



Astronomy
Australia
Ltd.

2013 / 14 Annual Report



Astronomy Australia Limited

Vision

Astronomers in Australia will have access to the best astronomical research infrastructure.

Mission

AAL will achieve its vision by engaging with astronomers in support of the national research infrastructure priorities of the Australian astronomy decadal plan, and advising the Australian Government on the investments necessary to realise those priorities.

Principles

1. Access to major astronomical research infrastructure should be available to any Australian-based astronomer purely on scientific merit.
2. The concept of national astronomical research infrastructure includes participation in international facilities.
3. AAL recognises the roles of other organisations in Australia that manage components of the national astronomical research infrastructure.

About AAL

Astronomy Australia Limited (AAL) is a not-for-profit company whose members are all the Australian universities and research organisations with a significant astronomical research capability. AAL works with Australia's National Observatories, astronomers and the Australian Government to advance the infrastructure goals in the *2006-2015 Decadal Plan for Australian Astronomy*.

Since its incorporation in 2007, AAL has coordinated the Australian astronomy response to, and managed the funding for, a number of national schemes and projects, including the Australian Government's investments in astronomy infrastructure through the National Collaborative Research Infrastructure Strategy (NCRIS), the Education Investment Fund (EIF), Collaborative Research Infrastructure Scheme (CRIS) and the National Collaborative Research Infrastructure Strategy 2013 (NCRIS-2013).

Background image

Gemini/GMOS image of the face-on spiral galaxy IC 5332, proposed by the winner of the 2013 Australian Gemini School Astronomy Contest, Isobelle Teljega from St Margaret's Anglican School.

Front cover image

Gemini/GMOS image of the Gum 85 nebula by Paul FitzGerald, winner of the AusGO 2013 Australian Gemini Amateur Astronomy Contest.

AAL Membership as of 30th June 2014



Australian
National
University



Curtin University

MACQUARIE
UNIVERSITY



MONASH
University



THE UNIVERSITY
OF ADELAIDE
AUSTRALIA



THE UNIVERSITY OF
MELBOURNE



UNSW
THE UNIVERSITY OF NEW SOUTH WALES



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA



THE UNIVERSITY OF
SYDNEY



THE UNIVERSITY OF
WESTERN AUSTRALIA
Achieve International Excellence



University of
Western Sydney



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A message from the Chair

Maintaining and improving Australian astronomers' access to world-leading astronomical infrastructure is critical if Australia is going to remain a world power in Astronomy. It was therefore wonderful that all member institutions participated in the Astronomy Australia Limited (AAL) Annual General Meeting in November 2013. I am delighted to welcome Prof Ron Ekers to the Board and note that the members were fully engaged in the decision to elect Ron to the Board. Ron is a pioneer in radio astronomy and has played a leadership role in astronomy, both in Australia and internationally. Congratulations to Ron for being awarded the prestigious 2014 Grote Reber Gold Medal for his innovative and significant contributions to radio astronomy. Congratulations also to Prof Anne Green and Dr Ian Chessell who the members chose to re-elect to the Board. It is important for a Board to continually be reinvigorated by new appointments, and I pay tribute to Prof Warrick Couch and his decision to retire from the Board. Warrick was a founding director of AAL and also has made invaluable contributions as Chair. On a personal note, I would like to thank the members for electing me to the role of Chair, and I also acknowledge Prof Stuart Wyithe's significant contributions as Chair during 2013.

In early 2014 I had the pleasure of meeting Vice-Chancellor Glover at the University of Western Sydney. After that meeting I was therefore delighted to receive and approve the University of Western Sydney's application to become a member of AAL. We now have

Prof Brian Schmidt, Chair, AAL Board of Directors



fifteen members comprising every organisation in Australia with a significant astronomy research capability. We continually strive to strengthen communications with our members and during the year I was pleased to note the large numbers of visits to member institutions and the direct engagement with many astronomers on infrastructure matters.

During February and March 2014 AAL and a number of Australian institutions were visited by a senior team from the Giant Magellan Telescope Organisation (GMTO), and also by the European Southern Observatory (ESO) Director-General, Tim de Zeeuw. These visits gave GMTO and ESO an opportunity to engage directly with astronomers, industry, AAL and government, and reinforce the strengths of the GMT project as well as the long-term strategic benefits of Australian membership of ESO. AAL also partnered with the Melbourne Planetarium to form an Australian Node of the ESO Science and Outreach Network, to help promote ESO-related news and events.

AAL continued its efforts to strengthen Australia-China astronomy collaborations, in order to capitalise on the complementary expertise and resources from both nations. During the past year we supported activities

Commitment to Training

Over 30% of Australian users of AAL-supported facilities in 2013/14 were students, demonstrating the importance of these resources in building the skills and expertise of the next-generation of world-leading scientists.

Highly Collaborative

Australian astronomers are exceptionally collaborative, with almost 90% of the publications in 2013/14 from AAL-supported facilities involving international collaborations. This is a key factor driving Australia's high level of research impact and productivity in astronomy.

under our Memorandum of Understanding regarding Antarctic astronomy with the Division for Basic Research of the Chinese Academy of Sciences, including a very successful travel award initiative that allowed teams of Australian astronomers to visit China to collaborate on a range of key priority science areas. Importantly, we secured the agreement of the Australian Astronomical Observatory (AAO) to take a leadership role in representing Australia in Antarctic astronomy collaborations with China. The AAO's leadership role further strengthens the foundation upon which China-Australia astronomical collaborations can build.

Every ten years, the Australian astronomical community – led by the National Committee for Astronomy – carries out a strategic planning process to appraise its existing capabilities,

assess scientific impact, and agree on a vision and priorities for the future. The currency for the last Decadal Plan ends in 2015, and therefore a huge focus for the community in recent months has been the development of the next Plan. AAL is not involved in the Decadal Planning process; our role is to advance the infrastructure priorities set out in the Plan. AAL acknowledges the extraordinary effort and coordination that goes into this planning activity, and we look forward to supporting the infrastructure priorities that the community identifies in the next Decadal Plan for 2016-25.



Prof Brian Schmidt
Chair

Shin Oya, Colin Bonner, and Hirofumi Okita with a Fulcrum 3D sodar at Mauna Kea Observatory, June 2014.



Industry Highlight

Sodar technology in demand

UNSW-led work to measure the atmospheric turbulence in Antarctica resulted in the PhD student, Colin Bonner, establishing a company, Fulcrum 3D, to apply the technology more widely. In 2014, Fulcrum 3D delivered a sonic radar to the Subaru telescope at Mauna Kea Observatory and signed a contract to supply two sodars to China. Fulcrum 3D also supplies sodars to the wind energy industry and in the last 12 months has signed distributor agreements in the UK and Latin America.

A message from the CEO

The Australian Government's ongoing support of the National Collaborative Research Infrastructure Strategy (NCRIS) was one of the most positive developments during the financial year. In the previous annual report I noted that the May 2013 budget included \$185.9M for NCRIS, of which AAL secured \$12.2M for astronomy facilities. In the May 2014 budget the Australian Government allocated an additional \$150M for NCRIS, an excellent result in a difficult budgetary environment. In coming months AAL will work closely with the Department of Education to review the previous NCRIS investments into astronomy and be available to manage any new astronomy NCRIS allocation. I was also delighted that during the year AAL secured \$1.1M in grants from the Department of Industry to complement the NCRIS investment. As ever, AAL was guided by the Australian Astronomy Decadal Plan in its recommended allocation of this \$13.3M, with \$6.8M allocated to Square Kilometre Array (SKA) pathfinders and \$4.5M towards accessing large optical telescopes located overseas.

The SKA, and the journey to achieve that goal, will possibly be the major force in Australian astronomy for many years. It was wonderful for the Murchison Widefield Array to achieve a successful first year of operations, and with the help of NCRIS, MWA operations are fully funded until June 2015. AAL made a much larger investment of NCRIS funding to support early Australian SKA Pathfinder (ASKAP) operations, and CSIRO will match that investment to construct, install and commission six additional Mark II Phased Array Feeds (PAFs). This will result in ASKAP being equipped with a total of 30 Mark II PAFs, six of which will be installed on the central BETA antennas.

One year ago Australian astronomers were faced with the daunting prospect that national



Mark McAuley attends the launch of HERMES at the Anglo-Australian Telescope.

Project Highlight

MWA commences operations

The Murchison Widefield Array (MWA) radio telescope, a precursor to the Square Kilometre Array (SKA), began operations in July 2013 and is now using its unique sensitivity to low-frequency radio signals to gain new insights into the ancient Universe. In addition, MWA can make important practical contributions by monitoring space debris to protect space-based assets, and providing early warning of solar storms that can cause billions of dollars damage.

Innovative technologies developed for MWA are providing a crucial test-bed to inform the low-frequency component of the SKA (SKA-low). Already, MWA infrastructure is being used in SKA-low test antennas, which will lead to the final array made up of millions of antennas. MWA can pipe up to 300MB per second of science-rich data over a high-speed network to the iVEC Pawsey Centre. As the first operational Australian SKA Precursor, the MWA is providing the first major test of these data transfer and storage systems, and is helping to ensure that the data infrastructure is ready and optimised for the SKA.

access to large optical telescopes would cease at the end of 2015. Using the new funding which AAL secured during the year, AAL was able to negotiate continued access to the Magellan telescopes at fifteen nights per year until the end of 2017, and access of ten nights per year to the Keck telescopes during 2016 and 2017. Discussions were also underway for a modest amount of Gemini access during 2016. While the long-term solution for access to large optical telescopes is still unclear, Australian astronomers will continue to have some access to these important facilities until at least 2017.

