENT

HIGHLIGHT OF THE YEAR

PAWSEY OPEN DAY

The Centre hosted its first Open Day on 20 August 2016, where members of the public were invited to see what happens behind the scenes of a supercomputing facility. More than 300 people attended the event to learn about supercomputers and their importance to the advancement of science in Australia. Approximately 220 visitors came through Pawsey's exhibition space to learn about our centre and research projects and to have a 'selfie' taken with Magnus. Another 80 people toured our restricted 'white space' which houses Magnus, the Centre's flagship supercomputer.

Throughout the day, tour groups attended presentations from archaeologists, physicists, and radio astronomers, who discussed science projects that require the use of a supercomputer.

As a result of the success of the Open Day and the subsequent increase in community interest, the Centre now conducts free group tours of the supercomputing facilities on a monthly basis.

RESEARCH ENGAGEMENT

PAWSEY FRIDAYS

Successfully running for over a year, Pawsey Fridays build a sense of community for Pawsey users and staff, opening dialogue and encouraging collaboration. Pawsey Fridays take place bimonthly and feature a presentation by a local researcher followed by a networking sundowner for staff and researchers. Presentations have focused on 3D reconstruction of Australia's wartime history, the search for the Malaysia Airlines missing aircraft MH370, Catching Shooting Stars, by the Desert Fireball Network and Precision in Agriculture.

Hundreds of people attended Pawsey Fridays during the reporting period.

IMAGES:
Pawsey Friday event with Desert Fireball Network researchers, from Curtin University

BIG DATA WEEK

The annual Perth Big Data Week is a Pawsey initiative which opens the doors of science and technology to the public and showcases the latest developments in data science and data science projects.

Big Data Week 2017 was launched by Chief Scientist of Western Australia, Professor Peter Klinken on Monday 8 May at the Pawsey Supercomputing Centre. Attendees of the launch included special Guest of Honour, the Honourable David Kelly MLA, Minister for Water; Fisheries; Forestry; Innovation and ICT; and Science.

Perth Big Data Week is a local series of events which aim to raise awareness of data science and big data analytics in Western Australia. Perth Big Data Week has been running annually since 2013. The theme for 2017 was *Connecting the Dots* – discussing the importance of data, its use and applications in society, including science and research, medicine, business and human engagement.

These events are independently run by a diverse range of organisations which showcase the breadth of data science being undertaken in Perth. In 2017, more than 500 people took part in the event throughout the week.

IMAGES: *During Big Data Week launch. Top to bottom. the Hon. Minister Dave Kelly with a journalist. Chief Scientist of Western Australia, Professor Peter Klinken. The panel discussion: The Role of Big Data in Western Australia with Tamryn Barker – CEO, CORE Innovation Hub, Jonathan Fievez – CTO, Carnegie Clean Energy and Stuart Gibbon – ED Strategy & Delivery, OGCIO.*

INDUSTRY & GOVERNMENT ENGAGEMENT

"Businesses that collaborate on innovation with research organisations are three times more likely to experience productivity growth, improved sales and exporting activity."[1]

The Australian Government commissioned a National Research Infrastructure Roadmap (NRIR) as part of its National Innovation and Science Agenda (NISA) in December 2015, to identify the focus areas for Australian Science and set out the long term requirements in terms of investment into research infrastructure. The 2016 roadmap was led by the Australian Chief Scientist, Dr Alan Finkel and released to Government in February 2017.

Digital Data and eResearch Platforms was identified as one of the nine focus areas that require ongoing government support. The roadmap recognised that "Australia's Tier 1 facilities need upgrading at regular intervals to keep pace with research needs. These upgrades should be coordinated so Australia always has at least one facility operating at full capacity."

As part of this process, a review into governance arrangements for Australia's High Performance Computing facilities commenced when the draft NRIR was being circulated. An external consultant met with stakeholders of the two HPC facilities in Australia (Pawsey and NCI) to discuss how to strengthen and streamline their governance arrangements. The outcomes of this review are expected to be released during the next financial year.

Pawsey actively engages and assists government organisations across Australia whenever possible. As such, a number of significant Western Australian Government agencies directly utilise Pawsey's resources. Departments include the Department of Mines and Petroleum, the Department of Parks and Wildlife and the Department of Health.

Pawsey also engages with and welcomes industry groups with HPC requirements to utilise Pawsey infrastructure and expertise. This can be done either directly or through collaboration with academic/CSIRO researchers. Collaboration with researchers holds the advantage of leveraging the extensive expertise within CSIRO and universities.

Pawsey's strong relationships with its partner organisations have been key to its industry engagement strategies, with a number of successful cooperative industry/partner projects running on Pawsey systems – including Bombora Wave Power, Carnegie Wave Energy, the Grains Research and Development Corporation, Rio Tinto, Chevron, Alcoa, BHP Billiton, CGG Veritas and Schlumberger. Projects supported by Pawsey are estimated to leverage around $7 million per year in industry funding for partner organisations.

Pawsey engages with industry when projects lie within spheres of research and development and follow the principles of competitive neutrality. Typical applications include computational modelling and feasibility studies as to whether companies can benefit from high-performance computing.

1 http://www.innovation.gov.au/

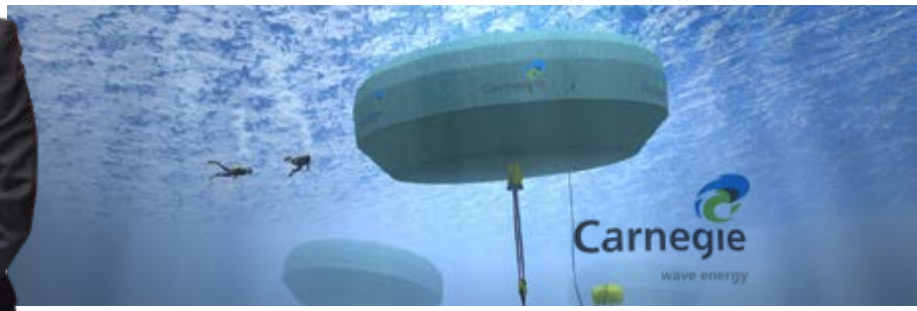
The Hon. Craig Laundy MP, Assistant Minister for Industry, Innovation and Science visited the Centre and was joined by SKA pathfinder and Industy researchers using Pawsey infrastructure.

Juan Carlos Guzman, Research Team Leader at CSIRO Astronomy and Space Science Division.

Mr Shawn Ryan, Non-Executive Director and cofounder of Bombora Wave Power

Direct industry engagement in 2016-17 was demonstrated by engineering group, DHI, who utilised Pawsey systems to perform ocean current modelling. The Australian Maritime Safety Authority was then able to utilise the outcomes of this project to predict ocean drift of sea vessels.

Researchers from Carnegie Clean Energy and The University of Western Australia have been using Pawsey systems to develop a wave energy device that converts ocean swell into zero-emission, renewable power and desalinated freshwater.

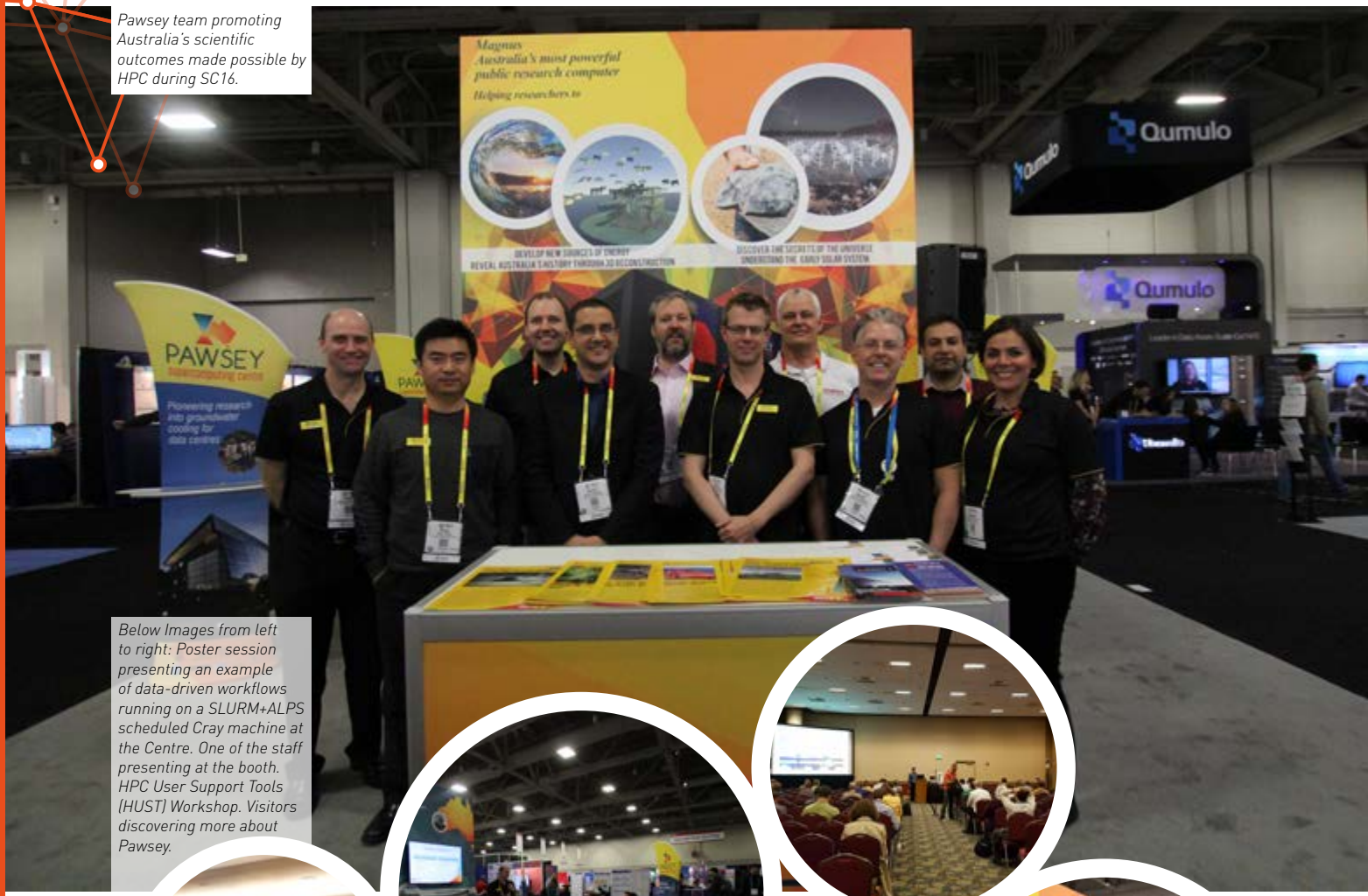


A team of researchers from Curtin University has been working with Perth company Bombora Wave Power to examine and optimise the performance of Bombora's mWave™ wave energy converter. This photo shows Bombora Mid-scale test site at Como Jetty, Western Australia

bombora
wavepower

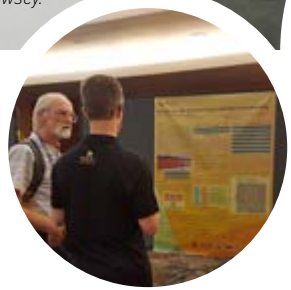
DHI

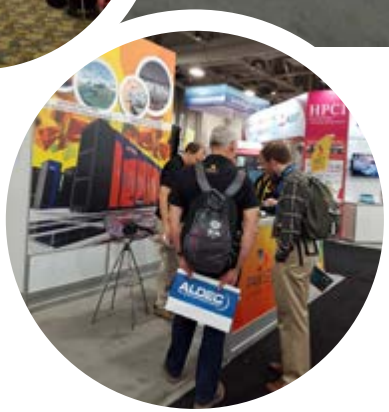
Helped by the world-class facilities at Pawsey, a dedicated team from DHI, an international software development and engineering consulting firm, has developed a numerical modelling system for predicting the fate of large drifting vessels. The complex modeling system has been developed in collaboration with Australian Maritime Safety Authority.



Pawsey team promoting Australia's scientific outcomes made possible by HPC during SC16.

Below Images from left to right: Poster session presenting an example of data-driven workflows running on a SLURM+ALPS scheduled Cray machine at the Centre. One of the staff presenting at the booth. HPC User Support Tools (HUST) Workshop. Visitors discovering more about Pawsey.





INTERNATIONAL ENGAGEMENT

Engaging with peer supercomputing sites around the world and encouraging collaborative practice enables the Centre to strengthen its position as a player in the international HPC community.

REPRESENTING AUSTRALIA IN THE UNITED STATES

The Supercomputing Conference (SC) event, held annually in November in the United States, is the world's premier conference on supercomputing. In 2016, SC broke attendance records, with more than 11,100 registered attendees, while the exhibition hall featured 349 exhibitors from industry, academia and research organisations. The conference provided the ideal opportunity for Pawsey to engage with other leading centres, promote groundbreaking Australian science and to build on Pawsey expertise.

Pawsey hosted the Australian HPC booth for the three-day exhibition, to which more than 500 visitors came to talk to staff and collect a memento to take away with them. Pawsey staff engaged with conference attendees, providing extensive information about the Centre's capabilities, while giving away more than 250 Pawsey wombats and 500 Australian HPC lizards.

Pawsey staff delivered a series of presentations from the exhibition booth, which included topics on the Square Kilometre Array, bioinformatics research, projects of Australian national significance and storage and cloud computing.

HPC USER SUPPORT TOOLS (HUST)

In collaboration with Lawrence Livermore National University and the Victorian Life Sciences Computation Initiative, Pawsey has coordinated the HPC User Support Tools (HUST) Workshop at the conference for the past two years. The workshop is a forum for HPC user support teams to share ideas and experiences across a range of topics. A notable contribution from Pawsey was the automated build tool, Maali, a Centre-developed initiative. Maali simplifies, documents and automates the installation of software on supercomputers, making the infrastructure more accessible to users.

GERMANY 2017

The International Supercomputing Conference (ISC), held annually in Germany, provides Pawsey with an ideal opportunity to showcase leading-edge research outcomes, build its international reputation and promote Australian science. It also provides a unique opportunity to learn about new technologies, engage with peer organisations and network with key supercomputing personnel from around the world.

Seven Pawsey experts attended ISC 2017, joining more than 3,000 people from 60 countries. The concepts of Data Analytics and Deep Learning were key themes of the 2017 conference.

OTHER COLLABORATIVE OPPORTUNITIES

Pawsey has established links with the National Energy Research Scientific Computing Center (NERSC) in California, USA, with staff visiting Perth and engaging with the Pawsey team. A collaboration agreement is close to being signed with this organisation, which will allow Pawsey staff to learn from their NERSC peers about their experience in running a Cray supercomputer at one of the biggest HPC facilities in the United States. With this agreement, Pawsey staff will be able to share knowledge and information with NERSC staff in common areas of interest.

A Memorandum of Understanding is also in progress between Pawsey and the National Supercomputing Centre in Singapore (NSCC) which operates different computational systems and supports other areas of science. Once agreed, both organisations will be able to learn new approaches, share knowledge in new areas and exchange best practice.

Additionally, the Data Team staff are also collaborating with Centro Svizzero di Calcolo Scintifico (CSCS – Swiss National Supercomputing Centre) in relation to data analysis and machine learning topics.

COMMUNITY ENGAGEMENT

Promoting innovation and encouraging future generations to explore careers in science is a key focus at Pawsey. Through Centre visits and tours, Pawsey shares its expertise and knowledge to highlight the endless scientific possibilities of supercomputing. This is particularly targeted to the next generation and those with an active interest in technical and scientific innovation.

The Pawsey Supercomputing Centre believes in fostering a culture of science and as such, Pawsey holds numerous events and initiatives throughout the year.

In 2016, staff provided tours to almost 600 young Australians, including groups from Coder Dojo, CSIRO's Pulse@Parkes, Cape Naturaliste College and Morley School, among others. Following the Pawsey Open Day, community monthly tours were made available once per month and were attended by more than 100 people (including a good representation of high school students).

Twenty-five students from Butler College, Byford Secondary College and Willetton Senior High School took part in the CSIRO's PULSE@Parkes session at Pawsey.

PAWSEY VISITORS & OUTREACH

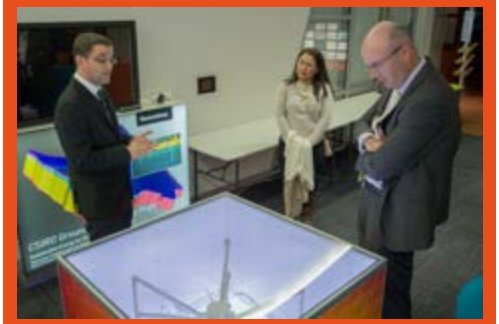
As an international Centre of HPC capabilities and services, Pawsey generates a high level of interest from local, national and international groups. The Centre encourages groups to visit and tour its world-class facility as part of the Pawsey engagement strategy to promote Big Science outcomes.

IN 2016-17 THE PAWSEY SUPERCOMPUTING CENTRE ATTRACTED MORE THAN 1332 VISITORS.

Visiting groups consist of international delegations; local, state and federal government representatives; industry groups and researchers. Visitors to the Centre can see first-hand the cutting-edge supercomputing resources that are putting Australia at the forefront of scientific research, enhancing innovation in spheres such as industry, life science, medicine and astronomy.

Left: "Ninjas" from CoderDojo WA in the Tape Cell during their tour of the facility. Right: Pawsey was the destination picked by Cape Naturaliste College's students. During their visit they enjoyed a presentation by Curtin University's Fireballs in the Sky.

Next page images. Top lef: Visit by Australia's High Commissioner to South Africa, Mr Adam McCarthy. Top right: Some of WA's political and business leaders join us during National Science Week for the 'Safari Innovation Tour'. Bottom left: Members of the International SKA board during their visit to WA. Bottom right: WA Korea Energy and Resources Business Forum (WAKER) tour.



VISIT HIGHLIGHTS FROM 2016-17

- Chief Scientist, Dr Alan Finkel
- Minister Craig Laundy
- DFAT High Commissioner to South Africa
- American Chamber of Commerce in Australia - AmCham- Innovation Mission Tour
- Republic of Korea Ambassador-designate
- The Acting US Ambassador (Chargé d'Affaires) Jim Caruso and Consul General
- Representatives from the SKA during a board meeting
- High school students at PULSE@Parkes
- CEDA Trustee meeting
- CoderDojo Ninja tour
- Innovate Australia Presentation

The visits list can be found in the appendix.

INDUSTRY VISITS AND EVENT VENUE

Pawsey's exhibition area is an attractive venue for IT, science organisations and industry associations to hold events that align with Pawsey goals. Hosting events at the Pawsey Centre provides an opportunity to showcase Pawsey infrastructure, services and research projects that generate Big Science outcomes for Australia.

More than 18 organisations utilised the Centre's exhibition space as an event venue in 2016-17.

Biodiversity and Climate Change Virtual Laboratory (BCCVL) hosted a Perth workshop in the exhibition space, with more than 25 people attending

222
INTERNATIONAL VISITORS

87
NATIONAL VISITORS

343
STATE VISITORS

112
INDUSTRY REPRESENTATIVES

566
VISITORS FROM THE COMMUNITY

RESOURCES

PAWSEY INFRASTRUCTURE

PAWSEY GENERATES THE THIRD HIGHEST AMOUNT OF SOLAR POWER FOR ANY FACILITY IN PERTH. WITH THE GROUNDWATER COOLING SYSTEM AND SOLAR PANELS OPERATING, THE NET EMISSIONS OF THE CENTRE ARE LOWER.

INFRASTRUCTURE OVERVIEW

The Pawsey Supercomputing Centre building incorporates a number of best practice features and solutions. These include:

- A 'dual skin' building construction to ensure the most effective insulation of the supercomputing environment from external temperature extremes.
- Fibre optic high-speed network, linking researchers from Australia and overseas to the facility. This includes a dedicated, high-speed link to the Murchison Radio Astronomy Observatory, some 800 kilometres north of Perth.
- Scalable liquid cooling and electrical services, which will enable flexible supercomputer expansion within the 1,000 square metre computer hall.
- A unique groundwater cooling system for removing heat from the supercomputer and reinjecting and dissipating this heat into the aquifer, 100 metres below the Pawsey Supercomputing Centre, with no net loss of groundwater or perceptible impact on the aquifer.

140kVA Pawsey's solar PV array

- A Photo Voltaic (PV) system has been incorporated into the building's shaded facade, plus an extensive PV array on the roof of the building. This PV installation generates 140kW of electricity onsite, which acts to offset the electrical and CO_2 footprint of the Supercomputing Centre.
- The Pawsey Supercomputing Centre is an automated, secure, 'intelligent' building, with real-time monitoring to facilitate efficient operation and support fine tuning of operations to reduce overall power costs.
- Overall, the Facility has been designed to be as 'future proof' as possible, allowing Pawsey to anticipate and accommodate the high power, cooling and physical requirements of the next generation of supercomputers.

PAWSEY SYSTEMS

MAGNUS

Magnus is a Cray XC40 supercomputer that empowers cutting-edge research through high-end supercomputing projects across the entire range of scientific fields supported by the Pawsey Supercomputing Centre. In the 2016-17 period, Magnus was ranked as number 111 in the Top500 list of supercomputers around the globe.

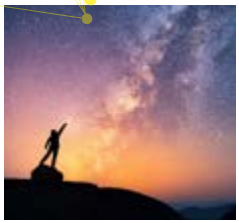
To solve Big Science problems that cannot be solved anywhere else, Magnus enables software to scale efficiently to tens of thousands of processors through its Cray Aries interconnect. While capacity supercomputers aim to solve many science problems, Magnus is a capability-scale supercomputer that enables solutions to Big Science problems.

Temporary workspace storage, known as the scratch file system, is provided by a three-cabinet Cray Sonexion 1600 Lustre appliance, with a usable capacity of 3 PB and a sustained read/write performance of 70 GB/sec.

Maintenance was undertaken early in 2017 to address performance and stability issues that were observed towards the end of 2016. Additional work was undertaken on the supercomputing schedulers to support the arrival of the Advanced Technology Cluster (ATC) in the first half of the year.

A replacement group filesystem went into production in March 2017. The filesystem provides 1.5 PB of usable storage running Intel Enterprise Edition Lustre 3.0 and is fully backed up by a complementary tape system.

Magnus comprises eight compute cabinets, each holding 48 blades with four nodes per blade and two compute processors per node. Each node hosts two 12-core Intel 'Haswell' processors running at 2.6 GHz, for a total of 35,712 cores, delivering in excess of 1 PetaFLOPs of computing power. Temporary workspace storage, known as the scratch file system, is provided by a three-cabinet Cray Sonexion 1600 Lustre appliance, with a usable capacity of 3PB and a sustained read/write performance of 70 GB/sec.



PAWSEY SYSTEMS

Galaxy consists of three cabinets, containing 118 compute blades, each with four nodes. Each node supports two, 10-core Intel 'ivy bridge' processors operating at 3 GHz, totalling 9,440 cores, delivering around 200 TeraFLOPS of compute power. In addition, it has 64 nodes, each with one 8-core processor and 1 GPU. Galaxy has 1.3 Petabytes of storage capacity.

GALAXY

Galaxy is a Cray XC30 system that supports radio-astronomy activities. It fulfils the real-time processing requirements of the Australian Square Kilometre Array Pathfinder (ASKAP) telescope and the Murchison Widefield Array (MWA) telescope. Galaxy runs the ASKAP Central Science Processor allowing pseudo-real-time processing of data delivered to the Pawsey Supercomputing Centre from the Murchison Radio Astronomy Observatory (MRO).

ASTROFS

To support ASKAP and MWA's additional storage requirements, a 1.9 PB Lustre filesystem was procured and attached to the Galaxy supercomputer. This provides a capability that will be operating beyond the lifetime of Galaxy and can be expanded in both performance and capacity to facilitate any future requirements.

ADVANCED TECHNOLOGY CLUSTER

In providing state of the art services to Australian researchers, the Centre will continue to build leading-edge HPC capability and deliver Big Data solutions. Pawsey understands that Australian researchers will require more compute power than is currently available, and is currently investigating a full capital refresh to address this need. Part of this process entailed the procurement of the Advanced Technology Cluster (ATC), to enable user access to emerging HPC technologies. The cluster is the successor to the Fornax service and a testbed of future technologies that will inform the next-generation technology selection for the successor to Magnus. The ATC, now known as 'Athena' is a state of the art, high-performance computing system that will provide Pawsey researchers with access to cutting edge technologies and facilitate the evaluation of these technologies. Athena will also ensure that Pawsey researchers are well equipped to engage in sophisticated computational techniques, such as deep machine learning.

ZYTHOS

Zythos, a latest-generation SGI UV2000 system, is a large, shared-memory machine targeted towards data-intensive jobs.

Zythos is a partition within the Zeus cluster. Access to Zythos is allocated through the Pawsey Supercomputing Centre Director's Share.

ZEUS

Zeus is an SGI Linux cluster that supports pre- and post- processing of data, large shared memory computations and remote visualisation work. Zeus enables a diverse range of workflows to be undertaken in conjunction with the Cray supercomputers.

Zeus is provided as a support system for projects that are allocated time on other Pawsey resources.

ZEUS CLUSTER EXPANSION

A procurement activity is underway to expand the Zeus cluster. The expansion will provide Pawsey researchers access to a mid-range compute platform. In combination with Nimbus (Pawsey's cloud platform), researchers will be able to start scaling with the cloud, graduate to the mid-range cluster and finally achieve the petascale with Magnus.

In total, 3,430,421 core hours were used on Zeus over the reporting period.

Zythos consists of 24 UV blades. Twenty of the blades each contain two hex-core Intel 'Sandy Bridge' processors and 256 GB RAM, and the remaining four each contain a single hex-core Intel processor, an Nvidia K20 GPU and 256 GB RAM. Altogether, the machine boasts 264 CPU cores, 4 GPUs and a total of 6 TB RAM.

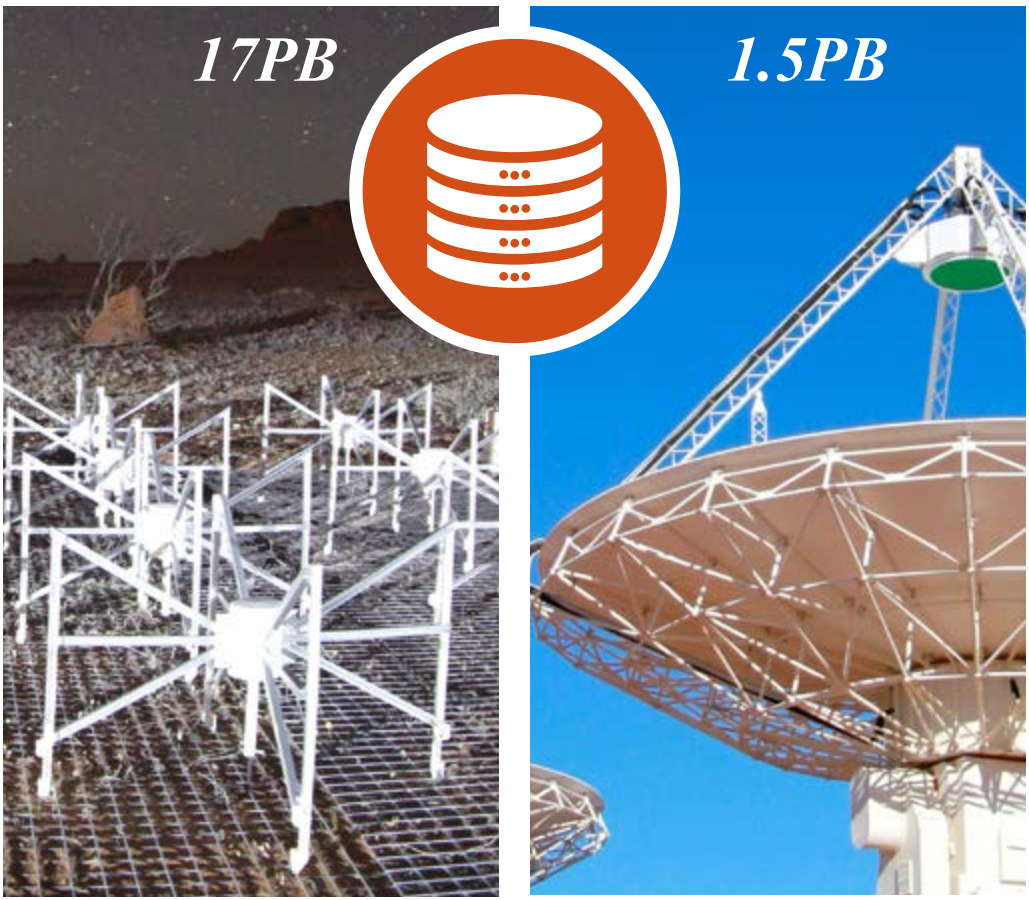
Zeus is an SGI Linux cluster that supports pre- and post- processing of data, large shared memory computations and remote visualisation work. Zeus enables a diverse range of workflows to be undertaken in conjunction with the Cray supercomputers.

Zeus is provided as a support system for projects that are allocated time on other Pawsey resources.

DATA STORAGE

Projects using the Pawsey Supercomputing Centre's resources often produce vast amounts of data. Not only does this data need to be stored, but scientific computing places new demands on researchers to curate and share their data, as well as to ensure the value, accuracy and longevity of their results.

At the end of this reporting period, 21 PB of data was stored on Pawsey systems, with 17 PB from the Murchison Widefield Array (MWA), 1.5PB from the Australian Square Kilometre Array Pathfinder (ASKAP) and 2 PB from general science users. The data uptake for the year was approximately 7.5 PB. This is expected to increase next year, as ASKAP starts full production late in 2017 and MWA makes system upgrades to MWA2.



Night Sky at Murchison Widefield Array Site Western Australia - Photo credit - Copyright John Goldsmith CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) which is located at the Murchison Radio Astronomy Observatory in Australia's Mid West. Credit: Pete Wheeler, ICRAR.

The Pawsey data store consists of a Hierarchical Storage Management (HSM) system which is currently able to store up to 35 PB of data, and is expandable to at least 100PB. The system seamlessly moves user data between 6PB of spinning disk and 35PB of tape and automatically ensures there is sufficient free space on the disk systems.

SOFTWARE UPGRADES

During 2015-16 there were a series of software upgrades to systems to increase reliability prior to the CSIRO ASKAP Science Data Archive (CASDA) going live in December 2015 and Early Science commencing in June 2016. MWA also continued ingesting live data for the complete year.

Completed upgrades in the 2016-17 period include the purchase of additional tape media, which increased data storage from 35 PB to 47 PB.

Planned upgrades for next year include the purchase of more tape media, which will allow an additional 10 PB of data to be stored.

USER ACCESS

Pawsey staff have developed a new application portal for users to apply and more easily update their storage allocations. Users will also be able to better manage their storage allocations/ quotas, delegate responsibilities to other team members and obtain enhanced reporting of their current data holdings.

This has resulted in significant performance and usability enhancements to the data portal for researchers to better upload, search and retrieve their data.

CLOUD COMPUTING

RESEARCH CLOUDS

In April 2017, Pawsey launched a new cloud service - Nimbus. Nimbus is an OpenStack based cluster used to deploy 'Virtual Machines' for researchers. These virtual machines allow for a wide variety of services, from data analytics tools, to web based data sharing engines and parallelised cluster processing.

Early adopters began using the service in April, which was followed by a full production system by the end of June 2017. A key priority during this period was the orderly migration of existing Western Australian cloud users to Nimbus. Early users of the service include researchers in genomics, astronomy, engineering, geoscience, public health and computer science.

Future plans for Nimbus include supporting research client uptake of advanced data analytics tools (such as Hadoop and Apache Spark) and building mechanisms for integrating workflows across the range of Pawsey high-performance computing and large data storage facilities.

VISUALISATION

Visualisation provides new, tangible ways to interact with and understand complex data and communicate it through easily-accessible visual mediums.

Pawsey staff continue to support and assist researchers from member institutions by providing technical solutions and advice for research projects ranging from sports science, medical imaging and geoscience to cultural heritage, archaeology and business management.

This support centres on the management and operation of three large-screen, high-resolution (4K or greater) 3D visualisation facilities at ARRC, Pawsey and UWA. In addition, staff help researchers with support and access to high-end visualisation workstations, VR headsets, 3D stereoscopic cameras and the design and installation of novel display systems.

The visualisation team has helped more than 45 researchers to bring more understanding to their projects.

REMOTE VISUALISATION

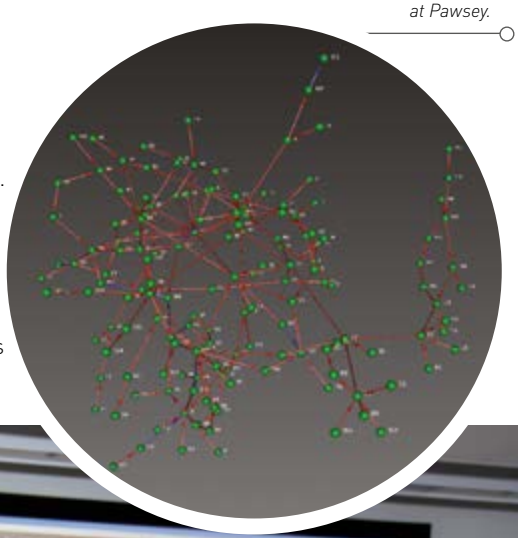
Pawsey staff have implemented a new remote visualisation service, leveraging the hardware of the Zeus cluster. The service utilises Strudel software, developed by MASSIVE at Monash University. This service simplifies the setup of a remote visualisation session, enabling researchers to visualise their data that is stored in Pawsey supercomputers, without the need to transfer the data.

IMPACT CASE

Risk management is a key consideration of any project. Risk maps, which are traditionally visualised in 2D, can be used to model and analyse risks but as projects grow, they can become complicated, making visualisation of the entire risk map in 2D impractical. One way of overcoming this problem is to visualise the risk maps in stereo 3D. Pawsey investigated and developed a prototype application for 3D visualisation of risk maps, which identify risk clusters and their characteristics, as projects grow. This method of visualisation can be used to predict potential risks at various stages of a project and simplify the process in complex and large-scale project situations.

During the year, the visualisation team helped visualise a risk map in 3D for a researcher from Curtin University. Such was the success of the project that university partners showed interest in continued utilisation of the 3D risk map. Furthermore, the Pawsey visualisation team discovered that the map can be applied to not only one domain but across multiple disciplines, such as education and archaeology.

3D Risk Map Visualisation. The Visualisation Room at Pawsey.



ALLOCATIONS & USAGE

RADIO ASTRONOMY ALLOCATION: PAWSEY AND THE SKA PROJECT

25 percent of Pawsey systems are allocated to radio astronomy use

The Square Kilometre Array (SKA) is an international project to build a next-generation radio telescope, which will be 50 times more sensitive and able to survey 10,000 times faster than today's most advanced telescopes. A $2.3 billion joint effort between institutions from more than 20 countries; the SKA will be cohosted by South Africa and Australia.

The SKA will help scientists answer fundamental questions about the origins of the universe, such as how the first stars and galaxies were formed.

The Australian component of the telescope will be located at the Murchison Radio Astronomy Observatory (MRO), the centre of a radio-quiet zone, near Boolardy in Western Australia, 315 Kilometres northeast of Geraldton. The Australian component covers the low-frequency range of the SKA.

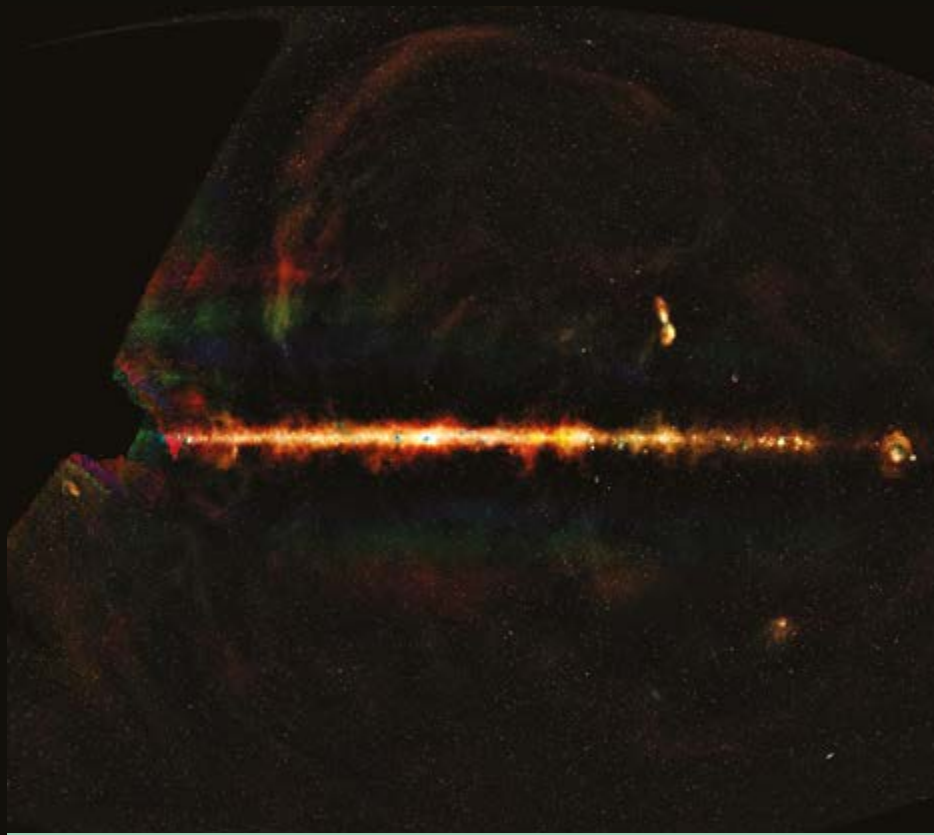
The Pawsey Supercomputing Centre is one of around 20 members of the SKA Science Data Processing (SDP) consortium. The consortium is responsible for designing the infrastructure, hardware and software necessary to process, archive and visualise the data produced by the SKA.