Part of the solution for national access to large optical telescopes will be provided by AAL's membership of the Giant Magellan Telescope Organisation. It was terrific to see the GMT project undergo a successful preliminary design review and demonstrate that the project is technically ready to commence construction. Work is now underway for the GMTO Founders to commit the funds required to trigger the commencement of construction.

While large international projects and facilities are becoming the major source of astronomical research infrastructure and investment, the past twelve months have also seen successes from mature facilities and more modest investments. Highlights included the launch of

Access to World-class Facilities

AAL invested \$7.6M in FY2013/14, giving Australian researchers access to facilities worth over \$500M.

HERMES on the Anglo-Australian Telescope by Minister Macfarlane, the C/X receiver upgrade to the Australia Telescope Compact Array, the immediate uptake of the theory node of the All Sky Virtual Observatory, and the successful servicing of the PLATO-R unit to enable continued operation of the HEAT terahertz facility in Antarctica.

Finally, AAL only exists because of its members. I was therefore delighted that the University of Western Sydney became AAL's fifteenth member. I had the pleasure of visiting the Penrith Observatory to meet with UWS astronomers, and was greatly impressed by their facilities which underpin a successful public outreach programme. As a former observatory education officer, I greatly appreciate the power of astronomy to inspire the population more than any other scientific discipline.



Mr Mark McAuley
Chief Executive Officer



Department of Industry Minister Ian Macfarlane congratulates AAO Director Professor Warrick Couch at the official launch of the HERMES instrument on the AAT. Image credit: Phil Fitzgerald, Dept of Industry

AAL in 2013/14

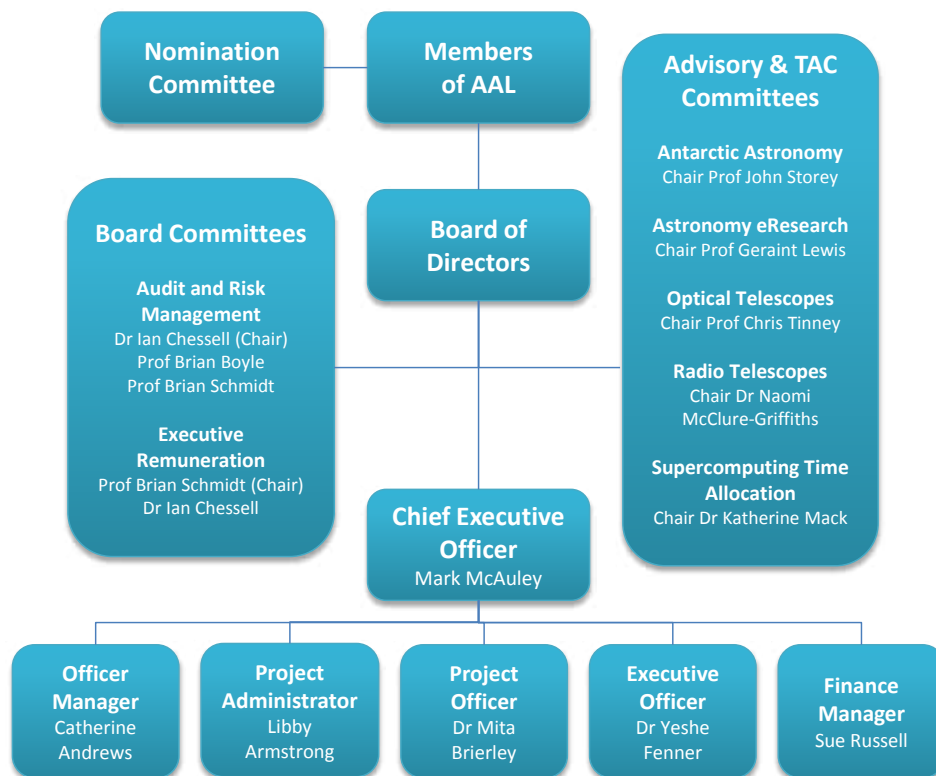


Antennas of CSIRO's Australian SKA Pathfinder telescope at the Murchison Radio-astronomy Observatory in outback Western Australia. Image credit: CSIRO.

Organisational Structure

AAL's membership includes all institutions with an astronomy research capability in Australia. AAL's four advisory committees are broadly representative of the astronomical community and are well placed to understand and reflect the views of the wider astronomy community. AAL relies on its committees to monitor and assess the progress of all projects and subprojects, evaluate key performance indicators, and advise on opportunities for collaboration and improving project outcomes. The AAL Board makes key decisions about projects based on the committees' recommendations as well as the Board's own considerable and diverse expertise.

Organisational chart as of 30th June 2014



Board of Directors as of 30th June 2014

Prof Brian Schmidt (Chair)	Appointed 18 Apr 2007, reappointed 30 Sep 2008 and 11 Nov 2011
Prof Stuart Wyithe (Deputy Chair)	Appointed 11 Nov 2011
Prof Brian Boyle	Appointed 5 Nov 2009, reappointed 2 Nov 2012
Dr Ian Chessell	Appointed 5 Nov 2010, reappointed 19 Nov 2013
Prof Ronald Ekers	Appointed 19 Nov 2013
Prof Anne Green	Appointed 5 Nov 2010, reappointed 19 Nov 2013
Prof Robyn Owens	Appointed 2 Nov 2012

Information about Directors



Prof. Brian Schmidt AC

BSc (Physics & Astronomy), A.M. in Astronomy, PhD (Astronomy), FAA, NAS, FRS

Special responsibilities - Board Chair from 18 November 2013. Member of the Executive Remuneration Committee and Audit and Risk Management Committee, from February 2014

Prof Brian Schmidt is an ARC Australian Laureate Fellow at the Australian National University. He is the Project scientist for the new SkyMapper Telescope which will undertake a comprehensive optical survey of the southern sky. His research has focused on the physics of distant exploding stars to trace the expansion of the Universe. He has received a variety of awards over his career culminating in his sharing the 2011 Nobel Prize for Physics. He has been an active member of several national astronomy and science bodies including the Major National Research Facilities selection panel, Australian Square Kilometre Array Steering Committee, Australian Decadal Working group on International Facilities and Mid-Term Review of the Australian Astronomy Decadal Plan.

Prof. Stuart Wyithe

BSc(Hons), PhD

Special responsibilities – Board Chair until 19 November 2013 and subsequently appointed Deputy Chair. Member of Gemini Board and Finance Committee and until February 2014 was a member of the Executive Remuneration Committee, Audit and Risk Management Committee and Optical Telescopes Advisory Committee.

Prof. Stuart Wyithe is an ARC Australian Laureate Fellow and a Professor at The University of Melbourne. Previously, he was University Associate Dean in the Melbourne School of Graduate research (2009-2011). A cosmologist and author of over 100 scientific publications, he has a history of collaboration at the national and international level, encompassing both theory and observation. He has received many awards, including the Pawsey Medal from the Australian Academy of Science and the Malcome McIntosh prize. He served as MWA Science Council Chair (2010-2011), during which he developed and implemented project policies. He has contributed to the running of a range of national bodies and is the current Chair of the Australian Academy of Science's National Committee for Astronomy.



Prof. Brian Boyle

BSc(Hons), PhD, PSM, FAA

Special responsibilities - Member of the Audit and Risk Management Committee and Antarctic Astronomy Advisory Committee.

Prof. Brian Boyle is the Acting SKA Director for the Department of Industry, Innovation, Science, Research, and Tertiary Education, following his role as CSIRO SKA Director. Previously, he was the Director of the CSIRO Australia Telescope National Facility (2003-2009) where he initiated the construction of ASKAP, and Director of the Anglo-Australian Observatory (1996-2003). His main research interests are cosmology, active galactic nuclei and quasars. During his career he has overseen the successful commissioning of world-class instruments and has led many international scientific collaborations. He has been a Fellow of the Australian Institute of Company Directors since 2005. As Chairman of the National Committee for Astronomy, he led the development of the Decadal Plan for Australian Astronomy 2006-15. He was also the facilitator for the NCRIS investment plan for optical and radio astronomy.

Dr Ian Chessell

BSc(Hons), PhD (Physics), FTSE

Special responsibilities - Member of the Executive Remuneration Committee and Audit and Risk Management Committee.

Dr Ian Chessell followed a career in the Defence Science and Technology Organisation, retiring as Australia's Chief Defence Scientist in 2003. Dr Chessell served as a member of the Prime Minister's Science, Engineering and Innovation Council (2001-2003) and in 2003 he was awarded the Centenary Medal for services to defence science. He was elected a Fellow of the Australian Academy of Technological Sciences and Engineering in 2003. He was Chief Scientist of South Australia from 2008-2010. He is a member of the Defence South Australia Advisory Board, the Board of QinetiQ Pty Ltd and is Chair of the Goyder Institute for Water Research. He has chaired a number of science reviews including Commonwealth reviews of National ICT Australia in 2005, the Anglo-Australian Telescope in 2006, and CSIRO's Climate Adaptation Flagship in 2011.





Prof. Ronald Ekers

BSc(Hons), PhD (Astronomy), FAA, FRS

Special responsibilities - a member of the Optical Telescope Advisory Committee.

Prof. Ron Ekers is a CSIRO Fellow and was the Director of the Australia Telescope National Facility from 1988 to 2003. He graduated from the University of Adelaide in 1963 and gained his PhD in astronomy at the Australian National University in 1967. His professional career has taken him to the California Institute of Technology, the Institute of Theoretical Astronomy in Cambridge, UK, the Kapteyn Laboratory in Groningen, The Netherlands and the National Radio Astronomy Observatory, New Mexico USA. He was director of the VLA, the major national radio telescope in the USA, from 1980 until 1987. He was elected a Fellow of the Australian Academy of Science, a Foreign Member of the Royal Dutch Academy of Science in 1993, a Foreign Member of the American Philosophical Society in 2003 and a Fellow of the Royal Society in 2005. He is past President of the International Astronomical Union (IAU). His research interests include extragalactic astronomy, especially cosmology, galactic nuclei, ultra high energy particle physics and radio astronomical techniques



Prof. Robyn Owens

BSc(Hons), MSc (Mathematics), PhD (Mathematics), FAICD, FATSE

Special responsibilities – a member of Astronomy eResearch Advisory Committee.

Prof. Robyn Owens is Deputy Vice-Chancellor (Research) at the University of Western Australia (UWA) and has responsibility for research policy development and leadership of the University's research activities, postgraduate education, industry liaison, intellectual property and commercialisation. Previously she was the Head of the School of Computer Science & Software Engineering at UWA and has also lectured in Australia and internationally in mathematics and computer science. She has an extensive background in mathematical analysis and research with a focus on computer vision, including feature detection in images, 3D shape measurement, image understanding, and representation.

Prof. Anne Green

BSc(Hons), PhD, GAICD, FASA, FAIP

Special responsibilities - Deputy Chair until 18 November 2013 and member of the Radio Telescopes Advisory Committee.

Prof. Anne Green is a Professor at the University of Sydney, and is Director of the Square Kilometre Array Molonglo Project, a pathfinder instrument that will help advance science and technology for the next generation of radio telescopes. Previously she was the Head of the School of Physics, the Director of the Science Foundation for Physics, and the Director of the Molonglo Observatory, all associated with the University of Sydney. Her research career spans more than 20 years in radio astronomy, with a focus on the structure and ecology of the Milky Way Galaxy. She has also been an active member of several national and international astronomy committees with responsibility for setting strategy and managing competing priorities. She is currently a Member of the Australian Astronomical Observatory Advisory Committee. Since 2007, she has been a Graduate Member of the Australian Institute of Company Directors



Prof. Warrick Couch

BSc(Hons), MSc, PhD (Astronomy), DSc, FAA, FASA, FAIP

Retired from Board 19 November 2013.

Special responsibilities - Board member of the Giant Magellan Telescope Organisation.

Prof. Warrick Couch has recently taken up the position of Director of the Australian Astronomical Observatory. Previously he was the Director of the Centre for Astrophysics and Supercomputing at Swinburne University of Technology. He has a research career spanning 30 years in optical astronomy, with an extensive and distinguished track record in terms of (i) use of university, national and international telescope facilities, (ii) research publications and citation impact (Australian citation laureate and "Highly Cited" researcher), and (iii) securing external research grant funding. He is or has been an active member of key national astronomy committees and bodies that are responsible for dealing with research policy and priorities, which have given him considerable experience in developing short- and long-term strategies and priorities for our national astronomy infrastructure, and implementing related funding programs.

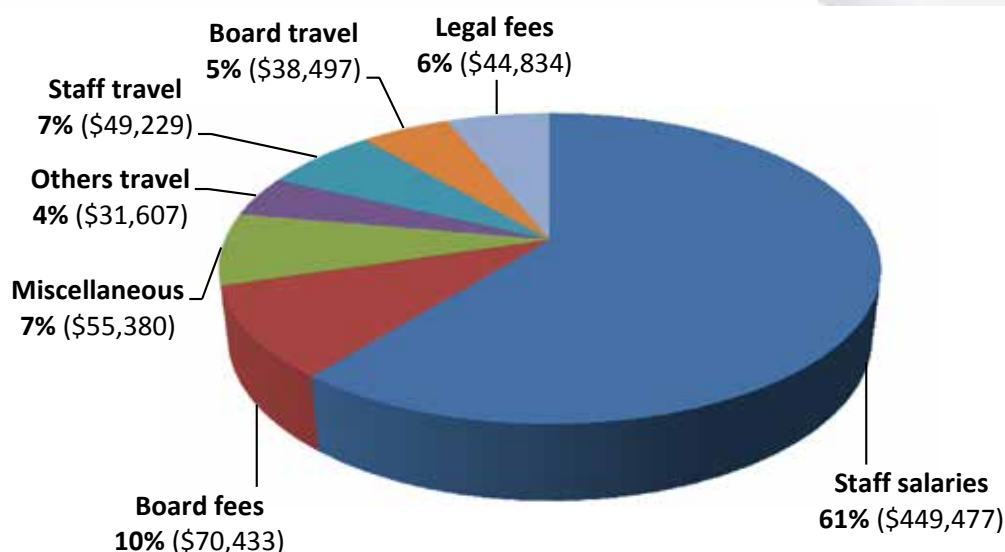


Financial Summary

The following summary highlights the key financial transactions (exclusive of GST) for the 2013/14 financial year. The audited financial accounts are available on the AAL website at: <http://astronomyaustralia.org.au/publications>.

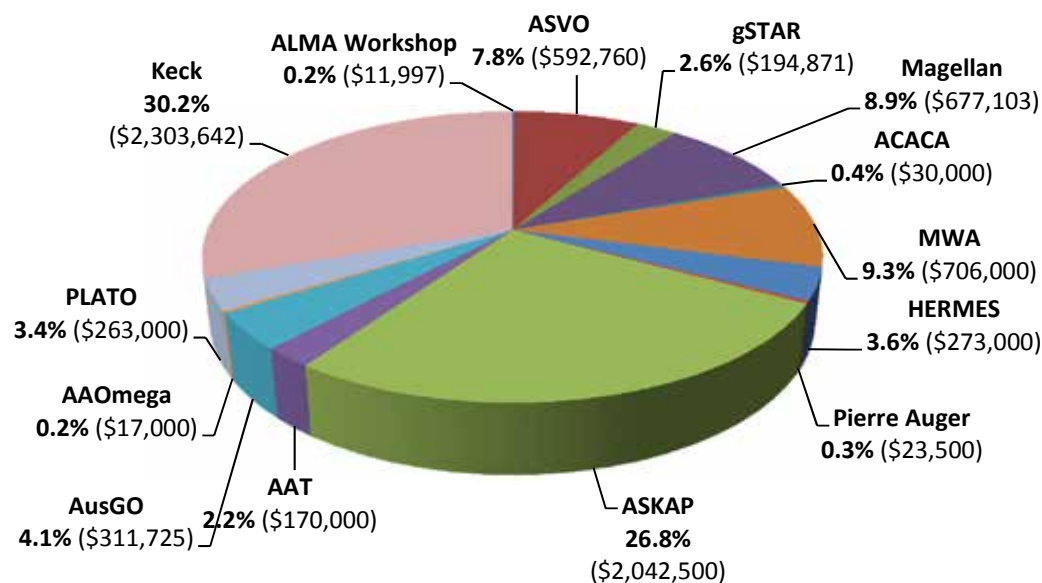
AAL Operating Expenses

Actual operating expenses for 2013/14 were \$739,458. The breakdown of costs is similar to the previous financial year.



Grants Paid to Projects during 2013/14

Total grants paid in 2013/14 were \$7,617,098.



Grants Received and Balance of Grants held as at 30 June 2014

Grant	Grants Received	Closing Balance
AAO Grant	-	\$760,035
NeCTAR Grant	\$240,000	-
CRIS Grant	\$2,316,000	\$1,810,500
Australia-China scholarships Grant (ACACA)	-	\$20,000
NCRIS 2013 Grant	\$5,361,532	\$1,172,390
AAO 2014 Grant	\$1,120,000	\$1,120,000
	\$9,037,532	\$4,882,925

Reserves

During 2013/14 AAL maintained four reserves with net interest earned used for projects associated with the relevant funding agreement. There were the following transfers to and from Reserves:

Reserve	Net Interest	Transfer from Reserve	Purpose of Funds	Closing Balance
NCRIS Reserve	\$18,624	\$209,880 \$125,000	ASVO 1.0 ASVO-MWA design study	0
EIF Reserve	\$1,661	\$27,871	gSTAR data sharing cluster	0
Overseas Optical Reserve*	\$108,408	\$51,662 \$113	AAL management fee Bank fee	\$2,639,737 [#]
NCRIS 2013 Reserve	\$23,275			\$23,275

* The Overseas Optical Reserve is primarily used to cover shortfalls in payments to overseas optical telescope facilities.

[#] \$168,364 of Overseas Optical Reserve is committed for future Magellan payments.