The Australian component of the Science Data Processor of the SKA is under consideration to be hosted at the Pawsey Supercomputing Centre. The Pawsey Supercomputing Centre's cutting-edge resources and expertise will be crucial in processing immense data products produced by this world-leading astronomy project.

Two pathfinder projects to the SKA, the CSIRO's Australian Square Kilometre Array Pathfinder (ASKAP) and the Murchison Widefield Array—led by Curtin University—are located approximately 700km north of Perth at the Murchison Radio-astronomy Observatory. Both ASKAP and the MWA already make use of the Pawsey Supercomputing Centre's facilities, with the Pawsey Supercomputing Centre supercomputer 'Galaxy' the Science Data Processor for the ASKAP and MWA projects.

The MWA telescope is comprised of more than 2,000 dipole antennas, situated at the Murchison Radio Observatory. On the same site the CSIRO-operated ASKAP telescope operates a collection of 36 novel dish antennas that rapidly survey the sky using innovative Phased Array Feeds. After the telescopes collect the vast amounts of data on site, it passes through a dedicated network of 10-gigabit optical fibre links and streams down to the Pawsey Centre. More than 18 PB of data from both ASKAP and the MWA are stored at Pawsey Supercomputing Centre, of which 8 PB were collected in the 2016-17 period.

With Pawsey Supercomputing Centre's experience processing data from both pathfinders, the Centre has vital experience testing the technologies and potential problems the SKA may face.



TOP IMAGE: A Molleweide projection in Galactic coordinates of the GLEAM survey, showing how it covers the entire southern sky. Red indicates the lowest frequencies, green the middle frequencies and blue the highest frequencies. Credit: Natasha Hurley-Walker (ICRAR/Curtin) and the GLEAM Team.

IMAGES BELOW: ASKAP antennas under a starry sky at the Murchison Radio Observatory. Credit: Alex Cherney/terrastro.com

Murchison Widefield Array antenna - Credit: Natasha Hurley Walker

The Galaxy supercomputer is exclusively dedicated to the ASKAP and MWA radio telescopes, and should be considered a part of the telescopes. Galaxy accounts for 25% of Pawsey's supercomputing expenditure from the Australian Government's Super Science fund. ASKAP and MWA use Galaxy to produce data products that are made available via the Pawsey data store, and these data products can then be analysed by researchers. The data products are three-dimensional images; two dimensions of the sky and a third dimension for frequency (microwave colours).

In 2017 ASKAP scientists received an additional 1,072,000 core hours through the national computational merit allocation scheme on Magnus, for the scientific analysis of the data products. ICRAR scientists received 2,700,000 core hours across six projects through the Pawsey Partner competitive merit allocation scheme on Magnus, for both scientific analysis and algorithm development.

ENERGY AND RESOURCES ALLOCATION

Pawsey continues to work actively with researchers in the Western Australian State science priority areas and attracts the best research projects through its merit allocation schemes. For the Energy and Resources Scheme, there was a 2.5 times oversubscription with researchers requesting 138 million hours, 55.5 million hours were available and subsequently awarded.

The decrease in global expenditure for resources exploration has resulted in an economic decline in the mining industry, with a follow-on effect to the Australian and Western Australian economy. To combat this, new technologies to uncover mineral deposits are needed to maintain this vitally-important sector of the Australian economy. Pawsey Supercomputing Centre is committed to enabling researchers to investigate these technologies, including enhanced identification, improved imaging and advanced extraction techniques. The application of innovative methods in the resource and minerals sector will demonstrate direct benefits to the Australian economy, revitalising the industry and placing Australia firmly at the forefront of minerals and resource exploration in the global scientific community.

This commitment is signalled by Pawsey's Energy and Resources Scheme, which provides significant compute time for meritorious research projects. The scheme is open to Australia's energy and resources research community and receives guidance on qualification from national and state science priorities. Project examples include energy generation, storage and distribution, resource exploration, extraction and processing. The Energy and Resources Scheme allocates researchers 20 percent of the total resources of Magnus, the most advanced research computer in the Southern Hemisphere, to investigate these areas. With scientists across Australia engaged in world-leading resources and energy projects made possible by HPC, the Pawsey Supercomputing Centre is acknowledged as a leading global hub for these research sectors.

NATIONAL ALLOCATION

The National Computational Merit Allocation Scheme (NCMAS) was two times oversubscribed during the reporting period.

As part of the National Merit Allocation Scheme (NCMAS), in 2017, the Pawsey Supercomputing Centre made available 100 million core hours for researchers representing 54 projects across Australia.

The success rate (total allocated vs requested) from researchers applying for Pawsey resources during that allocation was 50 percent, with more than 200 million core hours requested.

From the time allocated, 20 percent was for researchers at Curtin University, followed by Monash University with 17.5 percent, the University of New South Wales with 16.2 percent and Melbourne University with 13.3 percent. Researchers from Adelaide University, University of Sydney, University of Queensland, Australian National University and others, also received allocations.

As a national supercomputing facility, the Pawsey Supercomputing Centre provides access to its supercomputing infrastructure and services through the National Computational Merit Allocation Scheme (NCMAS), Australia's premier meritorious allocation scheme. NCMAS spans both national peak facilities, Pawsey and its sister supercomputing centre, NCI; and other specialised compute facilities across the nation.

The NCMAS constitutes 35 per cent of available compute time on Magnus. Only a project proposal that fulfils the constraints of the particular scheme and that is deemed to be technically feasible is eligible to receive a compute-time allocation on a Pawsey supercomputer. For the National Computational Merit Allocation Scheme, the process is conducted by an independent panel of computational researchers who prioritise and award compute time to eligible projects according to their scientific merit.

PAWSEY PARTNERS ALLOCATION

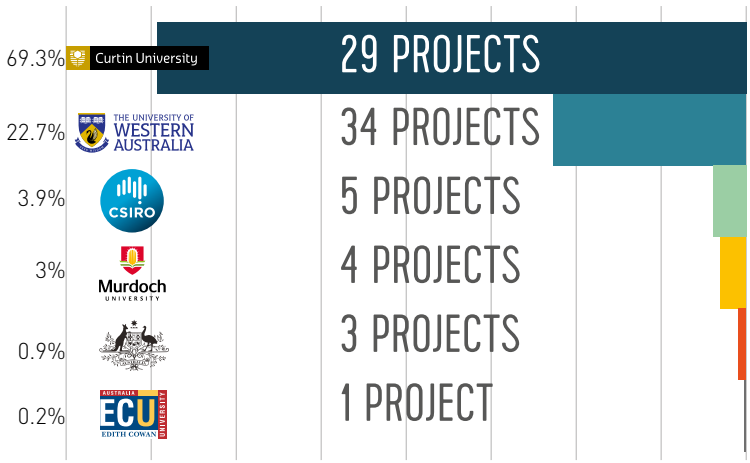
The Pawsey Partner scheme constitutes 40 percent of the available compute time on Magnus, with a total of 115 million core hours available for allocation to successful projects throughout 2017.

217 million core hours were requested through the 2017 Partner Scheme round, with 110 million core hours awarded to Partners. The remaining 5 million core hours are set aside for exceptional applications during the year. In 2017 there was one exceptional allocation, awarded to a new research group at UWA.

For the first time, 2017 opened the scheme to include researchers from Western Australian government agencies through the same competitive merit process.

Projects included research from the Department of Health, Department of Parks and Wildlife and the Department of Environment Regulation; who made up 0.9% of the allocation.

This year, 69.3 percent of time was allocated to projects from Curtin University, 22.7 percent to UWA projects, 3.9 percent to CSIRO, 3 percent to Murdoch University and 0.2 percent to Edith Cowan University.



Pawsey's Partner Scheme provides significant compute time for meritorious projects led by researchers from its partner institutions. These include CSIRO, Curtin University, Edith Cowan University, Murdoch University and The University of Western Australia, who contribute significant financial and operational support to the Centre.

WA State Government agency employees are also considered Pawsey Partners and are therefore eligible to access Pawsey services under the Partner Share. Such staff are eligible to be Principal Investigators of Partner Share projects and contribute to the 50 percent FTE criteria.

PAWSEY DIRECTOR'S SHARE

The Director's Share is used at the discretion of the Executive Director of Pawsey and broadly applies to users not eligible under competitive merit schemes.

Typical uses of the Director's Share include:

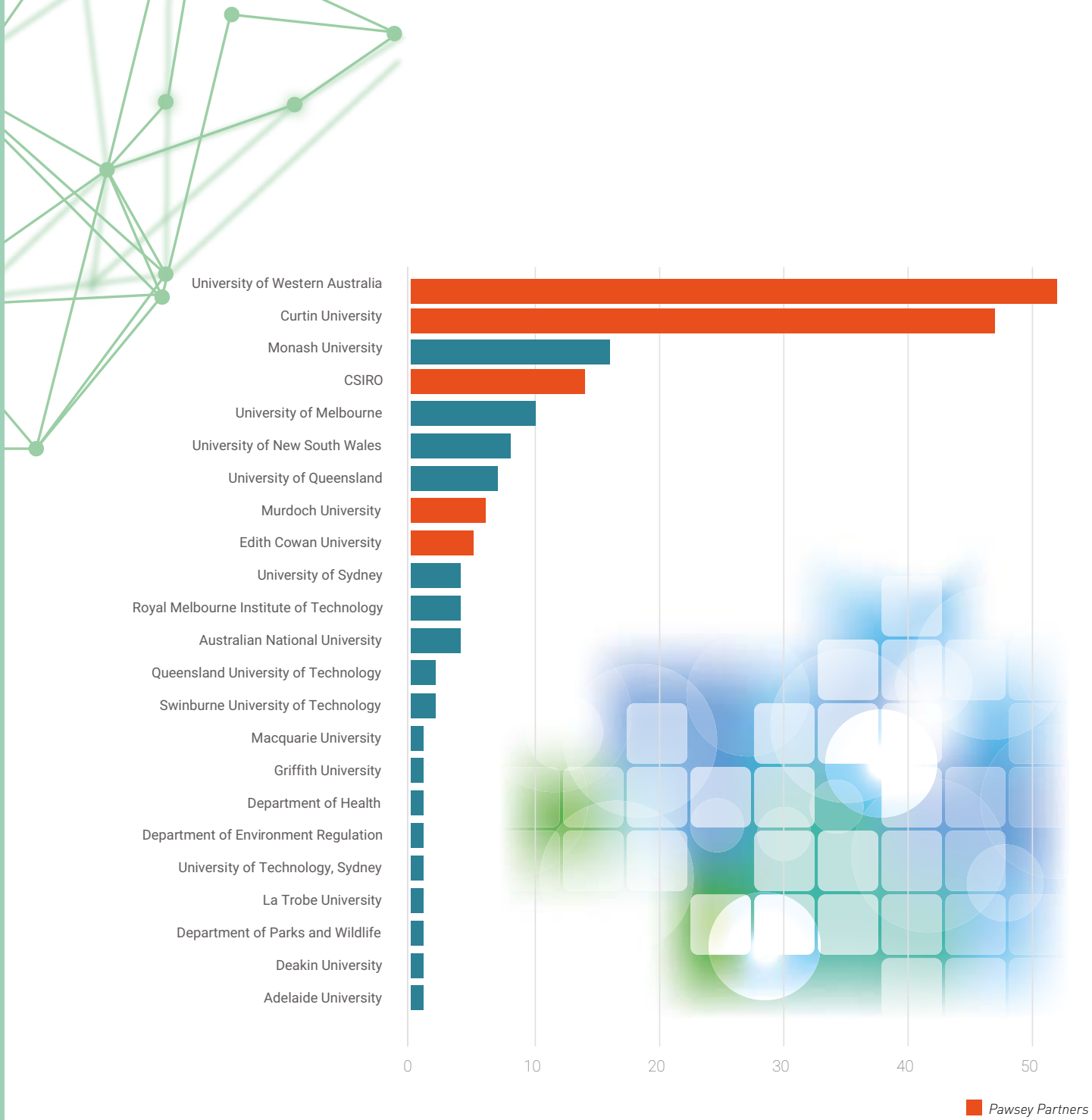
- access to supercomputers for provision of training courses;
- porting, evaluating and benchmarking software in anticipation of a subsequent competitive merit application;
- access for non-research purposes, such as generation of data products for researchers, or software development;
- access by government agencies;
- commercial access by industry; and
- extraordinary research, such as urgent assistance in civil emergencies.

The Director's Share comprises 5 percent of available compute time on Magnus. Director's Share projects also have access to the Zeus cluster and it is the only mechanism for access to Zythos. A typical Director's Share allocation on Magnus is 50 thousand core hours.

Approximately fifty Director's Share allocations were made during 2016-2017. The majority of these are to assist researchers migrate onto Pawsey supercomputers, and in particular perform compatibility tests and performance benchmarking in preparation for a competitive merit application.

Notable Director's Share allocations include Prof Sean Smith from the University of New South Wales, who was granted a 1,500,000 allocation from the Director's Share for urgent work towards a transformative electrocatalysis technology patent. Carnegie Wave Energy were allocated 350,000 core hours towards publishable research on their wave power design. DHI was allocated 830,000 core hours for their work on behalf of the Australian Maritime Safety Authority and Gold Coast Water.

IMAGE:
Professor Charitha Pattiaratchi, an oceanographer from The University of Western Australia, is using the Magnus supercomputer, via the Director's Share, to conduct oceanic drift modelling and predict the trajectory of aircraft debris from MH370. Utilising the world-class facilities at Pawsey, Prof Pattiaratchi is focusing on debris that washed up at Reunion Island, and tracing it back to its original location through ocean currents. Examining patterns of debris dispersal in the ocean will assist the search team investigators in locating the crash site with the aim to discover the whereabouts of flight MH370 on the ocean floor.


University of Western Australia
Curtin University
Monash University
CSIRO
University of Melbourne
University of New South Wales
University of Queensland
Murdoch University
Edith Cowan University
University of Sydney
Royal Melbourne Institute of Technology
Australian National University
Queensland University of Technology
Swinburne University of Technology
Macquarie University
Griffith University
Department of Health
Department of Environment Regulation
University of Technology, Sydney
La Trobe University
Department of Parks and Wildlife
Deakin University
Adelaide University
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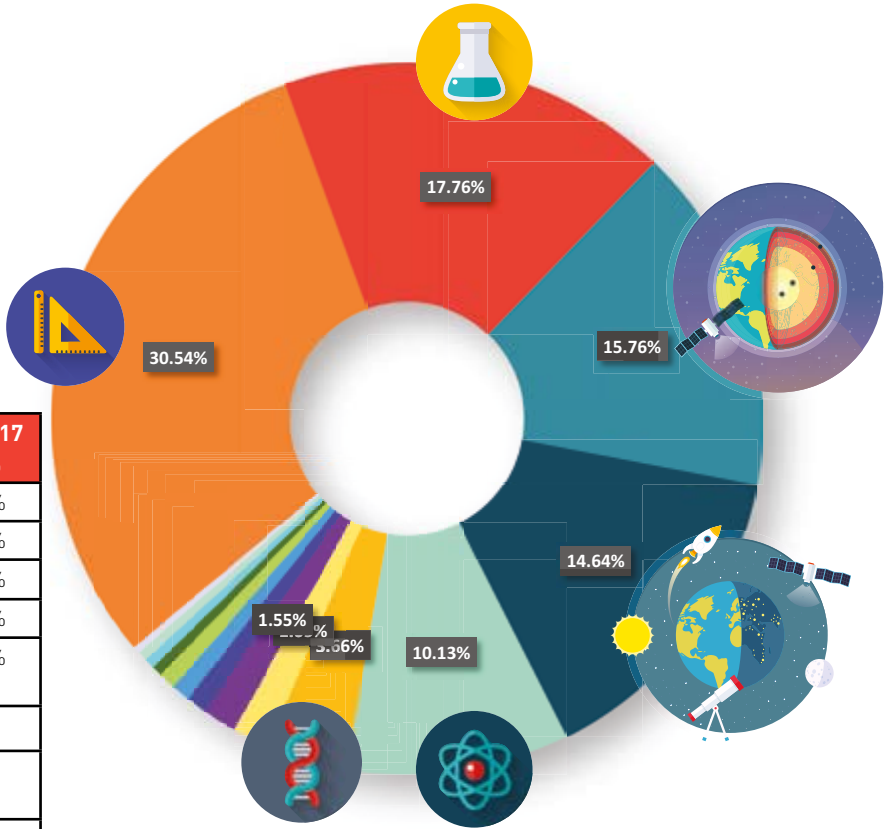
Pawsey Partners

2016 - 2017
USAGE OF SUPERCOMPUTERS



Area of science	2016-2017 usage	2015-2017 usage %
Engineering	90,711,496	30.54%
Chemical Sciences	52,744,034	17.76%
Geosciences	46,826,591	15.76%
Radioastronomy	43,495,395	14.64%
Physical Sciences (exc. radio astronomy)	30,092,639	10.13%
Biological Sciences	10,880,192	3.66%
Information & Computing Sciences	4,887,363	1.65%
Earth Sciences (exc. Geosciences)	4,619,030	1.55%
Technology	2,860,263	0.96%
Mathematical Sciences	2,495,583	0.84%
Environmental Sciences	2,327,077	0.78%
Medical & Health Sciences	1,423,287	0.48%
Pawsey Operations	1,410,486	0.47%
Agricultural And Veterinary Sciences	1,332,918	0.45%
History and Archaeology	934,350	0.31%
Built Environment and Design	4,264	0.00%

EXPERTISE

PAWSEY EXPERTISE

Pawsey has a dedicated team of more than 40 staff, including visualisation specialists, supercomputing experts, data analysts, executives and operational staff. Pawsey's international team of highly-regarded experts includes senior professors and doctors of various scientific fields, including radio astronomy, visualisation, programming, data-intensive science and cross-platform Strudel applications.