Statement of profit and loss and other comprehensive income for the year ended 30 June 2014

	2014 \$	2013 \$
Revenue including Government Grants	8,243,260	5,597,621
Expenses		
Depreciation	(2,535)	(3,909)
Grants paid	(7,605,101)	(4,854,973)
Direct grant project expenses	(12,165)	(42,247)
Employee benefits expenses	(519,910)	(536,149)
Other expenses	(217,013)	(221,866)
Surplus (Deficit) before income tax attributable to members of the entity	(113,464)	(61,523)
Income tax	-	-
Surplus (Deficit) after income tax attributable to members of Astronomy Australia Ltd	(113,464)	(61,523)
Other comprehensive income	-	-
Total comprehensive income for the year attributable to members of Astronomy Australia Ltd	(113,464)	(61,523)

The Company is an income tax exempt charitable institution.

Statement of changes in equity for the year ended 30 June 2014

	Retained Surpluses	NCRIS Reserve Account	Overseas Optical Reserve Account	EIF Reserve Account	NCRIS- 2013 Reserve Account	Total Equity
	\$	\$	\$	\$	\$	\$
Balance at 30 June 2012	58,287	423,670	2,515,019	86,150	-	3,083,126
Surplus attributable to equity members	(61,523)	-	-	-	-	(61,523)
Allocated to Reserves	(213,518)	61,925	118,968	32,625	-	-
Transfers from Reserves	312,786	(169,339)	(50,882)	(92,565)	-	-
Balance at 30 June 2013	96,032	316,256	2,583,105	26,210	-	3,021,603
Surplus attributable to equity members	(113,464)	-	-	-	-	(113,464)
Allocated to Reserves	(151,967)	18,624	108,407	1,661	23,275	-
Transfers from Reserves	414,526	(334,880)	(51,775)	(27,871)	-	-
Balance at 30 June 2014	245,127	-	2,639,737	-	23,275	2,908,139

Statement of Financial Position as at 30 June 2014

	2014 \$	2013 \$
Current Assets		
Cash and cash equivalents	6,626,571	6,903,577
Trade and other receivables	1,268,300	98,818
Total Current Assets	7,894,871	7,002,395
Non-Current Assets		
Property, plant and equipment	4,166	5,000
Total Non-Current Assets	4,166	5,000
Total Assets	7,899,037	7,007,395
Current Liabilities		
Trade and other payables	4,943,257	3,932,462
Employee benefits	47,641	53,330
Total Current Liabilities	4,990,898	3,985,792
Total Liabilities	4,990,898	3,985,792
Net Assets	2,908,139	3,021,603
Equity		
Reserves	2,663,012	2,925,571
Retained surpluses	245,127	96,032
Total Equity	2,908,139	3,021,603

The complete audited financial accounts are available on the AAL website at:
<http://astronomyaustralia.org.au/publications>.

AAL Committees

Committee membership as of 30th June 2014

Antarctic Astronomy Advisory Committee (AAAC)

John Storey (Chair), University of New South Wales, until 31 December 2014

Michael Burton, University of New South Wales, until 31 December 2014

Gary Hill, University of Adelaide, until 30 September 2014

Mike Ireland, Macquarie University, until 30 September 2014

Jon Lawrence, Australian Astronomical Observatory, until 30 September 2014

Sarah Maddison, Swinburne University of Technology, until 31 December 2014

Jill Rathborne, CSIRO, until 31 December 2014

Nick Tothill, University of Western Sydney, until 30 September 2014

Brian Boyle, Astronomy Australia Ltd (ex-officio)

Astronomy eResearch Advisory Committee (AeRAC)

Geraint Lewis (Chair), University of Sydney, until 31 December 2015

Jessica Chapman, CSIRO, until 31 December 2014

Christopher Fluke, Swinburne University of Technology, until 31 December 2015

Chris Power, University of Western Australia, until 31 December 2015

Raquel Salmeron, the Australian National University, until 31 December 2014

Ross Wilkinson, Australian National Data Service, until 31 December 2014

Lindsay Botten, NCI Director (ex-officio)

Ian Gibson, Intersect Australia Ltd CEO (ex-officio)

Jenni Harrison, iVEC Head of Data (ex-officio)

Jarrod Hurley, Swinburne University of Technology Supercomputer Manager (ex-officio)

Robyn Owens, Astronomy Australia Ltd (ex-officio)

Astronomy Supercomputer Time Allocation Committee (ASTAC)

Katherine Mack (Chair), University of Melbourne, until 31 December 2014

Geoff Bicknell, Australian National University, until 31 December 2014

Steve Ord, Curtin University, until 31 December 2014

Chiara Tonini, Swinburne University of Technology, until 31 December 2015

Matthew Whiting, CSIRO, until 31 December 2015

Ben Evans, NCI Representative (ex-officio)

Mark George Beckett, iVEC Representative (ex-officio)

Jarrod Hurley, Swinburne University of Technology Representative (ex-officio)

Optical Telescopes Advisory Committee (OTAC)

Chris Tinney (Chair), University of New South Wales, until 31 December 2014

Martin Asplund, the Australian National University, until 31 December 2015

Michael Drinkwater, University of Queensland, until 31 December 2014

Simon Driver, University of Western Australia, until 31 December 2015

Lisa Kewley, the Australian National University, until 31 December 2014

Andy Sheinis, Australian Astronomical Observatory, until 31 December 2015

Warrick Couch, Director, Australian Astronomical Observatory (ex-officio)

Ron Ekers, Astronomy Australia Ltd (ex-officio)

Karl Glazebrook, AAL's Gemini STAC Representative (ex-officio)

Radio Telescopes Advisory Committee (RTAC)

Naomi McClure-Griffiths (Chair), CSIRO, until 31 December 2015

Bryan Gaensler, University of Sydney, until 31 December 2014

Carole Jackson, Curtin University, until 31 December 2015

Jean-Pierre Macquart, Curtin University, until 31 December 2014

Nick Seymour, Curtin University, until 31 December 2015

Lister Staveley-Smith, University of Western Australia, until 31 December 2014

Rachel Webster, University of Melbourne, until 31 December 2014

Lewis Ball, Head, CASS/CSIRO (ex-officio)

Anne Green, Astronomy Australia Ltd (ex-officio)

Committee Meetings

A total of 14 Advisory Committee meetings were held in 2013/14; one meeting per quarter, for RTAC, OTAC and AeRAC Advisory Committees and two meeting in quarters 1 and 2, 2013/14 for AAAC.

ASTAC held two meetings in 2013/14.

Nominations to Overseas Committees

Giant Magellan Telescope

Board

- Prof Warrick Couch,
Australian Astronomical Observatory
- Mr Mark McAuley,
Astronomy Australia Ltd

Finance Committee

- Mr Mark McAuley (Chair),
Astronomy Australia Ltd

Science Advisory Committee

- Prof Chris Tinney,
University of New South Wales

Gemini

Board

- Prof Stuart Wyithe,
Astronomy Australia Ltd

Finance Committee

- Prof Stuart Wyithe,
Astronomy Australia Ltd

Science and Technology Advisory Committee

- Prof Karl Glazebrook (Deputy Chair),
Swinburne University of Technology

AURA Oversight Council for Gemini

- Mr Mark McAuley,
Astronomy Australia Ltd

Nomination Committee (For the 2013 AGM election)

Prof Warrick Couch (Chair)

Prof Rachel Webster

Prof Alexander Heger

A/Prof Darren Croton

Dr Simon Johnson

Astronomy Australia Limited

University of Melbourne

Monash University

The Astronomical Society of Australia

CSIRO

Members and their representatives as of 30th June 2014

Australian Astronomical Observatory

Australian National University

Commonwealth Scientific and Industrial Research Organisation

Curtin University

Macquarie University

Monash University

Swinburne University of Technology

University of Adelaide

University of Melbourne

University of New South Wales

University of Queensland

University of Sydney

University of Tasmania

University of Western Australia

University of Western Sydney

Prof Warrick Couch

Prof Matthew Colless

Dr Simon Johnston

Prof Steven Tingay

Prof Quentin Parker

Prof Alexander Heger

Prof Karl Glazebrook

Dr Gavin Rowell

Prof Rachel Webster

Prof John Storey

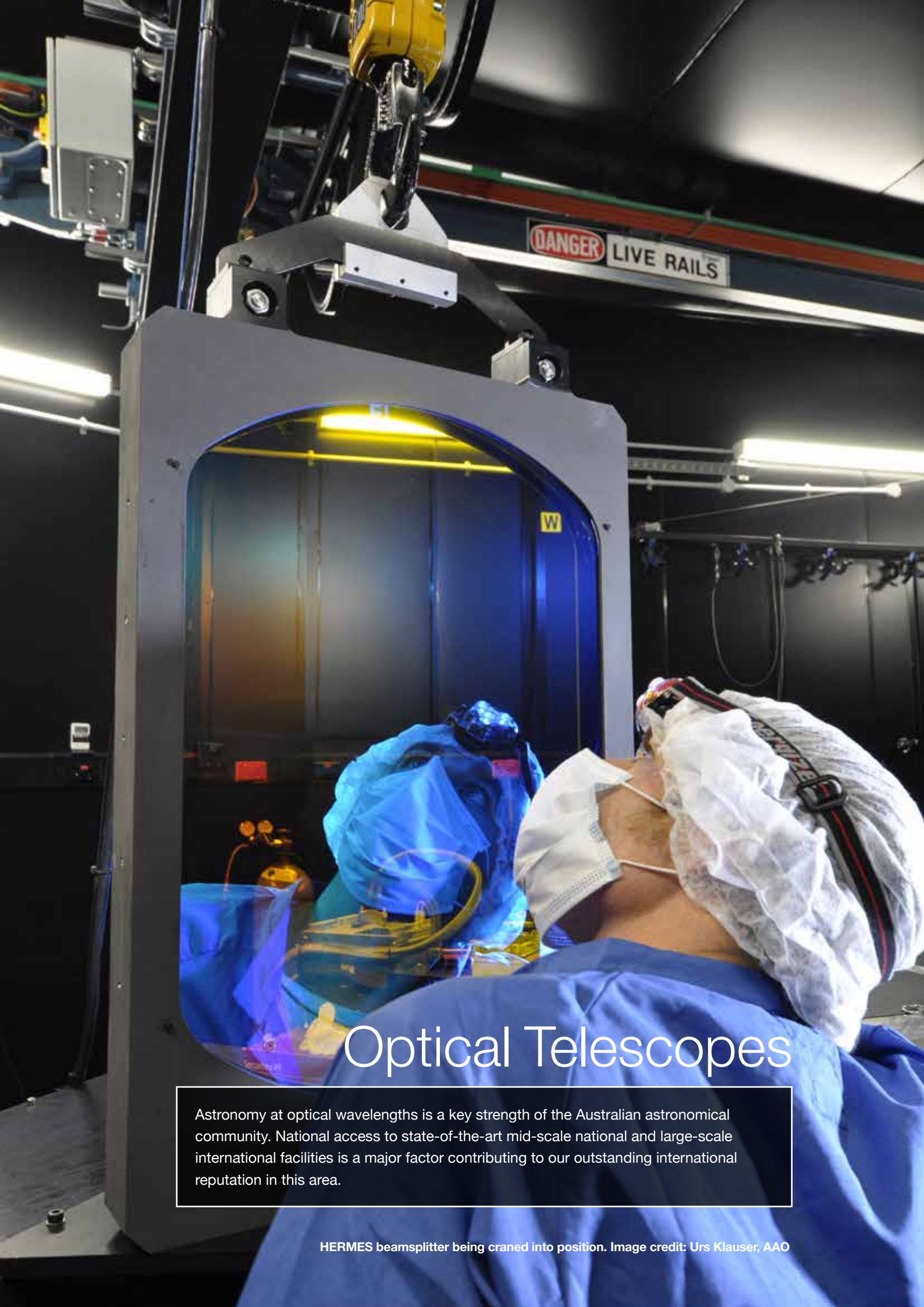
Prof Halina Rubinsztein-Dunlop

Prof Peter Tuthill

Prof John Dickey

Prof Peter Quinn

A/Prof Miroslav Filipovic



Optical Telescopes

Astronomy at optical wavelengths is a key strength of the Australian astronomical community. National access to state-of-the-art mid-scale national and large-scale international facilities is a major factor contributing to our outstanding international reputation in this area.

HERMES beamsplitter being craned into position. Image credit: Urs Klauser, AAO

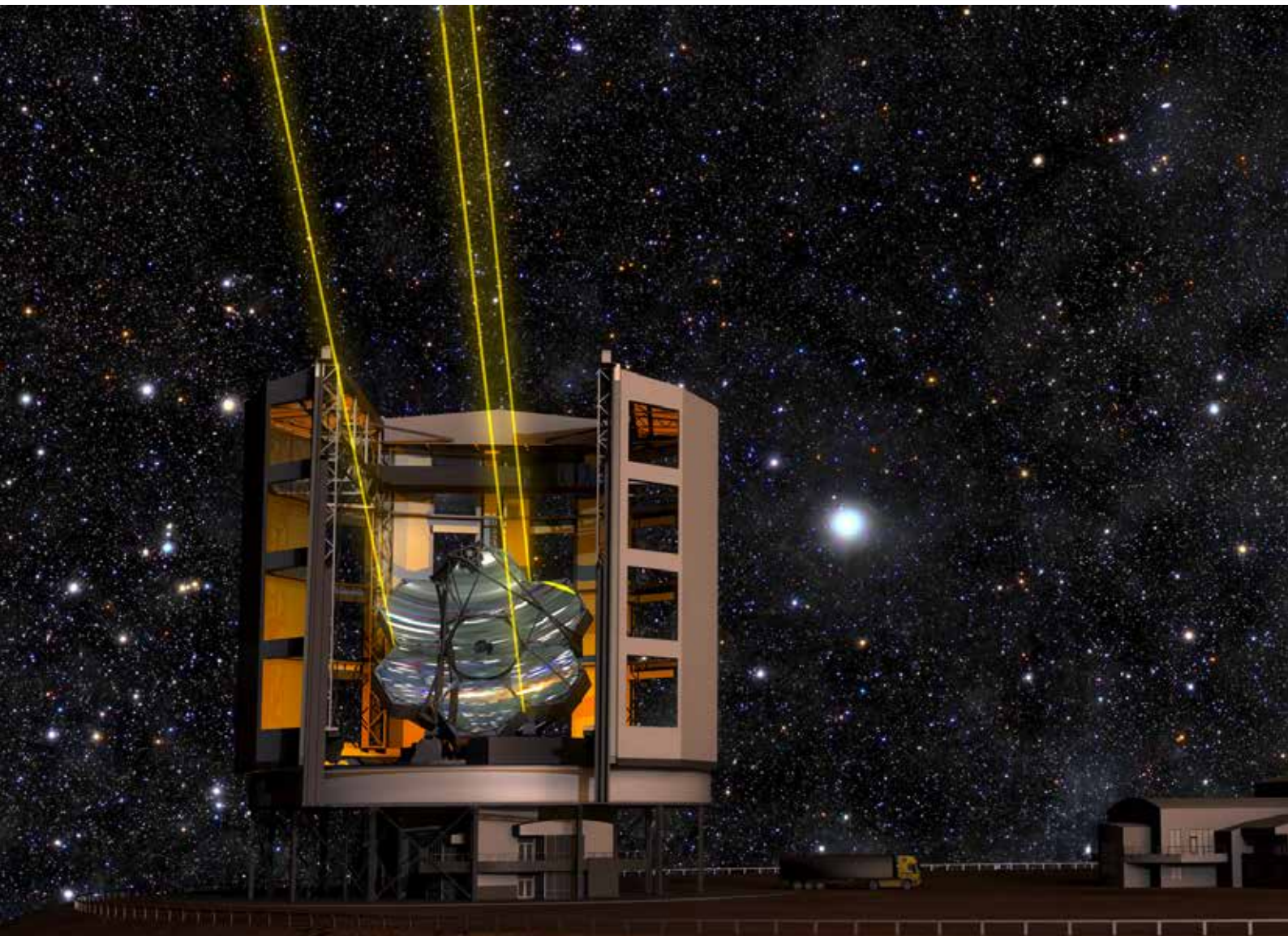
Optical Telescopes: Giant Magellan Telescope

The Giant Magellan Telescope (GMT), to be located at the Las Campanas Observatory site in Chile, is a next-generation extremely-large optical/infra-red telescope (ELT). It will have the resolving power of a 24.5-metre primary mirror, made by a combination of seven 8.4-metre mirror segments. Access to an ELT will be critical to astronomers remaining competitive in the coming decades and involvement in an ELT project is a high priority of the Australian astronomical community. AAL and the Australian National University have both invested funds from the Australian Government to secure Australian astronomers a ~10% share in GMT.

Progress and current status

The Giant Magellan Telescope took another major step forward in January 2014 by successfully completing its preliminary design review. As a one billion dollar project involving significant technology innovation, the review process necessarily begins with several sub-

system reviews. For example, the adaptive optics sub-system is highly complex and can only be properly evaluated by a skilled panel focused on that component. The sub-system reviews were held during 2013 and informed an overall system level review which occurred in January 2014. In addition to these technical evaluations, the GMT Organisation





The casting of a GMT mirror: the heat up/melt/spin phase in a furnace at the Steward Observatory Mirror Lab at the University of Arizona.



underwent a management review considering matters such as its methodology for cost estimation and risk management. While these multiple reviews generated many hundreds of pages of documentation, the key conclusion of the review panel only required one sentence, *“...we find the Design Development Phase sufficiently completed to recommend that GMT start the Construction Phase as rapidly as possible.”*, Richard Kurz (Chair, System Level Preliminary Design Review panel)

While the GMT project is now preparing to formally transition to the construction phase, significant progress has already been achieved with the production of the telescope's primary mirrors. In August 2013, AAL's representatives on the GMT Board, Warrick Couch (AAO Director) and Mark McAuley (AAL CEO), attended the casting of GMT's third primary mirror at the University of Arizona's Steward Observatory Mirror Lab, the only facility in the world where mirrors of this size are being made. Each of the primary mirrors will have a diameter of 8.4m and weigh about 20 tons, yet the surface has to be smooth to within a twentieth of a wavelength of light. With three mirrors now cast, and preparation underway to cast the fourth mirror in early 2015, GMT is already successfully undertaking major construction activities.