APPENDICES

APPENDIX 1: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Andrew Rohl	Realistic Modelling of the Effects of Solvent and Additives on Crystallisation	Curtin University	20,000,000	NCMAS	Magnus
Julian Gale	Atomistic simulation of minerals, materials and geochemistry	Curtin University	20,000,000	Partner	Magnus
Juan Carlos Guzman	ASKAP	CSIRO	19,031,040	Radio Astronomy	Galaxy
Igor Bray	Atomic Collision Theory	Curtin University	10,000,000	NCMAS	Magnus
Andrew Squelch	Geophysical subsurface modelling and imaging	Pawsey Supercomputing Centre	8,500,000	Energy and Resources	Magnus
Julian Gale	Atomistic Simulation for Geochemistry and Nanoscience	Curtin University	8,000,000	NCMAS	Magnus
Liang Cheng	On the prediction of extreme fluid loading and fluid-structure interaction	University of Western Australia	8,000,000	Energy and Resources	Magnus
Roman Pevzner	Seismic monitoring for CO_2 geosequestration: from survey design to quantitative interpretation	Curtin University	7,896,576	Energy and Resources	Magnus
Evatt Hawkes	Direct Numerical Simulations and Large Eddy Simulations of Turbulent Combustion	University of New South Wales	7,000,000	NCMAS	Magnus
Paolo Raiteri	Electro-crystallisation at the interface between two immiscible liquids	Curtin University	6,000,000	Partner	Magnus
Richard Sandberg	High-fidelity simulations of turbomachinery applications	University of Melbourne	5,700,000	NCMAS	Magnus
Yuan Mei	Equation of state and thermodynamics of hydrothermal-magmatic brines by molecular simulations	CSIRO	5,328,000	Energy and Resources	Magnus
Richard Sandberg	High-fidelity simulations for developing highly efficient and low-emission gas turbines	University of Melbourne	5,200,000	Energy and Resources	Magnus
Derek Leinweber	Electromagnetic Structure of Matter	Adelaide University	5,000,000	NCMAS	Magnus
Julio Soria	Investigation of the fluid dynamics and thermal performance of solar particle receivers using DNS	Monash University	5,000,000	Energy and Resources	Magnus
Jason Evans	Regional Climate Modelling in South-east Australia	University of New South Wales	4,400,000	NCMAS	Magnus
Sean Smith	First principle computational studies for new materials & methods in heterogeneous electrocatalysis	University of New South Wales	4,020,000	Energy and Resources	Magnus
Salvy Russo	Computational Materials Design of Excitonic Systems for Solar Energy Conversion	Royal Melbourne Institute of Technology	4,020,000	Energy and Resources	Magnus

2017

PI	Project Title	Institution	Total Allocation	Allocation	System
Vincent Wheatley	Scramjet-based Access-to-Space and Planetary Re-entry	University of Queensland	4,000,000	NCMAS	Magnus
Sean Smith	Computational Nanomaterials Science and Engineering	University of New South Wales	4,000,000	NCMAS	Magnus
Julio Soria	Investigations of transitional and turbulent shear flows using direct numerical simulations and large eddy simulations	Monash University	4,000,000	NCMAS	Magnus
Toby Potter	The Western Australian Modelling Project	University of Western Australia	4,000,000	Energy and Resources	Magnus
Ryan Lowe	Oceanographic Computational Fluid Dynamics Research	University of Western Australia	4,000,000	Partner	Magnus
James Hane	Bioinformatic analysis of agriculturally-important plants, pathogens and pests	Curtin University	4,000,000	Partner	Magnus
Irene Yarovsky	Theoretical Investigation of novel materials for industrial and biomedical applications	Royal Melbourne Institute of Technology	3,600,000	NCMAS	Magnus
Hugh Blackburn	High-Order Methods for Transitional and Turbulent Flows	Monash University	3,000,000	NCMAS	Magnus
Alan Mark	From molecules to cells - Understanding the structural and dynamic properties of cellular components	University of Queensland	3,000,000	NCMAS	Magnus
Suresh K. Bhatia	Interfacial Transport of Gases in Nanomaterials for Gas Separation and Storage Applications	University of Queensland	2,695,680	Energy and Resources	Magnus
Geoffrey Bicknell	Astrophysical Accretion Disks, Jets and Winds and Interactions with the Surrounding Medium	Australian National University	2,500,000	NCMAS	Magnus
Mohammednoor Altarawneh	Chemical Reactions Operating During Thermal Recycling of Brominated Plastics in e-waste	Murdoch University	2,500,000	Partner	Magnus
Abishek Sridhar	Development and Validation of Computational Framework for Oil-in-Water or Water-in-Oil Separation	Curtin University	2,500,000	Energy and Resources	Magnus
Mark Agostino	Structural basis of Wnt signalling pathway	Curtin University	2,500,000	NCMAS	Magnus
John Lattanzio	Convective nuclear burning in 3D - Fixing the weak link in stellar models	Monash University	2,400,000	NCMAS	Magnus
Ricardo Mancera	Molecular dynamics simulation of biophysical phenomena	Curtin University	2,100,000	Partner	Magnus
Huaiyu Yuan	Understanding continental lithosphere, its architecture and connection to surface mineral systems	University of Western Australia	2,100,000	Energy and Resources	Magnus

APPENDIX 1: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Tony Lucey	The Phenomenology of Unsteady Impinging Jets: Fluid Dynamics and Heat Transfer	Curtin University	2,100,000	Partner	Magnus
Toby Allen	Mechanisms of membrane-charge transport and ion channel function.	Royal Melbourne Institute of Technology	2,000,000	NCMAS	Magnus
Daniel Chung	Direct numerical simulation of wall-bounded and buoyancy-driven turbulent flows	University of Melbourne	2,000,000	NCMAS	Magnus
Hugh Wolgamot	Optimising operation and survivability of the CETO Wave Energy Converter through advanced modelling	University of Western Australia	1,820,160	Energy and Resources	Magnus
Mahreen Arooj	Characterisation of Lysozyme and hydrophobic anions at an Electrified Aqueous-Organic Interface	Curtin University	1,800,000	Partner	Magnus
Joshua Hollick	3D Reconstruction Processing for the HMAS Sydney (II) and HSK Kormoran 3D Imaging Project	Curtin University	1,800,000	Partner	Magnus
Alexander Heger	Fallback and Mixing in Supernovae from the Early Universe	Monash University	1,746,000	NCMAS	Magnus
Claudio Cazorla	Nanostructured multiferroic materials for efficient energy consumption in electronic devices	University of New South Wales	1,742,000	Energy and Resources	Magnus
Charitha Pattiaratchi	Developing better predictions for extreme water levels and waves around Australia	University of Western Australia	1,620,000	Partner	Magnus
Nikhil Medhekar	In Silico Design of Nanoscale Energy Materials	Monash University	1,560,000	Energy and Resources	Magnus
Evelyne Deplazes	Characterising the interactions of venom peptides with cell membranes and ion channels	Curtin University	1,504,512	Partner	Magnus
Tiffany Walsh	Development and application of bio/nano interfacial simulations	Deakin University	1,500,000	NCMAS	Magnus
Mohsen Talei	Prediction of sound generated by turbulent premixed flames	University of Melbourne	1,500,000	NCMAS	Magnus
Nigel Marks	Atomistic Modelling of Carbon Nanostructures	Curtin University	1,500,000	NCMAS	Magnus
Andreas Wicenec	Execution Framework prototyping and scaling for the SKA Science Data Processor	University of Western Australia	1,500,000	Partner	Magnus
Ben Mullins	Multiphase CFD Simulation of Aerosol Filtration Processes	Curtin University	1,500,000	NCMAS	Magnus

2017

PI	Project Title	Institution	Total Allocation	Allocation	System
Hans De Sterck	Advanced simulation methods for the coupled solar interior and atmosphere	Monash University	1,500,000	NCMAS	Magnus
Andrew Ooi	Computational Fluid Dynamics Studies of Buoyant Channel and Rough Pipe Flows	University of Melbourne	1,400,000	NCMAS	Magnus
Ravichandar Babarao	In silico design of robust porous materials for gas storage, separation and sensing harmful gases	CSIRO	1,400,000	Partner	Magnus
Erdinc Saygin	Seismic Characterisation of Large N Seismic Datasets	University of Western Australia	1,378,000	Energy and Resources	Magnus
Dave Edwards	Analysis of complex genomes	University of Western Australia	1,250,000	NCMAS	Magnus
Hongwei An	Effect of natural seabed on hydrodynamics around cylindrical structures	University of Western Australia	1,243,200	Energy and Resources	Magnus
Ben Corry	Simulation studies of biological and synthetic channels	Australian National University	1,200,000	NCMAS	Magnus
Lisa Harvey-Smith	ASKAP Early Science	CSIRO	1,072,000	NCMAS	Magnus
Mark Thompson	Transition, stability and control of bluff body flows	Monash University	1,000,000	NCMAS	Magnus
Christoph Federrath	Modelling the formation of galaxies, star clusters and binary-star systems	Australian National University	1,000,000	NCMAS	Magnus
Debra Bernhardt	New materials and fluids for catalysis, battery technologies and sensors.	University of Queensland	1,000,000	NCMAS	Magnus
Louis Moresi	Instabilities in the convecting mantle and lithosphere	University of Melbourne	1,000,000	NCMAS	Magnus
Cathryn Trott	Detection of the Epoch of Reionisation using the Murchison Widefield Array	Curtin University	1,000,000	Director	Magnus
Randall Wayth	MWA Science pre-processing	Curtin University	1,000,000	Director	Magnus
Laura Boykin	Global Food Security- Phylogenetics and Genome Assembly of the African cassava whitefly	University of Western Australia	1,000,000	Partner	Magnus
Daniel Price	Inhomogeneous cosmology in an anisotropic Universe	Monash University	1,000,000	NCMAS	Magnus
Lloyd Hollenberg	Multi-Million Atom Quantum Computer Device Simulations	University of Melbourne	1,000,000	NCMAS	Magnus
Andrew Grime	Advanced computing to transform design of offshore floating facilities	University of Melbourne	1,000,000	Energy and Resources	Magnus
Dietmar Mueller	Towards dynamic tectonic reconstructions	University of Sydney	1,000,000	NCMAS	Magnus

APPENDIX 1: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Nikhil Medhekar	Atomistic Simulations for Electronic, Chemical amd Mechanical Properties of Nanoscale Materials	Monash University	1,000,000	NCMAS	Magnus
Ricardo Mancera	Large scale molecular dynamics simulations of biomolecular systems	Curtin University	1,000,000	NCMAS	Magnus
Heather Sheldon	Geological simulation using MOOSE: applications to mineral exploration and CO_2 sequestration	CSIRO	980,000	Energy and Resources	Magnus
Ante Bilic	Computational design of new materials	CSIRO	900,000	Partner	Magnus
Chunsheng Lu	Novel plastic mechanisms at the nanoscale: an atomistic study	Curtin University	900,000	Partner	Magnus
Claudia Lagos	Exploring the parameter space of SURFS (Synthetic UniveRses for Future Surveys)	ICRAR	870,000	Partner	Magnus
Jatin Kala	Past and Future Climate Extremes in Western Australia	Murdoch University	864,000	NCMAS	Magnus
Claudio Cazorla	Nano-structured multifunctional materials for solid-state cooling	University of New South Wales	800,000	NCMAS	Magnus
Aijun Du	Nanomaterials for Energy, Nanoelectronics and Environmental Applications	Queensland University of Technology	800,000	NCMAS	Magnus
Mike Ford	Nanostructured anti-reflection coatings for LED applications	University of Technology, Sydney	800,000	NCMAS	Magnus
Rie Kamei	Full waveform inversion of complex seismic data sets	University of Western Australia	780,000	Energy and Resources	Magnus
Suresh Bhatia	Interfacial Barriers for the Transport of Nanoconfined Fluids	University of Queensland	750,000	NCMAS	Magnus
Ekaterina Pas	Development and Application of Quantum Chemistry Methods for the prediction of physicochemical properties	Monash University	750,000	NCMAS	Magnus
Pascal Elahi	Building Synthetic UniveRses for Surveys	University of Western Australia	750,000	NCMAS	Magnus
charlotte welker	Playing on the E-STRINGS: Effects of STReam INfall on Galactic Structure	University of Western Australia	725,000	NCMAS	Magnus
Cullan Howlett	SONGS - Simulations of Non-standard Gravity for Surveys	University of Western Australia	725,000	NCMAS	Magnus
Kerry Hourigan	Advanced Modelling of Biological Fluid Flows	Monash University	700,000	NCMAS	Magnus
Debra J Bernhardt	Computational chemistry for clean energy applications	University of Queensland	670,000	Energy and Resources	Magnus

2017

PI	Project Title	Institution	Total Allocation	Allocation	System
Feifei Tong	Effects of sharp edges on fluid-structure interactions	University of Western Australia	600,000	NCMAS	Magnus
Tara Hopley	Using genomics to assist conservation of Western Australia biodiversity	Department of Parks and Wildlife	600,000	Partner	Magnus
Chunyan Fan	Fundamental Study of Adsorption in Novel Micro- and Mesoporous Materials	Curtin University	576,000	Partner	Magnus
Ananthanarayanan Veeraragavan	Simulations of Microcombustion for Portable Power	University of Queensland	520,000	Energy and Resources	Magnus
Matthew Bellgard	Assembly of premium malting and wild barley genomes	Murdoch University	500,000	Partner	Magnus
Vishnu Pareek	Multiphase flow in process systems	Curtin University	500,000	Partner	Magnus
John Sader	Mapping the viscoelastic behaviour of simple liquids at ultra-high frequencies via large-scale molecular dynamics simulations	University of Melbourne	500,000	NCMAS	Magnus
Dino Spagnoli	Modelling surface processes on the oxide layer of AlGaN/GaN based sensors	University of Western Australia	483,840	Partner	Magnus
Michelle Spencer	New Molecules and Materials for Battery Electroytes and Electrodes	Royal Melbourne Institute of Technology	468,000	Energy and Resources	Magnus
Shahab Joudaki	Testing Gravity on Cosmic Scales with Weak Gravitational Lensing and Redshift Space Distortions	Swinburne University of Technology	450,000	NCMAS	Magnus
Ivica Janekovic	Data Assimilation for Western Australia using Regional Ocean Modelling System	University of Western Australia	420,000	Partner	Magnus
Cathryn Trott	Detection of the Epoch of Reionisation using the Murchison Widefield Array	Curtin University	412,877	Radio Astronomy	Galaxy
Randall Wayth	MWA Science pre processing	Curtin University	412,877	Radio Astronomy	Galaxy
Ben Thornber	Mix in high-acceleration implosions driven by multiple shocks	University of Sydney	400,000	NCMAS	Magnus
Erdinc Saygin	Multiscale Seismic Imaging of South East Asia	University of Western Australia	400,000	Partner	Magnus
Michelle Spencer	Modelling Nanoscale Materials for Sensing and Device Applications	Royal Melbourne Institute of Technology	400,000	NCMAS	Magnus
Paul Cally	Numerical modelling of MHD effects and sunspot interior structure and dynamics	Monash University	400,000	NCMAS	Magnus
Simon Driver	Spectral Energy Distribution Fitting for GAMA & WAVES	University of Western Australia	384,000	Partner	Magnus
Eric Moses	Statistical Genetic and Epidemiological Analyses for Complex Diseases	University of Western Australia	360,000	Partner	Magnus

APPENDIX 1: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Michael Dentith	3D Inversion of Magnetotelluric Data Applied to Exploration for Natural Resources - III	University of Western Australia	350,000	Energy and Resources	Magnus
David Schibeci	DHI compatibility pilot project	Pawsey Supercomputing Centre	830,000	Director	Magnus
Matthew Tuson	Statistical analysis and research conducted by the Centre for Applied Statistics (CAS), UWA 2017	University of Western Australia	302,320	Partner	Magnus
Ryan Mead-Hunter	Testing and validation of a CFD model for lung dosimetry	Curtin University	300,000	Partner	Magnus
Chris Power	How do stars shape the interstellar medium of galaxies?	University of Western Australia	300,000	Partner	Magnus
Craig O'Neill	Evolution of subduction systems in the Precambrian - Insights from ASPECT	Macquarie University	300,000	Energy and Resources	Magnus
Alan Aitken	Methodologies of geophysical inversion for Earth modelling and resource exploration	University of Western Australia	267,072	Energy and Resources	Magnus
Paula Moolhuijzen	High through detection of genes involved in wheat and fungal pathogen interactions	Curtin University	250,000	NCMAS	Magnus
Marcela Bilek	Harnessing the bioactivity of protein fragements and peptides	University of Sydney	250,000	NCMAS	Magnus
Brendan Kennedy	Discovering criteria for blood element differentiation using rigorous simulation	University of Western Australia	250,000	NCMAS	Magnus
Liangzhi Kou	Two-dimensional Layered van der Waals (vdWs) Heterostructures for Photovoltaic Application	Queensland University of Technology	250,000	NCMAS	Magnus
Tongming Zhou	Hydrodynamics of a truncated cylinder mounted on a plane wall in oscillatory flows	University of Western Australia	250,000	Partner	Magnus
Julien Cisonni	Modelling and prediction for tailored treatment of sleep-related breathing disorders	Curtin University	250,000	Partner	Magnus
Chunsheng Lu	Influence of impurities on mechanical properties of Sn anode materials for Li-ion batteries	Curtin University	250,000	Energy and Resources	Magnus
Zheng-Xiang Li	Plate Tectonics and Plume Dynmics – 4D Geodynamic Modelling	Curtin University	250,000	Partner	Magnus
Andrew King	Modelling and characterisation of a membrane based Wave Energy Converter	Curtin University	250,000	Partner	Magnus

2017

PI	Project Title	Institution	Total Allocation	Allocation	System
Weronika Gorczyk	Multi-scale four-dimensional large scale tectonics and genesis, transfer and focus of fluids	University of Western Australia	250,000	Energy and Resources	Magnus
Piotr Kowalczyk	Designing targeted carbon sieve structures for hydrogen isotope separation	Murdoch University	250,000	Partner	Magnus
George Milne	UWA Dengue Spread Model	University of Western Australia	250,000	Partner	Magnus
Katarina Miljkovic	Meteoroid impacts on the Earth and Mars	Curtin University	250,000	Partner	Magnus
Michael Kuhn	Ultra-High Resolution Topographic Gravity Modelling Over Australia	Curtin University	250,000	Partner	Magnus
Hongwei Wu	1-Modelling of LNG dispersion 2-Modelling of bio-oil/char slurry in a fluidized bed reactor	Curtin University	250,000	Partner	Magnus
Cormac Reynolds	High Angular Resolution Radio Astronomy with the LBA	CSIRO	250,000	Partner	Magnus
Martin Ebert	Optimisation of flat-panel imager for advanced radiotherapy treatment delivery verification	Health Department	250,000	Partner	Magnus
Yinong Liu	Exceptional properties by atomistic modelling of NiTi-Nb nanocomposites	University of Western Australia	250,000	Partner	Magnus
Liang Wang	High temporal and spatial resolution cosmological hydrodynamic zoom-in simulation suite	University of Western Australia	250,000	NCMAS	Magnus
Simon Illingworth	Reduced-order models of wall-bounded turbulence	University of Melbourne	250,000	NCMAS	Magnus
Attila Popping	IMAGINE: Imaging Galaxies Intergalactic and Nearby Environment	University of Western Australia	250,000	Partner	Magnus
Wei Wang	N-glycan profiling as a risk stratification biomarker for type 2 diabetes	Edith Cowan University	250,000	Partner	Magnus
Stefan Iglauer	Developing theoretical methods for finding contact angles & interfacial tensions using MD Simulation	Curtin University	250,000	Energy and Resources	Magnus
Aibing Yu	Simulation and Modelling of Particulate Systems	Monash University	250,000	Energy and Resources	Magnus
Rhodri Davies	From Plume Source to Hotspot	Australian National University	250,000	NCMAS	Magnus
Deidre Cleland	Stochastic optimisation of molecular geometries	CSIRO	250,000	NCMAS	Magnus