GMTO's senior management team visited Australia in March 2014. That visit enabled Australian astronomers, industry and government officials to learn about the recent successes of a project of critical importance to the future of Australian astronomy.



Artist's impression of the GMT. Image credit: GMTO

Optical Telescopes: 8m Telescope Access

The 2006 - 2015 Decadal Plan for Australian Astronomy set a target for Australian astronomers to have access to the equivalent of 20% of an 8-metre aperture telescope in order to maintain Australia's status as a world leader in optical astronomy and instrumentation. Securing this access remains one of AAL's highest priorities. AAL's previous investments provided Australian astronomers with access to the equivalent of ~16% of an 8-metre telescope during 2013/14. In the past year, AAL has ensured that the current access of 15 nights/year on the 6.5-metre Magellan telescopes in Chile will continue until December 2017. AAL also signed a new agreement (via the ANU) that gives 10 nights/year of National access in 2016 and 2017 on the world-class Keck Observatory 10-metre telescopes in Hawaii. While these are positive developments, a large fraction of 8-metre telescope National access has been met through Australia's membership of the International Gemini Partnership, which will cease from 2016. AAL secured additional funds in 2013/14 from the Australian Government to partly fill the resultant gap in access, and has entered into negotiations to use these funds to purchase more telescope time in 2016.

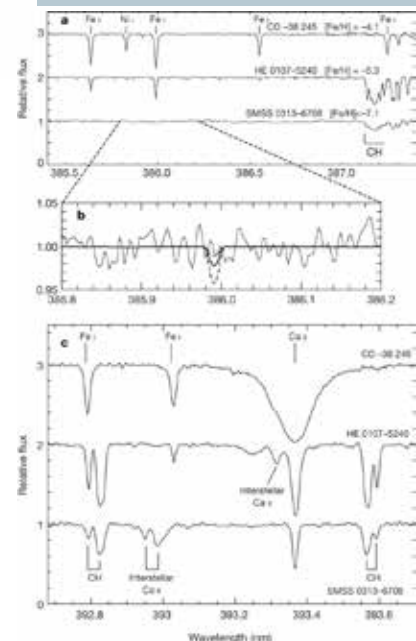
Spectra of the most metal-poor stars known, including the MIKE spectrum of the new record holder SMSS J031300.36-670839.3 which shows virtually no detectable iron features. From Keller et al. (2014, *Nature*, 506, 463).

Science Highlight

Australians discover most metal-poor star known

Australian astronomers have found the most metal-poor star known using the MIKE spectrograph on Magellan. As reported in the journal *Nature* (Keller et al. 2014, *Nature*, 506, 463), the star has at least 30 times fewer heavy elements than the most metal-poor star known previously. The star's chemistry shows the imprint of just a single supernova event from the very first generation of stars in the Milky Way, and may require scientists to re-think how the first generation of stars formed.

The star was identified as a candidate metal-poor star using Australian telescopes SkyMapper and the 2.3m telescope at Siding Spring Observatory, and confirmation required the resolution and collecting area of MIKE on Magellan.



Australian Gemini Office

AAL continues to support operations of the Australian Gemini Office (AusGO), which seeks to maximise Australian astronomer access to, and science output from, large-aperture overseas optical telescopes. Hosted at the Australian Astronomical Observatory (AAO), AusGO coordinates Australia's use of its time on the Gemini telescopes, from proposal submission to technical assessment, through to observation planning, assistance with data reduction, and publicising of results. AusGO also coordinates Australia's time on the Magellan telescopes, and is expected to play a similar role with Keck National access in the future.

Participants at the 2014 AusGO/AAO Observational Techniques Workshop work in groups to solve one of the "challenges" set for them. Image credit: J. Ghabache, AAO.



Key Performance Indicators FY2013/14

		Gemini	Magellan
Publications			
Number of facility-related refereed journal articles		35	19
Number of (unique) co-authors	Australian	66	35
	International	354	205
Number of student co-authors		8	6
Usage			
Number of users of the facility	Australian	59	19
	International (co-investigators on successful Australian proposals)	139	33
Number of institutions whose researchers used the facility	Australian	11	9
	International	68	22
Number of student users of the facility		13	6
Subscription rate (ratio of time requested to time available)		1.87	2.83

Education & Outreach Highlights

A major activity for AusGO in 2013/14 was the 2014 AusGO/AAO Observational Techniques Workshop, held at the AAO from 1-4 April 2014. AAO staff and other local experts introduced graduate students and early-career researchers to topics including detectors, proposal writing, adaptive optics, integral-field spectroscopy, and data reduction pipelines. The next workshop will be held in 2016.

The Australian Gemini Undergraduate Summer Studentship (AGUSS) program run by AusGO offers talented undergraduate students enrolled at Australian universities the opportunity to spend a summer working at the Gemini South observatory in La Serena, Chile, on a research project with Gemini staff. There were 22 applications for this year's AGUSS program, the most since the program was launched in 2006.

As well as the annual Australian Gemini School astronomy contest, this year AusGO also launched a contest targeted at Australia's amateur astronomy community. The winners of both contests have their chosen target observed using the Gemini South telescope.



2013/14 AGUSS students Rebecca Davies and Marcus Wong at Gemini South. Image credit: Rebecca Davies

Optical Telescopes: The Anglo-Australian Telescope

The Anglo-Australian Telescope (AAT) is the flagship telescope of Australia's national optical observatory, the Australian Astronomical Observatory (AAO), and has provided a foundation for Australia's excellence in optical astronomy since its commissioning forty years ago. Ongoing maintenance and continued development of innovative instrumentation for the AAT allows the telescope to continue producing leading science and is a priority of the Australian astronomical community. In 2013/14, AAL supported the AAT through NCRIS-2013 funds for maintenance and refurbishment of the AAT building and EIF funds for two AAT instruments: the HERMES and AAOmega spectrographs.

HERMES

The instrument

The AAO has finished another very successful instrument construction project with the completion of HERMES (High Efficiency and Resolution Multi-Element Spectrograph) in early 2014. HERMES was formally launched by the Minister for Industry, the Hon Ian Macfarlane, on 16 April 2014.

HERMES is a facility class instrument built for the AAT and will allow the simultaneous spectroscopic observation of up to nearly 400 targets at a spectral resolving power of about 30,000 with 4 separate simultaneous wavelength regions.

Progress and current status

HERMES integration was completed in October 2013. The on-sky commissioning took place between October-December



HERMES: the single V-groove block for lens mounting 40 lens sets. Image credit: AAO

2013. Commissioning was followed by defect rectification work, with the project achieving practical completion in June 2014.

HERMES is performing to specifications and has been offered to the observing community as a general user facility instrument since the beginning of semester 2014A. While the greatest demand for HERMES time has come from the GALAH Survey team (see science goal below), applications for time have been received for a growing number of other projects.



Minister Ian Macfarlane (right) with AAO electronics technician Rob Brookfield at the HERMES launch. Image credit: Phil Fitzgerald, Dept of Industry

Science Goal

Galactic Archaeology: unravelling the formation history of the Milky Way Galaxy

The primary science objective of the HERMES instrument is to unravel the Milky Way's formation history through a major survey of up to a million stars using chemical tagging and velocity measurements, called the Galactic Archaeology survey with HERMES (GALAH). The GALAH survey team has 72 members from 19 institutions in 7 countries.

The main survey began in February 2014 and it will take about 500 nights to collect the million-star dataset. In the first six months of observing, GALAH had observed 45,140 stars in 128 survey fields.

The GALAH Analysis Pipeline conducts the required bookkeeping of the observations, data reduction checks, radial velocity determination, continuum normalization, and spectrum synthesis determination of abundances. A series of papers outlining the survey goals, observational strategies and detailed pipeline processing are in preparation, expected to be online by late 2014.

AAOmega Upgrade

The instrument

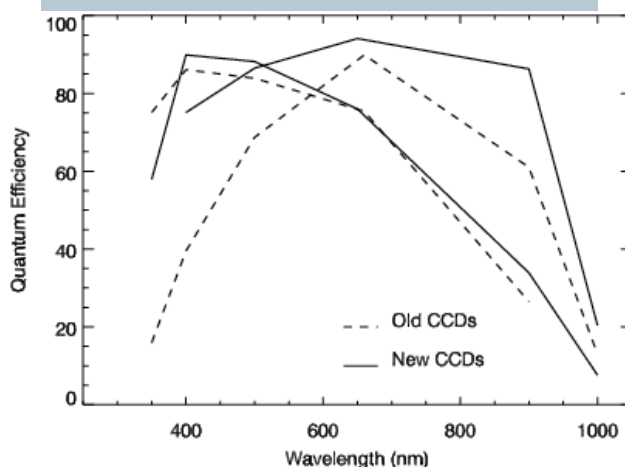
AAOmega is an existing dual-beam spectrograph on the AAT, with blue and red arms. At low resolution the spectrograph covers 370-850nm and is tuneable over this range at higher resolutions. The primary objective of the AAL-funded upgrade was to improve the efficiency and image quality at the blue and red wavelengths. This will increase the quality of science produced, increase the speed at which data can be gathered and open up new science windows at high redshift.

Progress and current status

During 2013/14 the new blue and red CCDs were thoroughly performance tested, with the results (shown at right) demonstrating a significant improvement in the quantum efficiency (QE) of the new red CCD of the spectrograph, enabling better performance at higher wavelengths. There is a small improvement of the QE in the blue arm, but more importantly in the blue arm, the new science grade 0 chip will bring significant improvements in cosmetic image quality over the old chip.

The blue CCD replacement was undertaken in February 2014. During the testing that followed, it became apparent that the new CCD would not maintain the stable temperature required for science observations. While AAO engineers detected and solved the problem, some rescheduling of science

Measured quantum efficiencies for the old (dashed) and new (solid line), blue (lower wavelengths) and red (higher wavelengths) AAOmega CCDs.



programs was required on short notice.

Observations using AAOmega resumed in early April, with all issues resolved.

The red CCD has been scheduled for replacement in August-September 2014.

AAT Building Upgrade

The project

The Australian Astronomical Observatory (AAO) are undertaking important maintenance of the Anglo-Australian Telescope (AAT) building and support structures to allow it to continue functioning reliably and within safety standards.

Three sub-projects are supported through AAL-managed NCRIS-2013 funds:

- Telescope Hydraulic Oil System replacement: The aging hydraulic system, including oil cooling system, will be replaced with modern systems that will be more efficient and reliable, and will comply with the current electrical wiring standards.
- Main Dome Shutter and Windscreen Electrical replacement: The electrical controls of both systems will be replaced with a modern programmable logic controller (PLC) system. The control system will be redesigned to ensure that both the main shutter and the windscreen are electrically interfaced with existing control systems, such as the telescope control system and the emergency brake system on the main shutter. The redesigned system with a modern PLC will then be assembled / tested / integrated into the existing systems and installed on the dome.
- Windscreen Maintenance Platform maintenance: A registered mechanical engineer will assess the windscreen, and design a suitable support structure with anchor points and guard rail.

Each of these three components will involve a tendering, design, fabrication, installation and commissioning phase, all of which will be completed by 30 June 2015.

The AAT. Image credit:
Ángel R. López-Sánchez,
AAO/Macquarie University



A photograph of a radio telescope antenna inside a dome. The antenna is a large, white, horn-shaped structure mounted on a black metal frame. In the foreground, a black metal frame holds several electronic components, including a large circuit board with various components and a smaller unit labeled 'F30'. To the left, there are more electronic components and a bundle of cables. The background shows the interior of a dome with a large circular opening at the top, through which bright light is coming. A yellow light fixture is visible on the right wall.

Radio Telescopes

Radio astronomy is a rapidly evolving discipline as the world prepares for the next-generation massive radio telescope - the Square Kilometre Array (SKA). Australian expertise in radio astronomy, based on extensive experience with our established national facilities, continues to strengthen with the development of two SKA pathfinder telescopes at the Murchison Radio Observatory in Western Australia.

An Australia Telescope Compact Array (ATCA) 4cm receiver installed on an antenna. Image credit: Christophe Brem

Radio Telescopes: SKA Pathfinders

One of the key priorities of the Australian astronomical community is to ensure that Australia is in the best possible position to participate in and host the international multi-billion dollar Square Kilometre Array (SKA). To advance this priority, AAL has provided support to both the Australian SKA Pathfinder (ASKAP) and the Murchison Widefield Array (MWA) projects. ASKAP and MWA are two of three SKA Precursor telescopes and are both located at the Murchison Radio-astronomy Observatory in the mid-west of outback Western Australia, a location chosen for its extremely low levels of radio frequency interference.

In 2013/14, AAL committed CRIS and NCRIS-2013 funding to support the operations of both ASKAP (\$7.64M) and MWA (\$1.18M) through to mid-2015. AAL's NCRIS-2013 agreement with CSIRO has enabled ASKAP to be equipped with six additional second-generation (Mark II) Phased Array Feeds (PAFs), bring the number of funded Mark II PAFs to a total of 30.

Artist's impression of the low-frequency SKA antennae (SKA-low). Image credit: Swinburne Astronomy Productions/ICRAR/U. Cambridge/ASTRON.



Murchison Widefield Array

The telescope

The MWA is the official low-frequency SKA precursor telescope and provides a unique window on the Universe in the 80-300 MHz band at the world's best site in this frequency range. MWA consists of 128 aperture arrays (known as tiles) that are distributed over a 3km-wide area. Curtin University owns and operates the MWA telescope, and is the lead partner in the MWA consortium that includes 11 other institutions from Australia, India, the United States and New Zealand.

MWA performs large surveys of the entire Southern Hemisphere sky as well as deep observations on targeted regions. It enables astronomers to pursue four key science objectives. The primary endeavour is the hunt for intergalactic hydrogen gas that surrounded early galaxies during the cosmological epoch of reionization. MWA is also providing new insights into our Milky Way galaxy and its magnetic field, pulsing and exploding stellar objects, and the science of space weather that connects our Sun to the environment here on Earth.

Progress and current status

2013/14 saw the launch of MWA (see Project Highlight on page 4) and the inaugural semester of scientific observations during July - December 2013. A high level of availability throughout the semester allowed the observing targets to be significantly exceeded. In total, 782 hours of observing were conducted and 933 terabytes of data taken during this first semester. Observing targets for the next semester covering February - June 2014 were also comfortably met.

2013/14 also saw the MWA operations model mature. Understanding of key issues and early operations risks—including power costs and the reliability (failure rate) of hardware in the field—has improved considerably and allowed further refinement of the operations model and procedures.

The MWA Operations Team at Curtin also made substantial progress in the development of tools that leverage the wealth of information available within the MWA architecture to support efficient instrument and science operations. These tools can be generated in near-real time from 'live' data to assist in

identifying and diagnosing instrument faults and are also applied retrospectively to help improve quality checking and flagging of data.

Facilities such as the MWA exist to support a community of users and are ultimately measured in terms of the service and data they provide. Significant progress was made in this key area through the reporting period. The MWA team developed, commissioned and continues to refine a variety of archive tools and interfaces in collaboration with members of the MWA science community.

The MWA is also making significant progress in the challenge of handling and moving the large volumes of data that will characterise next generation radio-astronomy facilities. During the reporting period nearly a petabyte of data was successfully mirrored to an archive at the Massachusetts Institute of Technology using automated archive mirroring protocols. The latency of these transfers—time from observation to on disk at MIT—has continued to improve (within underlying network constraints) to the point where the 5 terabytes of data taken in a night's observing can be archived at MIT within a few hours of the observations being conducted.

Senator Kim Carr (right) and Prof Steven Tingay (left) at the launch of MWA operations. Image credit: MWA Project



MWA Key Performance Indicators FY2013/14

Publications

Number of facility-related refereed journal articles (during first year of operations)	8
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Usage		Semester 13B	Semester 14A
Number of users of facility (proposal co-authors)	Australian	66	70
	International (co-investigators on successful Australian proposals)	81	94
Number of institutions whose researchers used the facility	Australian	12	11
	International	28	36
Number of student users of the facility		17	15

Percentage of time facility was available for observing	During 2013B/2014A	> 90%
	During the funded duty cycle	100%

Total number of hours of facility time used	1561 hrs
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Technical Highlight

Realisation of the full imaging power of the MWA

Recent results show that the full imaging potential of the MWA is being quickly realised and an excellent understanding of the instrument is being developed. This has involved scientists and engineers working closely together to develop and refine calibration algorithms and models for fundamental aspects of the instrument such as the primary beam response. Many of these lessons are being carried over into the SKA project, informing the design of SKA-low via the federally funded SKA pre-construction program.

The image below shows a large portion of the plane of our Milky Way, the galaxy in which we live, imaged by the Murchison Widefield Array as part of the GaLactic and Extragalactic MWA (GLEAM) Survey. The image shows structure in the Galaxy on a wide range of spatial scales, highlighting the ionised gas and magnetic fields that pervade the Galaxy, as well as many remnants of massive stars in the form of supernova remnants.

A three-colour image of the Milky Way extracted from an MWA drift scan. Image credit: Luke Hindson (Victoria University of Wellington), Natasha Hurley-Walker (Curtin University), the GLEAM team, and the MWA consortium



Australian SKA Pathfinder

The telescope

ASKAP is CSIRO's new wide field-of-view telescope made up of 36 antennas, each 12 metres in diameter, using innovative award-winning Phased Array Feeds (PAFs). Whilst ASKAP is a ground-breaking world-class telescope in its own right, it is also a key demonstrator instrument for new technologies being developed for the SKA project.

The ASKAP project has four principal goals:

- Delivering a world-leading instrument to study the southern sky and address the biggest questions regarding our knowledge of the Universe, in particular to establish and explore science themes that will be fully exploited by the SKA.
- Establishing a world-class astronomical observatory at the world's best site for metre and centimetre radio astronomy, attracting science engagement and further international investment to Australia, including the SKA.
- Developing new technologies to advance radio astronomy, such as innovative phased array feeds, and demonstrating its viability for the SKA
- Fostering the next generation of astronomers and engineers, the people who will build and use the SKA

Industry Linkages

CSIRO's ASKAP and SKA engagement with industry continued in 2013/14 through briefings, publications and tender updates, and early-phase research and development collaborations. Through the ASKAP project, CSIRO is working with a number of Australian Small and Medium Enterprises (SMEs) to solve complex challenges involved in building a next-generation radio telescope, and build the expertise required for the future multi-billion dollar international SKA project.