APPENDIX 1: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Randall Wayth	MWA Operations	Curtin University	206,438	Radio Astronomy	Galaxy
Mike Trefry	Multiphase and multicomponent modelling of petroleum hydrocarbons in the subsurface	CSIRO	100,000	Director	Magnus
Cindy Ong	RDS Data Ingestion and Processing Engine of Imaging Spectroscopy Hub (ISH) Project	CSIRO	100,000	Director	Magnus
Barry Doyle	Large scale haemodynamics	University of Western Australia	100,000	Director	Magnus
Parwinder Kaur	Applied Genomics: From conventional to next generation genetics	University of Western Australia	100,000	Director	Magnus
Scott Wilson	Multiomic approach to the study of complex multifactorial diseases	University of Western Australia	100,000	Director	Magnus
Drew Parsons	Modelling Complex Surfaces for Energy Storage, Mineral Processing and Oil Recovery	Murdoch University	100,000	Director	Magnus
Yun Wang	Molecuar Design of Lead-Free Perovskite Solar Cells	Griffith University	100,000	Director	Magnus
Judy Hart	Development of new inexpensive materials for efficient hydrogen production using solar energy	University of New South Wales	100,000	Director	Magnus
Klaus Regenauer-Lieb	Material instabilities using MOOSE	University of New South Wales	100,000	Director	Magnus
Robert Ong	Investigation of turbulent buoyant helium plume using OpenFOAM	University of Western Sydney	100,000	Director	Magnus
Christopher Leonardi	Determining the flow regime and pressure in CSG wells using the phase-field lattice Boltzmann method	University of Queensland	100,000	Director	Magnus
Michael Bunce	TrEnD Lab Bioinformatics - sequencing ancient and degraded DNA	Curtin University	100,000	Partner	Magnus
Peter Metaxas	Magnetic particle detection at the nanoscale	University of Western Australia	100,000	Partner	Magnus
Adrian Blockley	Potential Improvements in Dispersion Modelling with WRF: Application to the Collie Airshed	Department of Water and Environmental Regulation	100,000	Partner	Magnus
Alistair Forrest	Understanding gene expression and regulation in diagnosing human disease.	University of Western Australia	100,000	Partner	Magnus
Martin Meyer	DINGO and WALLABY post-processing at ICRAR	University of Western Australia	100,000	Partner	Magnus

2017

PI	Project Title	Institution	Total Allocation	Allocation	System
Richard Dodson	Imaging JVLA Data for CHILES	University of Western Australia	100,000	Partner	Magnus
Guang Xu	Diesel Particulate Matter Dispersion Analysis in Underground Mine by Using CFD Method	Curtin University	100,000	Partner	Magnus
Daniel Price	Phantom SPH code	Monash University	50,000	Director	Magnus
Ming Chiat Law	The Development of a Bioinspired Heavy Vehicle Drag Reduction Device	Curtin University	50,000	Director	Magnus
Lloyd Hollenberg	Large-scale Quantum Computer Simulations	University of Melbourne	50,000	Director	Magnus
Mehdi Khiadani	Numerical simulation of the turbulence properties of two-phase bubbly open channel flow	Edith Cowan University	50,000	Director	Magnus
Wensu Chen	Study of blast resistance capacity of basalt fibre strengthened structures	Curtin University	50,000	Director	Magnus
David Huang	Three Dimensional Tomographic Reconstruction of Rainfall Using Satellite Signals	University of Western Australia	50,000	Director	Magnus
Michael Vacher	Modelling plant breeding programs	University of Western Australia	50,000	Director	Magnus
Miles Sowden	Surface particulate matter concentration in the Pilbara using Himawari Remote Sensing	Edith Cowan University	50,000	Director	Magnus
Kaiming Bi	Using Pipe-in-Pipe (PIP) Concept to Mitigate Vortex Induced Vibration of Marine Tubular Structures	Curtin University	50,000	Director	Magnus
Bing Zhou	Parallel Algorithms for Solving Large-Scale Bioinformatics Problems on HPC Clusters	University of Sydney	50,000	Director	Magnus
Claire Trenham	CCAM regional climate model testing	CSIRO	20,000	Director	Magnus
Randall Wayth	MWA Operations	Curtin University	-	Director	Magnus

APPENDIX 2: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Juan Carlos Guzman	ASKAP	CSIRO	19,031,040	Radio Astronomy	Galaxy
Andrew Rohl	Biomimicry - A novel mechanism of ice inhibition by a small organic molecule	Pawsey	10,000,000	Director	Magnus
Julian Gale	Atomistic Simulation for Geochemistry and Nanoscience	Curtin University	7,000,000	NCMAS	Magnus
Evatt Hawkes	Direct Numerical Simulations of Turbulent Combustion	University of New South Wales	7,000,000	NCMAS	Magnus
Igor Bray	Atomic Collision Theory	Curtin University	6,250,000	NCMAS and Partner	Magnus
Damien Carter	Realistic Modelling of the Effects of Solvent and Additives on Crystal Growth	Curtin University	6,250,000	Partner	Magnus
Liang Cheng	On the prediction of extreme fluid loading on offshore structures	University of Western Australia	6,250,000	Geosciences and Parnter	Magnus
Amanda Barnard	Virtual Nanoscience	CSIRO	6,250,000	Partner	Magnus
Julian Gale	Atomistic simulation of minerals, materials and geochemistry	Curtin University	6,250,000	Geosciences and Partner	Magnus
Andrew Squelch	Geophysical subsurface modelling and imaging	Curtin University	6,000,000	Geosciences	Magnus
Roman Pevzner	Feasibility study of seismic monitoring strategies for purposes of CO_2 geosequestration	Curtin University	5,591,000	Partner	Magnus
Evatt Hawkes	Direct numerical simulations of turbulent lifted flames	University of New South Wales	5,000,000	Geosciences	Magnus
Dietmar Muller	Towards dynamic tectonic reconstructions	Sydney	4,500,000	NCMAS	Magnus
Toby Potter	The Western Australian Modelling Project	University of Western Australia	4,108,000	Geosciences	Magnus
Richard Sandberg	High-fidelity simulations of turbomachinery applications	Melbourne University	3,400,000	NCMAS	Magnus
Ryan Lowe	Oceanographic Computational Fluid Dynamics Research	University of Western Australia	3,200,000	Partner	Magnus
Alan Mark	From molecules to cells: Understanding the structural and dynamic properties of cellular components	University of Queensland	3,000,000	NCMAS	Magnus
Mark Agostino	Structural basis of Wnt signalling pathway	Curtin University	2,800,000	NCMAS and Partner	Magnus
Mahreen Arooj	Characterisation of Lysozyme at an Electrified Aqueous-Organic Interface	Curtin University	2,800,000	Partner	Magnus

2016

PI	Project Title	Institution	Total Allocation	Allocation	System
Linqing Wen	Australian Collaboration of Gravitational Wave Signal Processing	University of Western Australia	2,800,000	Partner	Magnus
Paolo Raiteri	Electro-crystallisation at the interface between two immiscible liquids	Curtin University	2,800,000	Partner	Magnus
Hugh Blackburn	High-Order Methods for Transitional and Turbulent Flows	Monash University	2,500,000	NCMAS	Magnus
Professor Julio Soria	Investigations of transitional and turbulent shear flows using direct numerical simulations	Monash University	2,500,000	NCMAS	Magnus
Geoffrey Bicknell	Astrophysical Accretion Disks, Jets and Winds and Interactions with the Surrounding Medium	Sydney	2,500,000	NCMAS	Magnus
Jeffrey Shragge	Computational modelling, imaging and inversion of 3D/4D seismic wavefields	University of Western Australia	2,500,000	Geosciences	Magnus
Irene Yarovsky	Theoretical Investigation of novel materials for industrial and biomedical applications	Royal Melbourne University Institute of Technology	2,400,000	NCMAS	Magnus
Simon Campbell	Convective nuclear burning in 3D - Fixing the weak link in stellar models	Monash University	2,400,000	NCMAS	Magnus
Sean Smith	Computational Nanomaterials Science and Engineering	University of New South Wales	2,400,000	NCMAS	Magnus
Tom Lyons	Past and Future Temperature Extremes and Vegetation in Western Australia	Murdoch University	2,400,000	Partner	Magnus
Yuan Mei	Molecular dynamics simulations of gold speciation in ore fluids	CSIRO	2,100,000	Geosciences	Magnus
Daniel Chung	Direct numerical simulation of wall-bounded and buoyancy-driven turbulent flows	Melbourne University	2,000,000	NCMAS	Magnus
Andrew Ooi	Computational Fluid Dynamics Studies of Bluff Body and Heat Transfer in a Buoyant Channel	Melbourne University	2,000,000	NCMAS	Magnus
Jason Evans	Regional Climate Modelling in South-east Australia	University of New South Wales	2,000,000	NCMAS	Magnus
Ricardo Mancera	Large scale molecular dynamics simulations of macrobiomolecular complexes	Curtin University	2,000,000	Partner	Magnus
Sean Smith	Computational Materials Design For Energy Applications	University of New South Wales	1,930,000	Geosciences	Magnus
Sergiy Shelyag	Radiative magneto-hyrdrodynamic modelling of interconnected solar interior and atmosphere	Monash University	1,800,000	NCMAS	Magnus

APPENDIX 2: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Louis Moresi	Instabilities in the convecting mantle and lithosphere - Underworld	Melbourne University	1,800,000	NCMAS	Magnus
Huaiyu Yuan	Multiple scale seismic structural inversion in Australia and global continents	University of Western Australia	1,736,000	Geosciences	Magnus
Alexander Heger	The Last Minutes of Oxygen Shell Burning in Supernova Progenitors	Monash University	1,600,000	NCMAS	Magnus
Weihua Liu	Molecular dynamics simulations of gold in ore fluid	CSIRO	1,600,000	Geosciences	Magnus
Vincent Wheatley	Performance Enhancement in Access-to-space Scramjets	University of Queensland	1,500,000	NCMAS	Magnus
Matthew Bellgard	Comparative genomics of barley varieties	Murdoch University	1,500,000	Partner	Magnus
Tongming Zhou	Numerical simulations of flow-structure interaction	University of Western Australia	1,500,000	Partner	Magnus
Assoc. Prof Ramesh Narayanaswamy	The Phenomenology of Unsteady Impinging Jets: Fluid Dynamics and Heat Transfer	Curtin University	1,500,000	Partner	Magnus
Dr Milinkumar T. Shah	Multiphase flow in process systems	Curtin University	1,500,000	Partner	Magnus
Chris Power	Large-Scale Simulations for Future Galaxy Surveys	University of Western Australia	1,500,000	Partner	Magnus
Claudia Lagos	Getting Gas into Galaxies from the Cosmic Web	University of Western Australia	1,500,000	Partner	Magnus
Charitha Pattiaratchi	Developing better predictions for extreme water levels and waves around Australia	University of Western Australia	1,500,000	Partner	Magnus
Abishek Sridhar	Development and Validation of Computational Framework for Oil-in-Water or Water-in-Oil Separation	Curtin University	1,500,000	Geosciences	Magnus
Suresh Bhatia	Transport of Nanoconfined Fluids in Gas and Electrochemical Energy Storage Applications	University of Queensland	1,417,000	Geosciences	Magnus
Tiffany Walsh	Development and application of bio/nano interfacial simulations	Deakin University	1,200,000	NCMAS	Magnus
Derek Leinweber	Electromagnetic Structure of Matter	Adelaide University	1,200,000	NCMAS	Magnus
Ben Corry	Simulation studies of biological and synthetic channels	Australian National University	1,200,000	NCMAS	Magnus
Nigel Marks	Modelling of Nuclear Materials and Carbon Nanostructures	Curtin University	1,100,000	NCMAS	Magnus
Neha Gandhi	Characterisation of structural features of intrinsically disordered proteins	Curtin University	1,060,000	Partner	Magnus
Christoph Federrath	Modelling the formation of galaxies, star clusters and binary-star systems	Australian National University	1,000,000	NCMAS	Magnus

2016

PI	Project Title	Institution	Total Allocation	Allocation	System
Professor Kerry Hourigan	Advanced Modelling of Biological Fluid Flows	Monash University	1,000,000	NCMAS	Magnus
Laura Boykin	African and Australian whiteflies: outbreak causes and sustainable solutions (Magnus)	University of Western Australia	1,000,000	Partner	Magnus
Joshua Hollick	3D Reconstruction Processing for the HMAS Sydney (II) and HSK Kormoran 3D Imaging Project	Curtin University	1,000,000	Partner	Magnus
Chunsheng Lu	An atomistic perspective on strengthening materials by nanoscale stacking faults	Curtin University	1,000,000	Partner	Magnus
Nikhil Medhekar	Atomistic Simulations for Electronic, Chemical amd Mechanical Properties of Nanoscale Materials	Monash University	1,000,000	NCMAS	Magnus
Ricardo Mancera	Large scale molecular dynamics simulations of biomolecular systems	Curtin University	1,000,000	NCMAS	Magnus
Scott Draper	High End Computational Modelling of CETO Wave Energy Converter	University of Western Australia	998,000	Geosciences and Partner	Magnus
Erdinc Saygin	Multiscale Seismic Imaging of South East Asia	Australian National University	946,000	Geosciences	Magnus
Mark Thompson	Transition, stability and control of bluff body flows	Monash University	900,000	NCMAS	Magnus
Shahab Joudaki	Testing Gravity on Cosmic Scales with Weak Gravitational Lensing and Redshift Space Distortions	Swinburne	900,000	NCMAS	Magnus
Mohsen Talei	Prediction of sound generated by turbulent premixed flames	Melbourne University	900,000	NCMAS	Magnus
Paul Cally	Numerical modelling of MHD effects and sunspot interior structure and dynamics	Monash University	900,000	NCMAS	Magnus
Heather Sheldon	Geological simulation using MOOSE: understanding ore deposits and aiding mineral exploration	CSIRO	850,000	Geosciences and Partner	Magnus
Claudio Cazorla	First-principles investigation of nanostructured multiferroic materials	University of New South Wales	800,000	NCMAS	Magnus
Ryan Mead-Hunter	Development and Validation of Large-Scale CFD Simulations of the Respiratory Tracts	Curtin University	800,000	NCMAS and Partner	Magnus
Rie Kamei	Full waveform inversion of large complex seismic data sets	University of Western Australia	800,000	Geosciences and Partner	Magnus
Andreas Wicenec	A Data-Driven Approach to Data-Intensive Astronomy on HPC Clusters	University of Western Australia	800,000	Partner	Magnus
Mohammednoor Altarawneh	Fundamental Understanding of the Role of Singlet Molecular Oxygen in Spontaneous fires	Murdoch University	800,000	Partner	Magnus

APPENDIX 2: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Dr James Hane	Genome analysis of plants, pathogen and pests relevant to wheat, lupin and other legumes.	Curtin University	800,000	Partner	Magnus
Lisa Harvey-Smith	ASKAP Early Science	CSIRO	750,000	NCMAS and Partner	Magnus
Christoph Arns	Integration of conventional and digital core analysis	University of New South Wales	750,000	NCMAS	Magnus
Hongwei An	Effect of natural seabed on hydrodynamics around cylindrical structures	University of Western Australia	750,000	Partner	Magnus
Debra Bernhardt	New materials and fluids for catalysis, battery technologies and sensors	University of Queensland	700,000	NCMAS	Magnus
Sebastien Allgeyer	Development of a better physics behind the tsunami modelling and coastal infrastructure behaviour	Australian National University	700,000	NCMAS	Magnus
Julien Cisonni	Modelling and prediction for tailored treatment of sleep-related breathing disorders	Curtin University	700,000	Partner	Magnus
Benjamin Mullins	Multiphase Filter CFD Simulation	Curtin University	700,000	Partner	Magnus
Debra J Bernhardt	Computational chemistry for clean energy applications	University of Queensland	670,000	Geosciences	Magnus
Matthew Tuson	Statistical analysis and research conducted by the Centre for Applied Statistics (CAS), UWA 2016	University of Western Australia	629,000	Partner	Magnus
Pascal Elahi	SSimPL-ACS The Survey Simulation PipeLine - Alternative Cosmologies Study	Sydney	600,000	NCMAS	Magnus
Ben Thornber	Mix in high-acceleration implosions driven by multiple shocks	Sydney	600,000	NCMAS	Magnus
David Gildfind	Simulation of hypersonic flows in expansion tubes	University of Queensland	600,000	NCMAS	Magnus
Eric Moses	Statistical Genetic and Epidemiological Analyses for Complex Diseases	University of Western Australia	600,000	Partner	Magnus
Kane O'Donnell	Computational x-ray absorption spectroscopy for materials science	Curtin University	600,000	Partner	Magnus
Dino Spagnoli	Modelling surface processes on the oxide layer of AlGaN/GaN based sensors	University of Western Australia	564,000	Partner	Magnus
Toby Allen	Mechanisms of charge-membrane interactions and transport.	Royal Melbourne University Institute of Technology	500,000	NCMAS	Magnus

2016

PI	Project Title	Institution	Total Allocation	Allocation	System
Chunsheng Lu	First-principles study on the mechanical properties of Li-Sn alloys for Li-ion battery anodes	Curtin University	500,000	Geosciences and Partner	Magnus
Chris Power	ZING: a suite of cosmological Zoom-IN simulations of smauG	University of Western Australia	500,000	Partner	Magnus
Rhodri Davies	From Plume Source to Hotspot	Australian National University	500,000	NCMAS	Magnus
Michelle Spencer	New Molecules and Materials for Battery Electroytes and Electrodes	Royal Melbourne University Institute of Technology	473,000	Geosciences	Magnus
Zheng-Xiang Li	4D Global Geodynamic Modeling	Curtin University	472,000	Partner	Magnus
Andrew King	Characterisation and power prediction for a novel Wave Energy Converter	Curtin University	462,000	Partner	Magnus
Jimmy Philip	A numerical investigation of entrainment in turbulent buoyant jets	Melbourne University	450,000	NCMAS	Magnus
Hongwei An	The Drag Crisis on a Subsea Pipeline	University of Western Australia	432,000	Geosciences and Partner	Magnus
Cathryn Trott	Detection of the Epoch of Reionisation using the Murchison Widefield Array	Curtin University	412,877	Radio Astronomy	Galaxy
Randall Wayth	MWA Science pre-processing	Curtin University	412,877	Radio Astronomy	Galaxy
Aijun Du	Nanomaterials for Energy, Nanoelectronics and Environmental Applications	Queensland University of Technology	400,000	NCMAS	Magnus
Grant Morahan	Genetic Signatures in Complex Human Diseases	University of Western Australia	400,000	Partner	Magnus
Ravichandar Babarao	Understanding how to make porous materials robust for energy applications	CSIRO	400,000	Partner	Magnus
Michelle Spencer	Modelling Nanoscale Materials for Sensing and Device Applications	Royal Melbourne University Institute of Technology	400,000	NCMAS	Magnus
Chris Power	Lurking in the Darkness: Intermediate Mass Black Holes in Low-Mass Galaxies	University of Western Australia	375,000	Partner	Magnus
Michael Dentith	3D Inversion of Magnetotelluric Data Applied to Exploration for Natural Resources - II	University of Western Australia	350,000	Geosciences and Partner	Magnus
Megan O'Mara	Investigating membrane protein dynamics, substrate recognition and transport	Australian National University	300,000	NCMAS	Magnus
Chunyan Fan	Mechanisms of Adsorption in Novel Mesoporous Materials and the Characterisation	Curtin University	288,000	Partner	Magnus

APPENDIX 2: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Alan Aitken	Methodologies for large-scale gravity/ magnetic inversion	University of Western Australia	256,000	Geosciences and Partner	Magnus
Rudi Appels	Collaborative project for wheat gene annotation and analysis	Murdoch University	250,000	Director	Magnus
Paula Moolhuijzen	Tan spot genomics high throughput analysis	Curtin University	250,000	NCMAS	Magnus
Ingo Jahn	Supercritical CO_2 Turbomachinery and Heat Exchangers	University of Queensland	250,000	NCMAS	Magnus
Marcela Bilek	Harnessing the bioactivity of protein fragments and peptides	Sydney	250,000	NCMAS	Magnus
Peter Munro	Evaluation of three widely used biomedical optical imaging techniques	University of Western Australia	250,000	Partner	Magnus
Liangzhi Kou	Two-dimensional Layered van der Waals (vdWs) Heterostructures for Photovoltaic Application	Queensland University of Technology	250,000	NCMAS	Magnus
Klaus Regenauer-Lieb	Rock instabilities using MOOSE	University of New South Wales	250,000	Geosciences	Magnus
Weronika Gorczyk	Multi-scale four-dimensional large scale tectonics and genesis, transfer and focus of fluids	University of Western Australia	250,000	Geosciences and Partner	Magnus
Chenghua Sun	Computer-aided bio-inspired catalysts for hydrogen production	Monash University	250,000	Geosciences	Magnus
Piotr Kowalczyk	Designing targeted carbon sieve structures for hydrogen isotope separation	Murdoch University	250,000	Partner	Magnus
Aaron Davis	Mcmc methods for NMR and AEM geophysical methods	CSIRO	250,000	Partner	Magnus
Dave Edwards	Analysis of complex genomes	University of Western Australia	250,000	Partner	Magnus
George Milne	UWA Dengue Spread Model	University of Western Australia	250,000	Partner	Magnus
Mervyn Lynch	Numerical Modelling of Environmental Systems	Curtin University	250,000	Partner	Magnus
Katarina Miljkovic	Modelling of high-speed impact bombardment with applications to terrestrial and planetary geophysics	Curtin University	250,000	Partner	Magnus
Drew Parsons	Subtle quantum mechanical forces of ions in solution.	Murdoch University	250,000	Partner	Magnus
Deidre Cleland	Stochastic optimisation of molecular geometries	CSIRO	250,000	NCMAS	Magnus

2016

PI	Project Title	Institution	Total Allocation	Allocation	System
Stephen Powles	ARC Linkage Project Gene identification for metabolism-based herbicide resistance in Lolium rigidum	University of Western Australia	217,000	Partner	Magnus
Craig Pennell	Western Australian Pregnancy (Raine) Cohort and the Preterm Birth Genome Project - Magnus	University of Western Australia	210,000	Partner	Magnus
Randall Wayth	MWA Operations	Curtin University	206,438	Radio Astronomy	Galaxy
Kym Ottewell	Genomics of West Australian flora	DPAW	200,000	Director	Magnus
Mike Ford	Nanostructured anti-reflection coatings for LED applications	UTS	200,000	NCMAS	Magnus
Drew Parsons	Modelling Complex Electrolytic Liquors for Energy Storage and Mineral Processing	Murdoch University	200,000	Partner	Magnus
Judith Lichtenzveig	Genomics and evolution of fungal pathogens of grain legume crops	Curtin University	200,000	Partner	Magnus
Professor Hongwei Wu	1-Modelling of LNG dispersion 2-Modelling of bio-oil/char slurry in a fluidised bed reactor	Curtin University	200,000	Partner	Magnus
Siqi Zhang	Tracking mantle slab dewatering using ASPECT	Macquarie	200,000	Geosciences	Magnus
Lloyd Hollenberg	Large-scale Quantum Computer Simulations	University of Sydney	150,000	Director	Magnus
Cormac Reynolds	High Angular Resolution Radio Astronomy with the LBA	Curtin University	150,000	Partner	Magnus
Artur Deditius	Behaviour of noble metals in semiconducting sulphides	Murdoch University	125,000	Partner	Magnus
Professor Martin Ebert	Development and Characterisation of Online Detector for Advanced Radiotherapy Treatment Verification	University of Western Australia	125,000	Partner	Magnus
Dr Andrew King	Mechanical Engineering Honours Projects	Curtin University	100,000	Director	Magnus
Dong Wang	Dynamic simulation of impacts on pipeline by submarine landslide with material point method	University of Western Australia	100,000	Director	Magnus
Michael Black	Establishing a standard analysis protocol for genomic analysis of rare diseases		100,000	Director	Magnus
Dr Andrew King	Data Centre Cooling By Using CFD	Curtin University	100,000	Director	Magnus
Richard Harper	Simulating the coupling relationship between water and carbon	Murdoch University	100,000	Director	Magnus
Ben Mullins	Greater Curtin Busway Air Quality Project	Curtin University	100,000	Director	Magnus
Mehdi Jangi	Large Eddy Simulation (LES) of compartments fire	Murdoch University	100,000	Director	Magnus

APPENDIX 2: SUPERCOMPUTING PROJECTS LIST

PI	Project Title	Institution	Total Allocation	Allocation	System
Michael Kuiper	Benchmarking Molecular dynamics code.	Melbourne University	100,000	Director	Magnus
Simon Allen	Renderman on a Cray	Pawsey	100,000	Director	Magnus
Cindy Ong	RDS Data Ingestion and Processing Engine of Imaging Spectroscopy Hub (ISH) Project	CSIRO	100,000	Director	Magnus
Ivica Janekovic	Data Assimilation for Western Australia using Regional Ocean Modelling System (ROMS)	University of Western Australia	100,000	Director	Magnus
Andrew Rohl	CIC Application Support	Curtin University University	100000	Director	Magnus
Andrew King	Modelling of Fluid-Induced Seismicity	CSIRO	100,000	Partner	Magnus
Michael Bunce	TrEnD laboratory bioinformatics	Curtin University	100,000	Partner	Magnus
Simon Driver	Spectral Energy Distribution Fitting for GAMA	University of Western Australia	100,000	Partner	Magnus
Michael Kuhn	Ultra-High Resolution Topographic Gravity Modelling Over Australia	Curtin University	100,000	Partner	Magnus
Scott Wilson	Genetic and epigenetic factors with a role in the aetiology of common complex disease	University of Western Australia	100,000	Partner	Magnus
Hongwei Wu	1-Modelling of LNG dispersion 2-Modelling of bio-oil/char slurry in a fluidised bed reactor	Curtin University	100,000	Partner	Magnus
Peter Metaxas	Dynamic nanodetectors for magnetic nanoparticles	University of Western Australia	100,000	Partner	Magnus
David Antoine	Australian Regional Environmental Remote Sensing	Curtin University	100,000	Partner	Magnus
Jingbo Wang	Quantum PageRanking	University of Western Australia	100,000	Partner	Magnus
Andrea Paparini	The microbiome of Australia's source water	Murdoch University	100,000	Partner	Magnus
David Mackey	De Novo Genome Assembly of Unique Australian Species	Murdoch University	100,000	Partner	Magnus
Kenji Bekki	Global warming of galactic disks in cosmological simulations	University of Western Australia	100,000	Partner	Magnus
Gabriel Keeble-Gagnere	Wheat chromosome 7A, whole-genome and post-genomics annotation and analysis	Murdoch University	100,000	Partner	Magnus
Yinong Liu	Exceptional properties by atomistic modelling of NiTi-Nb nanocomposites	University of Western Australia	100,000	Partner	Magnus
Evatt Hawkes		University of New South Wales	100,000	Director	Magnus
Charlotte Oskam	Uncovering the microbiome of Australian ticks	Murdoch University	75,000	Partner	Magnus

2016

PI	Project Title	Institution	Total Allocation	Allocation	System
Parwinder Kaur	Subterranean clover GENOMICS platform	University of Western Australia	75,000	Partner	Magnus
David A Mackey	De Novo Assembly of Wombat Genome	University of Western Australia	50,000	Director	Magnus
Yinong Liu	Micro mechanics of Shape Memory Alloys: Nanoreinforced Composites	University of Western Australia	50,000	Director	Magnus
Cuong Van Nguyen	The molecular structure of the vacuum/water interface of aqueous micro-droplet	Curtin University	50,000	Director	Magnus
Daniel Grimwood	QChem compilation/installation	Pawsey	50,000	Director	Magnus
Stefan Iglauer	Developing theoretical methods for finding contact angles & interfacial tensions using MD Simulation	Curtin University	50,000	Director	Magnus
Ryan Loxton	Large-scale Optimisation Models in Offshore Energy Projects	Curtin University	50,000	Director	Magnus
Selam Ahderom	Weed Sensing and Identification Through Computer Vision	Edith Cowan University	50,000	Director	Magnus
Jin Wang	Data Mining for Smart Water Meter Data Analysis	University of Western Australia	50,000	Director	Magnus
Mike Trefry	Multi-phase and multi-component modelling of petroleum hydrocarbons in the subsurface	CSIRO	50,000	Director	Magnus
Daniel Price	Phantom SPH code	Monash University	50,000	Director	Magnus
Guang Xu	Diesel Particulate Matter Dispersion Analysis in Underground Mine by Using CFD Method	Curtin University	50,000	Director	Magnus
Victor Calo	Scalable Parallel Direct Solvers for Energy Applications	Curtin University	50,000	Director	Magnus
Lifen Chen	ARC Industrial Transformation Research Hub for Offshore Floating Facilities	University of Western Australia	50,000	Director	Magnus
Mohsin Ahmed Shaikh	Multiscale Simulations of coupled arterial cells	Pawsey	50,000	Director	Magnus
Ming Chiat Law	The Development of a Bioinspired Heavy Vehicle Drag Reduction Device	Curtin University	50,000	Director	Magnus
Christopher Harris	SKA Science Data Processor Workpackage	Pawsey	50,000	Director	Magnus
David Annetts	Bayesian Lithological Inversion	CSIRO	50,000	Partner	Magnus
Carlo Pacioni	Applying coalescent-based genetic simulations to the conservation of endangered species	Murdoch University	50,000	Partner	Magnus

APPENDIX 3: DATA PROJECTS LIST

Project Name	PI Institution	Data Created	Allocation TB	Used TB	Usage %
ACCWI	Murdoch University	20-Jun-17	50	0.2	0.5
ANLEC passive seismic research project	University of Western Australia	11-Nov-14	98	97.8	99.8
ASKAP Commissioning Data	CSIRO	7-Oct-14	1500	1215.8	81.1
Advanced Imaging in Archaeology	University of Western Australia	25-Jul-14	5.5	5.2	94.3
Arecibo Ultra Deep Survey	University of Western Australia	30-Oct-14	80	47.2	59
Atom Probe Tomography	Curtin University	3-Dec-15	20	0	0
Barley	Curtin University	26-Feb-15	12	11.3	94.3
Breakthrough	Swinburne University	9-Mar-17	1000	0	0
CHILES Survey	University of Western Australia	9-Jul-14	24	23.6	98.2
CT Scan Data	CSIRO	9-Feb-15	40	38.4	96
DFN	Curtin University	29-Jul-14	1500	1211.6	80.8
DPaW Imagery	DPAW	11-Jul-14	40	36.6	91.5
DynResImmuno	Telethonkids	27-Sep-17	5	0.2	3.9
FANTOM-ENCODE	ICHR	25-Aug-17	10	4.1	41.3
GLEAM	ICRAR	2-Sep-15	100	46.3	46.3
GMRT Data	ICRAR	5-Dec-14	64	47.6	74.4
GSWA_Geophysics	Western Australian Department of Mines, Industry Regulation and Safety (DMP)	4-Jul-14	1.1	1	89.3
Genomics on Fungal Plant Pathogens	CSIRO	1-Aug-14	16	15.2	94.8
HAP	CSIRO	6-May-16	5	0.1	1.3
Helicobacter	University of Western Australia	9-Aug-17	5	0	0
Human Genomic Data for Complex Traits	University of Western Australia	21-Aug-14	70	67	95.8
Hydrographic Survey Data	Western Australian Department of Transport	28-Jul-15	25	19.6	78.6
IslandWakes	SESE	10-Jul-15	30	12.4	41.3
MHSI_CU	Curtin University	26-Feb-16	5	0	0
MHSI_DPaW	Western Australian Department of Biodiversity, Conservation and Attractions/ Parks and Wildlife service (DPAW)	4-Mar-16	10	0	0
MHSI_UWA	University of Western Australia	10-Aug-16	50	0	0
MODIS L1B Archive	Curtin University	11-Nov-14	170	169.7	99.8

2016-2017

Project Name	PI Institution	Data Created	Allocation TB	Used TB	Usage %
MREO	CSIRO	3-Oct-14	40	39.4	98.5
MWA Gleam Image Archive	University of Western Australia	3-Jul-14	11	11	99.8
Mira Canning Stock Route Project Archive	FORM	11-Jul-14	2	1.5	73.6
NGS Analysis Results	University of Western Australia	22-Apr-15	200	137.2	68.6
Nearshore Research Facility Data	University of Western Australia	12-Jan-15	54	38.8	71.8
Open_Basins	CSIRO	9-Mar-17	10	0	0.2
PMCP	CSIRO	30-Jul-14	50	44.5	89
Phospholipid Bilayers	Deakin University	18-Jul-14	7	6.9	98.2
Phylogenetic Trees	University of Western Australia	9-Jul-14	18	6.7	37.2
Plant Energy Biology	University of Western Australia	20-Aug-14	60	40.7	67.8
Pulsar Scintillometry	Chalmers	15-Sep-15	80	37.7	47.1
SB_AD	University of Western Australia	9-May-16	50	0	0
SWWA Downscaled Climate	Murdoch University	9-Sep-14	530	463.2	87.4
Seismic	University of Western Australia	12-Aug-16	110	23.8	21.6
Subterranean Clover	University of Western Australia	5-May-15	15	9.4	62.9
Surface Reflectance Data	Curtin University	14-Aug-14	43	42.8	99.5
Trial Observations of the Galactic Centre	University of Western Australia	6-Aug-14	24	23.7	98.7
VLBI	Curtin University	11-Jul-14	115	99.1	86.2
WA Node Ocean Data Network	Pawsey Supercomputing Centre	4-Jul-14	60	55.9	93.1
WACopernicus	Landgate	15-Mar-17	275	103	37.4
WAMSI_DSN_Private	Pawsey Supercomputing Centre	1-Feb-16	6	3.2	53
WAVES	The University of Western Australia	21-Mar-16	50	45.2	90.4
Weedvision	Edith Cowan University (ECU)	13-Jul-17	5	0.4	8.3
Wheat Improvement	Edith Cowan University (ECU)	6-Aug-14	15	11.9	79.2
ASKAP-craft	CSIRO	10-Aug-17	1260	0	0
Oraloncology	University of Western Australia	2-Jun-17	10	0	0

APPENDIX 4: OUTREACH

Category	Event/Organisation	No. of Attendees	Date
STEM/ Community	June Community tour	19	28/06/2017
International	Chevron Tour: Stuart Payne	2	27/06/2017
National	Metamorflix tour	3	20/06/2017
STEM	St Marys tour	24	13/06/2017
State	Murchison Elders Visit	6	8/06/2017
International/ Government	US businesses visit WA	11	8/06/2017
STEM	Excursion Cape Naturaliste College	30	7/06/2017
STEM/Community	May Community Tour	20	31/05/2017
International	ICRAR International Media tour	3	30/05/2017
STEM	TAFE Tours	7	30/05/2017
National	Mineral Resources Advisory Council tour	10	25/05/2017
STEM	Wesley College	25	24/05/2017
International	Chilean delegation coming with CSIRO	6	18/05/2017
State	Curtin Corporate Relations Tour	40	12/05/2017
State	BDW: Pawsey Cloud Service "Nimbus" Launch	45	12/05/2017
State	BDW: Big Data from Space: Update (Landgate)	52	12/05/2017
State	BDW: Bright Cluster 8 Capabilities on Machine Learning, Ceph, Hadoop and High Performance Computing (Dell EMC)	18	11/05/2017
STEM	Pawsey User Training - Tour	13	10/05/2017
State/ Government	Minister Dave Kelly	2	8/05/2017
State	BDW Media Call	1	8/05/2017
State	BDW Launch: Discussion Panel	30	8/05/2017
STEM/ Community	April Community Tour	15	26/04/2017
STEM/ Community	Special School Holidays Tour	12	12/04/2017
State	Pawsey Friday featuring Dr Selam Ahderom, from Edith Cowan University	39	31/03/2017
Industry/ Government/ International	Carolyn MacGregor and Prof Hugh Dawkins	3	31/03/2017
International	SKA Board and David Luchetti	5	28/03/2017
International	StudyPerth/Curtin University Chinese bloggers and interns students	9	27/03/2017
State	CEDA Trustee meeting	6	15/03/2017
STEM/ Community	Monthly Tours for the community	12	22/02/2017
State	Dr Debra Cousins and Ian Loftus	2	21/02/2017
STEM	PULSE@Parkes	31	21/02/2017

Category	Event/Organisation	No. of Attendees	Date
State/ Partner	Pawsey Roadshow at Murdoch University	10	15/02/2017
State	Pawsey Training February	11	15/02/2017
National engagement	National Pawsey Roadshow Hobart	40	9/02/2017
State	Pawsey Friday featuring Desert Fireball Network (DFN) from Curtin University	40	3/02/2017
National engagement	National Pawsey Roadshow Brisbane, Melbourne and Adelaide	40	2/02/2017
International	New Zealand University and Government Study tour	18	2/02/2017
STEM/ Community	Monthly Tours for the community	12	25/01/2017
State/ Partner	Summer internship presentations	25	11/01/2017
National	CSIRO CASS Summer Students from around Australia	4	11/01/2017
Industry	James Pearce - Young Engineers	3	9/12/2016
State	Curtin University Council Members	8	7/12/2016
International	The Acting U.S. Ambassador (Chargé d'Affaires) Jim Caruso and Consul General	7	6/12/2016
National	BCCVL Training workshop	50	1/12/2016
STEM/ Community	Monthly Tours for the community	12	30/11/2016
Industry	SMS management and technologies	18	30/11/2016
International	Republic of Korea Ambassador-designate	4	28/11/2016
International	WA Korea Energy and Resources Business Forum (WAKER) tour	16	17/11/2016
STEM	Morley School	10	10/11/2016
Industry	Am Cham Innovation Mission Tour	35	10/11/2016
International	Pietro Baracchi Conference tour- CSIRO ASKAP	90	3/11/2016
Industry	CEDA Trustee Luncheon	21	2/11/2016
International	NERSC visitors - USA	3	25/10/2016
International	Laura's team tour – Brazil and Indonesia	4	21/10/2016
International	Tour for lawyers from the Australian and New Zealand law firms	18	7/10/2016
International	ICRAR visitors from Thailand	5	30/09/2016
Community	First monthly tour after Open Day	16	28/09/2016
STEM	CoderDojo Ninja tour	8	26/09/2016
National	Tour of Pawsey for Kim Scheele and Henry Kleeman	2	9/09/2016
International	DFAT High Commissioner for South Africa tour	2	9/09/2016
State	Ian Loftus - WA State Government	1	6/09/2016
International	Consul General's visit	12	30/08/2016
International	Visit by Phil Diamond and Giovanni Bignami	4	30/08/2016

Category	Event/Organisation	No. of Attendees	Date
National	Minister Craig Laundy	7	25/08/2016
Community	Pawsey Open Day	300	20/08/2016
Industry	Innovate Australia Presentation	14	15/08/2016
National	Andrea Bedini computational scientists NCI	6	11/08/2016
Industry	Horizon Power Tour	5	10/08/2016
State	ANDS tech talks	2	5/08/2016
Industry	Bunnings IT team tour	16	3/08/2016
National	Visit of the Chief Scientist	5	25/07/2016
International	SKA SDP Tour		20/07/2016
State	ANDS tech talks tour 1 ECU librarians	15	8/07/2016
National	CSIRO Tour	2	6/07/2016
	Total	1422	

APPENDIX 5: PUBLICATIONS

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Abdurakhmanov IB	Wave-packet continuum-discretisation approach to ion-atom collisions: Nonrearrangement scattering	Physical Review A	Aug-16	Online & print	Physical Sciences	2.925
Abdurakhmanov IB	Accurate solution of the proton-hydrogen three-body scattering problem	Journal of Physics B-Atomic Molecular and Optical Physics	2016	Online & print	Physical Sciences	1.792
Abdurakhmanov IB	Solution of the proton-hydrogen scattering problem using a quantum-mechanical two-centre convergent close-coupling method	Journal of Physics B-Atomic Molecular and Optical Physics	2016	Online & print	Physical Sciences	1.792
Abishek S	Influence of Contact Angle Dynamics on Interaction between Mist Droplets and Isolated Cylindrical Fibres	Journal of Molecular Recognition	2016	Online	Engineering	2.175
Aitken, A.R.A	Australia's lithospheric density field, and its isostatic equilibration	Geophysical Journal International	2015	Online & print	Earth Sciences	2.484
Alicai, T	Cassava brown streak virus has a rapidly evolving genome: implications for virus speciation, variability, diagnosis and host resistance	Scientific Reports		Online & print	Biological Sciences	4.259
Anderson, D	Genome-wide association study of IgG1 responses to the choline-binding protein PspC of Streptococcus pneumonia	Genes and Immunity		Online & print	Biological Sciences	2.524
Anderson JP	Proteomic analysis of Rhizoctonia solani identifies infection-specific, redox associated proteins and insight into adaptation to different plant hosts	Molecular & Cellular Proteomics	2016	Online & print	Biological Sciences	6.54
Anderson JP	Mass-spectrometry data for Rhizoctonia solani proteins produced during infection of wheat and vegetative growth	Data in Brief		Online & print	Biological Sciences	
Andrys. J	Regional climate projections of mean and extreme climate for the southwest of Western Australia (1970–1999 compared to 2030–2059)	Climate Dynamics		Online & print	Earth Sciences	4.146
Andrys, J	Evaluation of a WRF Ensemble using GCM Boundary Conditions to Quantify Mean and Extreme Climate for the Southwest of Western Australia (1970-1999)	International Journal of Climatology		Online	Earth Sciences	3.76
Andrys, J	Multi-decadal Evaluation of WRF Downscaling Capabilities Over Western Australia in Simulating Rain- fall and Temperature Extremes	Journal of Applied Meteorology and Climatology		Online	Earth Sciences	2.365

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Avazbaev SK	Polarisation of Lyman-emission in proton-hydrogen collisions studied using a semiclassical two-centre convergent close-coupling approach	Physical Review A	2016	Online & print	Physical Sciences	2.925
Bailey J	Antiproton stopping power data for radiation therapy simulations	Physica Medica	2016	Online & print	Physical Sciences	1.99
Beall A.P	Dripping or Delamination? A Range of Mechanisms for Removing the Lower Crust or Lithosphere	Geophysical Journal International		Online & print	Earth Sciences	2.414
Beardsley AP	First Season MWA EoR Power Spectrum Results at Redshift 7	Astrophysical Journal		Online	Radio astronomy	5.533
Bentel J.M	Erdheim-Chester disease associated with a novel, complex BRAF p.Thr599_Vl600delinsArgGlu mutation	British Medical Journal Case Reports	2017	Online	Medical and Health Sciences	
Bray AW	Solving close-coupling equations in momentum space without singularities II	Communications in Computational Physics	2016	Online & print	Physical Sciences	2.004
Bray I	Internal consistency in the close-coupling approach to positron collisions with atoms	The European Physical Journal	2016	Online & print	Physical Sciences	
Bristow J	Free energy of ligand removal in the metal-organic framework UiO-66	Journal of Physical Chemistry C	2016	Online & print	Chemical Sciences	4.536
Bristow JK	A general forcefield for accurate phonon properties of metal-organic frameworks	Physical Chemistry Chemical Physics	2016	Online & print	Chemical Sciences	4.123
Brugger J	A review of the coordination chemistry of hydrothermal systems, or do coordination changes make ore deposits?	Chemical Geology	2016	Online & print	Earth Sciences	3.347
Brune, S	Abrupt plate accelerations shape rifted continental margins	Nature	2016	Online & print	Earth Sciences	40.137
Burt, R	Capacitance of nanoporous carbon-based supercapacitors is a trade-off between the concentration and the separability of the ions	Journal of Physical Chemistry Letters	2016	Online	Engineering	9.353
Burt, R	Molecular dynamics simulations of the influence of drop size and surface potential on the contact angle of ionic-liquid droplets	Journal of Physical Chemistry C	2016	Online & print	Radio astronomy	4.536
Callingham	Extragalactic Peaked-Spectrum Radio Sources at Low Frequencies	Astrophysical Journal		Online	Radio astronomy	5.533
Campbell, I. H	The rise of the continental crust	Earth and Planetary Science Letters	2016	Online & print	Earth Sciences	4.409

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Cantinotti M	Three-dimensional printed models in congenital heart disease	The International Journal of Cardiovascular Imaging	2016	Online & print	Medical and Health Sciences	
Carrion-Castillo A	Evaluation of results from genome-wide studies of language and reading in a novel independent dataset	Genes Brain and Behavior	Jul-16	Online & print	Biological Sciences	3.743
Charlton M	Heating due to momentum transfer in low-energy positronium-antiproton scattering	Physical Review A	Sep-16	Online & print	Physical Sciences	2.925
Cheng, L	Effect of wave boundary layer on hydrodynamic forces on small diameter pipelines	Ocean Engineering		Online & print	Engineering	1.894
Christiaens, I	Two novel genetic variants in the mineralocorticoid receptor gene associated with spontaneous preterm birth	BMC Medical Genetics		Online	Medical and Health Sciences	2.198
Corbett, M. S. P	Revisiting the scissor-like mechanism of activation for the erythropoietin receptor	FEBS letters	2016	Online	Chemical Sciences	3.623
Cuellar-Partida, G	WNT10A exonic variant increases the risk of keratoconus by decreasing corneal thickness	Human Molecular Genetics		Online & print	Medical and Health Sciences	5.167
Davies, D. R	The mantle wedge's transient 3-D flow regime and thermal structure	Geochemistry, Geophysics, Geosystems		Online	Earth Sciences	3.201
Deditius A.P.	Constraints on the solid solubility of Hg, Tl, and Cd in arsenian pyrite	American Mineralogist		Online & print	Chemical Sciences	2.021
de la Pierre M	Structure and dynamics of water at step edges on the calcite (10-14) surface	Crystal Growth & Design	2016	Online	Earth Sciences	4.055
Denman ZJ	Supersonic Combustion of Hydrocarbons in a Shape-Transitioning Hypersonic Engine	Proceedings of the Combustion Institute	2016	Online & print	Engineering	3.214
Denman ZJ	Ignition Experiments of Hydrocarbons in a Mach 8 Shape-Transitioning Scramjet Engine	Journal of Propulsion and Power	2016	Online & print	Engineering	1.144
Deplazes, E	Membrane-binding properties of gating modifier and pore-blocking toxins: Membrane interaction is not a prerequisite for modification of channel gating	Biochimica et Biophysica Acta (BBA)-Biomembranes	29/04/2016	Online & print	Chemical Sciences	3.498
Drori R	A Supramolecular Ice Growth Inhibitor	Journal of the American Chemical Society	2016	Online & print	Chemical Sciences	13.858

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Dutkiewicz, A	Controls on the distribution of deep-sea sediments	Geochemistry, Geophysics, Geosystems		Online	Earth Sciences	3.201
Dutkiewicz, A	Vigorous deep-sea currents cause global anomaly in sediment accumulation in the Southern Ocean	Geology		Online & print	Earth Sciences	4.635
Fabrikant II	Near-threshold behaviour of positronium-antiproton scattering	Physical Review A	Jul-16	Online & print	Physical Sciences	2.925
Fan Q	Childhood gene-environment interactions and age-dependent effects of genetic variants associated with refractive error and myopia: The CREAM Consortium	Scientific Reports	May-16	Online & print	Medical and Health Sciences	4.259
Farmahini, A.H	Effect of Structural Anisotropy and Pore-Network Accessibility on Fluid Transport in Nanoporous Ti3SiC2 Carbide-Derived Carbon	Carbon	2016	Print	Chemical Sciences	6.337
Felix JF	Genome-wide association analysis identifies three new susceptibility loci for childhood body mass index	Human Molecular Genetics	Jan-16	Online & print	Medical and Health Sciences	5.34
Feng et al	A Matched Filter Technique for Slow Radio Transient Detection and First Demonstration with the Murchison Widefield Array	Astronomical Journal		Online	Radio astronomy	2.609
Flasche S	The Long-Term Safety, Public Health Impact, and Cost-Effectiveness of Routine Vaccination with a Recombinant, Live-Attenuated Dengue Vaccine (Dengvaxia): A Model Comparison Study	PLoS Medicine		Online	Medical and Health Sciences	11.862
Foley RC	Reactive oxygen species play a role in the infection of the necrotrophic fungi, Rhizoctionia solani in wheat	PLoS ONE		Online	Biological Sciences	2.806
Fraser PR	Structure of 23 Al from a multi-channel algebraic scattering model based on mirror symmetry	Journal of Physics G: Nuclear and Particle Physics	2016	Online & print	Physical Sciences	2.899
Fraser PR	Importance of resonance widths in low-energy scattering of weakly bound light-mass nuclei	Physical Review C	Sep-16	Online & print	Physical Sciences	3.82
Fursa DV	Calculations of electron-impact ionisation of Fe25+ and Fe24+	Journal of Physics B-Atomic Molecular and Optical Physics	2016	Online & print	Physical Sciences	1.792

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Ganne, J	Statistical petrology reveals a link between supercontinents cycle and mantle global climate	American Mineralogist		Online & print	Physical Sciences	2.021
Garcia-Bloj, B	Waking up dormant tumor suppressor genes with zinc fingers, TALEs and the CRISPR/ dCas9 system	Oncotarget	2016	Online	Medical and Health Sciences	5.1683
George et al	A study of halo and relic radio emission in merging clusters using the Murchison Widefield Array	Monthly Notices of the Royal Astronomical Society		Online & print	Radio astronomy	4.961
Gilligan R	Leaching of brannerite in the ferric sulphate system. Part 2: Mineralogical transformations during leaching	Hydrometallurgy		Online & print	Physical Sciences	2.605
Golicz AA	The pangenome of an agronomically important crop Brassica oleracea	Nature Communications		Online	Biological Sciences	12.124
Hane JK	A comprehensive draft genome sequence for lupin (Lupinus angustifolius), an emerging health food: Insights into plant-microbe interactions and legume evolution	Plant Biotechnology Journal		Online	Biological Sciences	7.443
Harb, L.H	Computational site-directed mutagenesis studies of the role of the hydrophobic triad on substrate binding in cholesterol oxidase	Proteins: Structure, Function and Bioinformatics	May-17	Online	Biological Sciences	2.289
Hassan, R.	A rapid burst in hotspot motion through the interaction of tectonics and deep mantle flow	Nature		Online & print	Earth Sciences	40.137
Hedjazian, N.	Age independent seismic anisotropy under oceanic plates explained by strain history in the asthenosphere	Earth and Planetary Science Letters	2016	Online & print	Earth Sciences	4.409
Heng, Y. J	Albumin decrease is associated with spontaneous preterm delivery within 48 h in women with threatened preterm labor	Journal of Proteome Research	457-66	Online & print	Medical and Health Sciences	4.268
Henriques, S. T.	Interaction of Tarantula Venom Peptide ProTx-II with Lipid Membranes Is a Prerequisite for Its Inhibition of Human Voltage-gated Sodium Channel Na(V)1.7	Journal of Biological Chemistry	Aug-16	Online	Biological Sciences	4.125
Heywood, I	Wide-field broadband radio imaging with phased array feeds: a pilot multi-epoch continuum survey with ASKAP-BETA	Monthly Notices of the Royal Astronomical Society		Online & print	Radio astronomy	4.961
Hinney A	Evidence for three genetic loci involved in both anorexia nervosa risk and variation of body mass index	Molecular Psychiatry	May-16	Online & print	Medical and Health Sciences	13.204

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Hirakawa H	Draft genome sequence of subterranean clover, a reference for genus Trifolium	Nature Scientific Reports		Online	Biological Sciences	
Hirt, C.	Topographic gravity modelling for global Bouguer maps to degree 2160: Validation of spectral and spatial domain forward modelling techniques at the 10 microGal level	Journal of Geophysical Research: Solid Earth		Online	Engineering	3.35
Hopkins, A. M	The ASKAP/EMU Source Finding Data Challenge	Publications of the Astronomical Society of Australia		Online & print	Radio astronomy	4.095
Horikoshi M	Genome-wide associations for birth weight and correlations with adult disease	Nature		Online & print	Medical and Health Sciences	40.137
Hosseinpour, M.	Tectonic evolution of Western Tethys from Jurassic to present day: coupling geological and geophysical data with seismic tomography models	International Geology Review		Online & print	Earth Sciences	2.262
Hurley-Walker et al	GaLactic and Extragalactic All-sky Murchison Widefield Array (GLEAM) survey I: A low-frequency extragalactic catalogue	Monthly Notices of the Royal Astronomical Society		Online & print	Radio astronomy	4.961
Jiang, H	Three-dimensional direct numerical simulation of wake transitions of a circular cylinder	Journal of Fluid Mechanics		Online	Engineering	2.821
Jiang, H	Stable state of mode A for flow past a circular cylinder	Physics of Fluids		Online	Engineering	2.232
Jiang, H	Two- and three-dimensional instabilities in the wake of a circular cylinder near a moving wal	Journal of Fluid Mechanics		Online	Engineering	2.821
Johnston, S	Science with the Australian Square Kilometre Array Pathfinder	Publications of the Astronomical Society of Australia		Online & print	Radio astronomy	4.095
Jones, T. J.	Do mantle plumes preserve the heterogeneous structure of their deep-mantle source	Earth and Planetary Science Letters		Online & print	Earth Sciences	4.409
Kadyrov AS	TOPICAL REVIEW: Recent progress in the description of positron scattering from atoms using the convergent close-coupling theory	Journal of Physics B-Atomic Molecular and Optical Physics	2016	Online & print	Physical Sciences	1.792
Kaja, K.	Three-dimensional numerical simulations of vortex-induced vibrations of tapered circular cylinders	Applied Ocean Research		Online & print	Chemical Sciences	1.596

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Kang X	Suppression of instabilities in a premixed methane–air flame in a narrow channel via hydrogen/carbon monoxide addition	Combustion and Flame	2016	Online & print	Engineering	3.663
Kaniewska P	Transcriptomic changes in coral holobionts provide insights into physiological challenges of future climate and ocean change	PLoS ONE		Online	Earth Sciences	2.806
Kapinska et al	Spectral energy distribution and radio halo of NGC253 at low radio frequencies	Astrophysical Journal		Online	Physical Sciences	5.533
Kaur P	An advanced reference genome of Trifolium subterraneum L. reveals genes related to agronomic performance	Plant Biotechnology Journal		Online	Biological Sciences	7.443
Kaur P	Climate clever clovers: New paradigm for reducing environmental footprint of ruminants by tracking haplotype variation to breed low methanogenic forage crops	Frontiers in Plant Science		Online	Biological Sciences	4.298
Kellermeier M	Entropy drives calcium car-bonate ion association	ChemPhysChem	2016	Online	Chemical Sciences	3.075
Kheifets AS	Attosecond Time Delay in Photoemission and Electron Scattering near Threshold	Physical Review Letters	Sep-16	Online & print	Physical Sciences	8.462
Kim MS	Rapid prototyping	Circulation		Online & print	Engineering	3.544
Kinene, T	Rooting Trees, Methods for	Encyclopedia of Evolutionary Biology		Online & print	Biological Sciences	N/A
Kitsios V	Direct numerical simulation of a self-similar adverse pressure gradient turbulent boundary layer	International Journal of Heat And Fluid Flow	2016	Online & print	Engineering	1.873
Knipping J.L	Giant Kiruna-type deposits form by efficient aggregation of magmatic magnetite suspensions	Geology		Online & print	Chemical Sciences	4.635
Knipping J.L	Trace element distribution in magnetite as key to a new magmatic-hydrothermal model for Kiruna-type iron oxide-apatite deposits	Geochimica et Cosmochimica Acta		Online & print	Chemical Sciences	4.609
Kreiner E	Shared genetic variants suggest common pathways in allergy and autoimmune diseases	Journal of Allergy and Clinical Immunology	Feb-17	Online	Biological Sciences	13.081
Krisman A	Characterisation of two-stage ignition in diesel engine-relevant thermochemical conditions using direct numerical simulation	Combustion and Flame	2016	Online & print	Engineering	3.663
Krisman A	A direct numerical simulation of cool-flame affected autoignition in diesel engine-relevant conditions	Proceedings of the Combustion Institute	2017	Online & print	Engineering	3.214 (2016)

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Krisman A	Autoignition and edge flames in a turbulent jet at diesel engine relevant thermochemical conditions	Journal of Fluid Mechanics	Apr-17	Online	Engineering	2.821 (2016)
Kuhn, M	Topographic gravitational potential up to second-order derivatives: an examination of approximation errors caused by rock-equivalent topography (RET)	Journal of Geodesy		Online & print	Engineering	2.943
Landsberg WO	Characteristics of cascaded fuel injectors within an accelerating scramjet combustor	AIAA	2016	Online & print	Engineering	1.638
Leckie, S.H.F.	Unlocking the benefits of long-term pipeline-embedment processes: Image analysis-based processing of historic survey data	Journal of Pipeline Systems Engineering and Practice	2016	Online & print	Engineering	1.17
Lee HT	The genome of a southern hemisphere seagrass species (Zostera muelleri)	Plant Physiology	2016	Online & print	Biological Sciences	6.456
Lestinsky M	Physics book: CRYRING@ESR	The European Physical Journal Special Topics	2016	Online & print	Physical Sciences	1.862
Liu, L	Interfacial Resistance and Length-Dependent Transport Coefficients in Carbon Nanotubes	Journal of Physical Chemistry C	2016	Online & print	Engineering	4.536
Liu W	Arsenic in hydrothermal apatite: oxidation state, mechanism of uptake, and comparison between experiments and nature	Geochimica et Cosmochimica Acta	2017	Online & print	Earth Sciences	4.609 (2016)
Lynch et al	154 MHz detection of faint, polarised flares from UV Ceti	Astrophysical Journal Letters		Online	Radio astronomy	5.522
Lynch et al	A search for circularly polarised emission from young exoplanets	Monthly Notices of the Royal Astronomical Society	2016	Online & print	Radio astronomy	4.961
Mahdi	Matter in the Beam: Weak Lensing, Substructures, and the Temperature of Dark Matter	The Astrophysical Journal	2016	Online	Earth Sciences	5.533
Mallard, C	Subduction controls the distribution and fragmentation of Earth's tectonic plates	Nature	2016	Online & print	Earth Sciences	40.137
Marouli E	Rare and low-frequency coding variants alter human adult height	Nature	Feb-17	Online & print	Medical and Health Sciences	40.137
Matthews, K.J	Global plate boundary evolution and kinematics since the late Paleozoic	Global and Planetary Change	Oct-16	Online & print	Earth Sciences	3.915
Matthews, K. J	Oceanic microplate formation records the onset of India–Eurasia collision	Earth and Planetary Science Letters	2016	Online & print	Earth Sciences	4.409

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
McConnell, D	The Australian Square Kilometre Array Pathfinder: Performance of the Boolardy Engineering Test Array	Publications of the Astronomical Society of Australia	Sep-16	Online & print	Radio astronomy	4.095
McDonald MC	Utilising gene tree variation to identify candidate effector genes in Zymoseptoria tritici	G3-Genes Genomes Genetics	2016	Online	Biological Sciences	2.861
McSweeney	Low Frequency Observations of the Subpulse Drifter PSR J0034–0721 with the Murchison Widefield Array	Astrophysical Journal		Online	Radio astronomy	5.533
Mei Y	The dissociation mechanism and thermodynamic properties of HCl(aq) in hydrothermal fluids (25-700 ºC, 1-60k bar) by ab initio molecular dynamics simulations	Geochimica et Cosmochimica Acta	Mar-17	Online & print	Earth Sciences	4.609
Mei Y	Speciation and thermodynamic properties of zinc in sulfur-rich hydrothermal fluids: insights from ab initio molecular dynamics simulations and X-ray absorption spectroscopy	Geochimica et Cosmochimica Acta	2016	Online & print	Earth Sciences	4.609
Middeldorp CM	A Genome-Wide Association Meta-Analysis of Attention-Deficit/Hyperactivity Disorder Symptoms in Population-Based Pediatric Cohorts	Journal of the American Academy of Child and Adolescent Psychiatry	Oct-16	Online & print	Medical and Health Sciences	6.442
Montenegro JDM	Assessing the pangenome of modern hexaploid bread wheat	Plant Journal	Feb-17	Online & print	Biological Sciences	5.901
Moradi, N.	Two-dimensional numerical study on the effect of water depth on resonance behaviour of the fluid trapped between two side-by-side bodies	Applied Ocean Research	2016	Online & print	Physical Sciences	1.596
Müller B	The Status of Multi-Dimensional Core-Collapse Supernova Models	Publications of the Astronomical Society of Australia	2016	Online & print	Radio astronomy	4.095
Müller B	The Last Minutes of Oxygen Shell Burning in a Massive Star	The Astrophysical Journal	2016	Online	Radio astronomy	5.533
Müller, R.D	Ocean Basin Evolution and Global-Scale Plate Reorganisation Events Since Pangea Breakup	Annual Review of Earth and Planetary Sciences	2016	Online & print	Earth Sciences	9.78
Müller, R. D.	The GPlates Portal: Cloud-Based Interactive 3D Visualisation of Global Geophysical and Geological Data in a Web Browser	PLoS ONE	2016	Online	Earth Sciences	2.806
Müller, R. D.	Formation of Australian continental margin highlands driven by plate–mantle interaction	Earth and Planetary Science Letters	2016	Online & print	Earth Sciences	4.409

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Murphy et al	Low frequency spectral energy distributions of radio pulsars detected with the Murchison Widefield Array	Publications of the Astronomical Society of Australia		Online & print	Radio astronomy	4.095
Murphy et al	A search for long-timescale, low-frequency radio transients	Monthly Notices of the Royal Astronomical Society		Online & print	Radio astronomy	4.961
Nanjundan, A.K.	Sodium-ion Storage Properties of Graphene Oxide Reduced by Metals	Electrochemistry Acta	2016	Online & print	Chemical Sciences	0.816
Olson IA	Structure, Energetics, and Dynamics of Screw Dislocations in Even n-Alkane Crystals	Journal of Physical Chemistry Letters	2016	Online	Chemical Sciences	9.353
Pappa, I.	A genome-wide approach to children's aggressive behavior: The EAGLE consortium	American Journal of Medical Genetics Part B-Neuropsychiatric Genetics		Online & print	Medical and Health Sciences	3.258
Parmar PG	International Genome-Wide Association Study Consortium Identifies Novel Loci Associated With Blood Pressure in Children and Adolescents	Circulation-Cardiovascular Genetics	Jun-16	Online & print	Medical and Health Sciences	4.743
Perrin, A.	Reconciling mantle wedge thermal structure with arc lava thermobarometric determinations in oceanic subduction zones	Geochemistry, Geophysics, Geosystems	2016	Online	Earth Sciences	3.201
Pevzner, R.	Stage 2C of the CO2CRC Otway project: seismic monitoring operations and preliminary results	Energy Procedia		Online	Earth Sciences	1.07
Pina-varas, P.	Magnetotelluric Data from the Eastern Capricorn Orogen, Western Australia: An Example of Widespread Out-of-Quadrant Phase Responses	Geophysical journal International		Online & print	Earth Sciences	2.414
Pitchford LC	LXCat: an Open-Access, ¨Web-Based Platform for Data Needed for Modelling Low Temperature Plasmas	Plasma Processes and Polymers	2016	Online & print	Physical Sciences	2.846
Poger, D.	Validating lipid force fields against experimental data: Progress, challenges and perspectives	Biochimica et Biophysica Acta (BBA)-Biomembranes	Feb-16	Online & print	Chemical Sciences	2.8
Procopio	A high resolution foreground model for the MWA EoR1 field: model and implications for EoR power spectrum analysis	Publications of the Astronomical Society of Australia		Online & print	Radio astronomy	4.095
Qin K	Development of a computational tool to simulate foil bearings for supercritical CO_2 cycles	Journal of Engineering for Gas Turbines and Power	2016	Online & print	Engineering	1.534

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Qin K	Effect of Operating Conditions on the Elasto-Hydrodynamic Performance of Foil Thrust Bearings for Supercritical CO_2 Cycles	Journal of Engineering for Gas Turbines and Power	2016	Online & print	Engineering	1.534
Qin K	Development of a fluid-structure model for gas-lubricated bump-type foil thrust bearings	Applied Mechanics and Materials	Aug-16	Online & print	Engineering	0.16
Rawlins CM	Calculation of antihydrogen formation via antiproton scattering with excited positronium	Physical Review A	Jan-16	Online & print	Physical Sciences	2.925
Reich M	New advances in trace element geochemistry of ore minerals and accessory phases	Ore Geology Reviews	2017	Online & print	Earth Sciences	3.095
Reich M	The trace element signature of pyrite from Los Colorados iron oxide apatite (IOA) deposit: a missing link between IOA and IOCG deposit?	Economic Geology	2016	Online & print	Earth Sciences	2.519
Reischl B	Can point defects in surfaces in solution be atomically resolved by Atomic Force Microscopy?	Physical Review Letters	2016	Online & print	Physical Sciences	8.462
Rey, P. F.	The origin of contractional structures in extensional gneiss domes.	Geology	Jun-17	Online & print	Earth Sciences	4.635
Salles, T	Badlands: A parallel basin and landscape dynamics model	SoftwareX	Aug-16	Online	Earth Sciences	1.753
Salles, T	Badlands: An open source, flexible and parallel framework to study landscape dynamics	Computers & Geosciences	2016	Online & print	Earth Sciences	0.103
Schlanderer, S. C.	The boundary data immersion method for compressible flows with application to aeroacoustics	Journal of Computational Physics	2017	Online & print	Engineering	2.744
Seppä J	Atomic force microscope adhesion measurements and atomistic molecular dynamics simulations at different humidities	Measurement Science and Technology	2017	Online & print	Engineering	1.585
Shrine N	Genome-wide association study of copy number variation with lung function identifies a novel signal of association near BANP for forced vital capacity	BMC Genetics	Aug-16	Online	Medical and Health Sciences	2.266
Singh J.	The influence of shear-dependent rheology on turbulent pipe flow	Journal of Fluid Mechanics	2017	Online	Engineering	2.821 (2016)
Sossi, P. A	Petrogenesis and Geochemistry of Archean Komatiites	Journal of Petrology	2016	Online & print	Chemical Sciences	3.28
Stegeman P	Inception and evolution of coherent structures in under-expanded supersonic jets	Journal of Physics: Conference Series	2016	Online & print	Physical Sciences	0.45

APPENDIX 5: PUBLICATIONS

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Stegeman P	Interaction of shear layer coherent structures and the stand-off shock of an under-expanded circular impinging jet	Fluid-Structure-Sound Interactions and Control	2016	Online & print	Engineering	N/A
Su	Galactic synchrotron emissivity measurements between 250deg < l < 355deg from the GLEAM survey with the MWA	Monthly Notices of the Royal Astronomical Society	2016	Online & print	Radio astronomy	4.961
Subramanian, N	Understanding the accumulation of P-glycoprotein substrates within cells: The effect of cholesterol on membrane partitioning	Biochimica et Biophysica Acta (BBA)-Biomembranes	Apr-16	Online & print	Chemical Sciences	2.8
Suresh	Wavelet-Based Characterization of Small-Scale Solar Emission Features at Low Radio Frequencies	Astrophysical Journal		Online	Radio astronomy	5.533
Syme RA	Comprehensive Annotation of the Parastagonospora nodorum Reference Genome Using Next-Generation Genomics, Transcriptomics and Proteogenomics	PLoS ONE	2016	Online	Agricultural and Veterinary Sciences	2.806
Tardani D	Cu-As decoupling in an active geothermal system: a link between pyrite and fluid composition	Geochimica et Cosmochimica Acta	2017	Online & print	Chemical Sciences	4.609
Testa A	OculterCut: A comprehensive survey of local GC content bias across the fungal kingdom highlights the "two-speed" genome evolution mediated by Repeat-Induced Point Mutation in the Pezizomycotina	Genome Biology and Evolution	2016	Online	Biological Sciences	3.979
Thiele ST	The topology of geology 1: Topological analysis	Journal of Structural Geology	2016	Online & print	Earth Sciences	2.408
Thiele ST,	The topology of geology 2: Topological uncertainty	Journal of Structural Geology	2016	Online & print	Earth Sciences	2.408
Tong, F	Flow regimes for a square cross section cylinder in oscillatory flow	Journal of Fluid Mechanics	2017	Online	Engineering	2.821 (2016)
Troy NM	Differential gene network analysis for the identification of asthma-associated therapeutic targets in allergen-specific T-helper memory responses	BMC Genomics	2016	Online	Medical and Health Sciences	3.729
Tursunov EM	Theoretical study of the 6 Li+ astrophysical capture process in a three-body model	Physical Review C	Jul-16	Online & print	Physical Sciences	3.82
Varanasi, S.R	Optimal Electrode Mass Ratio in Nanoporous Carbon Electrochemical Supercapacitors	Journal of Physical Chemistry C	2016	Online & print	Engineering	4.536

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Vaughan J	Silver(I), gold(I) and palladium(II) complexes of a NHC-pincer ligand with an aminotriazine core: a comparison with pyridyl analogues	Dalton Transactions	2016	Online & print	Chemical Sciences	4.029
Veeraragavan A	Use of the method of manufactured solutions for the verification of conjugate heat transfer solvers	Journal of Computational Physics	2016	Online & print	Physical Sciences	2.744
Vernstrom et al	Low Frequency Radio Constraints on the Synchrotron Cosmic Web	Monthly Notices of the Royal Astronomical Society	2016	Online & print	Radio astronomy	4.961
Wain LV	Genome-wide association analyses for lung function and chronic obstructive pulmonary disease identify new loci and potential druggable targets	Nature Genetics	Feb-17	Online & print	Medical and Health Sciences	27.959
Wang H	A comparison between direct numerical simulation and experiment of the turbulent burning velocity-related statistics in a turbulent methane-air premixed jet flame at high Karlovitz number	Proceedings of the Combustion Institute	2017	Online & print	Engineering	3.214 (2016)
Wang H	A direct numerical simulation study of flame structure and stabilisation of an experimental high Ka CH4/air premixed jet flame	Combustion and Flame	2017	Online & print	Engineering	3.663 (2016)
Wang H	Turbulence-flame interactions in DNS of a laboratory high Karlovitz premixed turbulent jet flame	Physics of Fluids	2016	Online	Physical Sciences	2.232
Wang H	Petascale direct numerical simulations of a high Ka laboratory premixed jet flame – an analysis of flame stretch and flame thickening	Journal of Fluid Mechanics	2017	Online	Engineering	2.821 (2016)
Wang J	Effects of oxygen vacancies on polarisation stability of barium titanate	Science China Physics, Mechanics & Astronomy	2016	Online & print	Physical Sciences	2.237
Wessel, P.	Ridge-spotting: A new test for Pacific absolute plate motion models	Geochemistry, Geophysics, Geosystems	2016	Online	Earth Sciences	3.201
Williams AH	Comparative genomics and prediction of conditionally dispensable sequences in legume–infecting Fusarium oxysporum formae speciales facilitates identification of candidate effectors	BMC Genomics	2016	Online		3.729
Williams, S.	Alignment between seafloor spreading directions and absolute plate motions through time	Geophysical Research Letters	2016	Online	Earth Sciences	4.253

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First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Wu, J.	Comparative genomics integrated with association analysis identifies candidate effector genes corresponding to Lr20 in phenotype-paired Puccinia triticina isolates from Australia	Frontiers in Plant Science	2017	Online	Biological Sciences	4.298 (2016)
Yang, T.	Mantle–induced subsidence and compression in SE Asia since the early Miocene	Geophysical Research Letters	2016	Online	Earth Sciences	4.253
Yuan, H.	High-density seismic receiver function study constrains crustal structure of the Glenburgh Terrane and its role in Paleoproterozoic craton assembly in Western Australia	Journal of Geophysical Research		Online	Earth Sciences	3.318
Zahirovic, S.	Large fluctuations of shallow seas in low-lying Southeast Asia driven by mantle flow	Geochemistry, Geophysics, Geosystems	2016	Online	Earth Sciences	3.201
Zammit MC	Complete Solution of Electronic Excitation and Ionisation in Electron-Hydrogen Molecule Scattering	Physical Review Letters	2016	Online & print	Physical Sciences	8.462
Zatsarinny O	Calculations for electron-impact excitation and ionisation of beryllium	Journal of Physics B-Atomic Molecular and Optical Physics	2016	Online & print	Physical Sciences	1.792
Zhang, D.	A refined r-factor algorithm for TVD schemes on arbitrary unstructured meshes	International Journal for Numerical Methods in Fluids	2016	Online & print	Engineering	1.652
Zhang, P.	Mechanical properties of Li–Sn alloys for Li-ion battery anodes: A first-principles perspective	AIP Advances	2016	Online	Engineering	1.568
Zhang, Q.	Effect of limited sediment supply on sedimentation and the onset of tunnel scour below subsea pipelines	Coastal Engineering	2016	Online & print	Engineering	3.221
Zhao, M.	Vortex-induced vibration of four cylinders in an in-line square configuration	Physics of Fluids	2016	Online	Physical Sciences	2.232
Zhao, M.	Numerical simulation of vortex-induced vibration of two rigidly connected cylinders in side-by-side and tandem arrangements using RANS model	ASCE Journal of Fluids Engineering	2016	Online & print	Engineering	1.437
Zhao W	Anhydrous calcium oxalate polymorphism: a combined computational and synchrotron X-ray diffraction study	Crystal Growth & Design	2016	Online	Chemical Sciences	4.055

First Author	Article title	Journal name	Publication date	Online/print publication	Article field	Journal Impact Factor
Zhu Q	Resorcinol Crystallization from the Melt: A New Ambient Phase and New "Riddles"	Journal of the American Chemical Society	2016	Online & print	Chemical Sciences	13.858

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