Working with NSW-based SME, Innovation Composites, CSIRO has developed high-strength, weather-proof, insulated casings to shield the receivers from radio frequency interference. These casings are lighter and more cost-effective than previous designs, and may have broader applications. Additionally, CSIRO has engaged another local business, Puzzle Precision, to produce sophisticated electronic circuit boards and major components for the ASKAP digital systems. These relationships are contributing to the success of ASKAP, and have enhanced Australian capability in the production of mission-critical, highly reliable components for radio astronomy infrastructure.



An assembly line of electronics boards for the ASKAP Mark II PAF at Puzzle Precision in Newcastle, NSW. Image credit: CSIRO.

Progress and current status

The ASKAP project team passed a number of important milestones during 2013/14.

The first-generation (Mark I) PAF receivers were installed on six ASKAP antennas on-site in Western Australia. These antennas – and associated digital systems, hardware correlator and beamformer – form the Boolardy Engineering Test Array (BETA). BETA commissioning and early science activities, such as investigations into calibration, data visualisation, imaging and beamforming, have been undertaken by the newly launched ASKAP Commissioning and Early Science (ACES) team. Remote access and control of the ASKAP antennas from the Marsfield Science Operations Centre in Sydney was established to assist in the debugging and commissioning of BETA.

Testing and observations with BETA resulted in many significant highlights, including: phase closure and the first multibeam image (validating the hardware design); neutral hydrogen absorption measurement demonstrations; the first spectral line image, or ‘data cube’ – the data of which was shared with the user community; a continuum image using the full 15 baseline capability of the test array; and galactic neutral atomic hydrogen which captured both the intensity of the radio waves and how the galaxy is rotating.

The design for the second generation (Mark II) PAF receiver system has been confirmed. Near-optimal system noise temperature results were achieved across the ASKAP frequency band, retiring technical risks around the Mark II systems. A prototype full-size Mark II PAF has been produced and deployed to Western Australia for on-site system testing.

In November 2013, the outstanding engineering excellence and innovation of the ASKAP PAF receiver system received well-deserved recognition with a National Engineers Australia Excellence Award, having already won two Sydney division Engineering Excellence Awards.

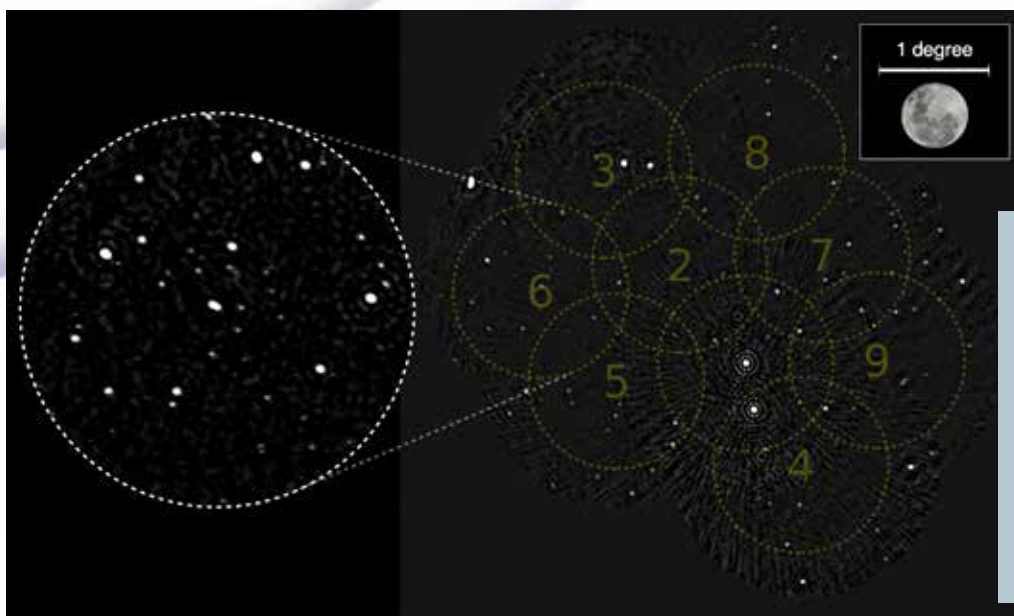
Early Adopter access and acceptance testing of the iVEC Pawsey Centre supercomputer began in 2013/14, along with further development of the CSIRO ASKAP Science Data Archive.

The project team have also been working closely with the ASKAP Survey Science Teams on simulations for the ASKAP Early Science program.

In November 2013, the SKA organisation announced that CSIRO will play a lead role in the next stage of the SKA project, through involvement in a number of R&D consortia, such as Dish, Infrastructure-Australia and Assembly, Integration and Verification.

The completed full-size Mark II phased array feed receiver in June 2014, undergoing final verification tests prior to deployment to the Murchison Radio-astronomy Observatory. Image credit: CSIRO.





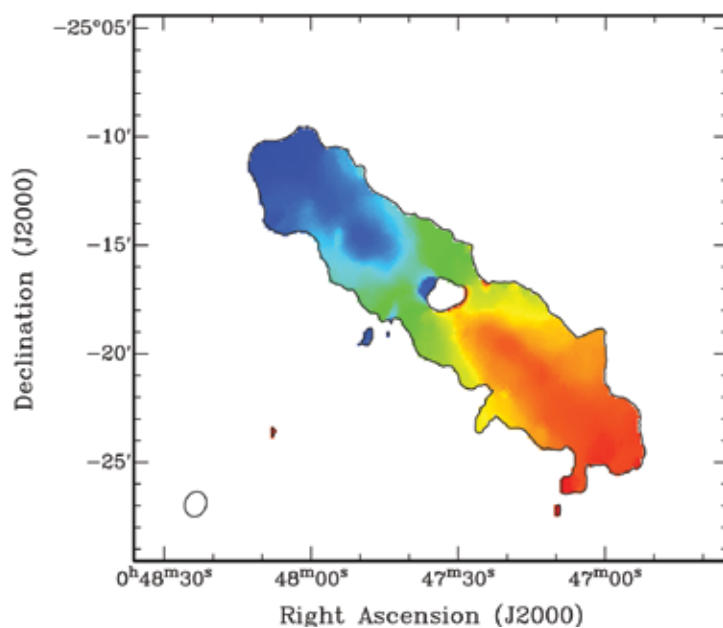
Technical Highlight

ASKAP commissioning images show telescope's potential

By June 2014, after just a few months of commissioning, new images of the sky using ASKAP demonstrated that it is functioning very well as an aperture-synthesis telescope. One of the images, of a field containing a number of distant galaxies, covers 10 square degrees on the sky — 50 times larger than the full Moon — and was made from nine overlapping beams captured simultaneously, with a dynamic range of 50,000:1 (see image above).

Two novel features contribute to the high-quality of the images: CSIRO's phased array feed receiver technology that allows the telescope to see large areas of sky at once, and the ASKAP antennas' third axis of rotation.

ASKAP's 'snapshot' image of the galaxy NGC 253, made over just 11 hours. The colours show that the galaxy is rotating. The 'hole' in the centre is a region where radio emission is absorbed. Image credit: Paolo Serra and the ACES team/CSIRO.



Radio Telescopes: ATNF

The Australia Telescope National Facility (ATNF) is Australia's national radio observatory. The facility is operated by CSIRO and comprises of a number of telescopes, including ASKAP, Parkes and the Australia Telescope Compact Array (ATCA). In addition to providing operations funding for ASKAP, in 2013/14 AAL supported the ATNF by providing EIF funds for the upgrade of the ATCA C/X receivers. The upgrade has dramatically increased the sensitivity and spectral coverage of the telescope, helping to maintain the ATCA's competitive status in a new era of high sensitivity telescopes.

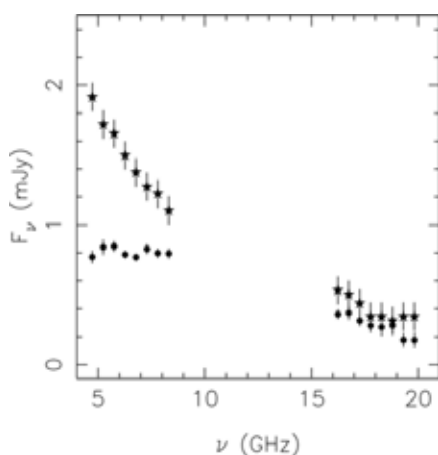
Australia Telescope Compact Array C/X Receiver Upgrade

The Project

The C/X upgrade project was the final phase of the ATCA centimetre receiver upgrade. The project has merged the 6cm and 3cm bands from the original separate (4.4 – 6.9GHz & 8.0 – 9.2GHz) bands to provide continuous improved coverage (4 – 10.8GHz). This complemented a previous low-frequency upgrade that improved the coverage of the 1.25 – 1.8GHz & 2.2 – 2.5GHz bands to approximately 1.1 – 3GHz.

Together, these upgrades have given the ATCA unprecedented access to the centimetre radio spectrum from 1.1 GHz to 10.8 GHz, while doubling its sensitivity and more than tripling its survey speed. This high performance capability is enabling fundamentally new scientific programs in many areas. These include the identification and understanding of transients detected by CSIRO's new ASKAP antennas and an improved understanding of magnetic field origins in galaxy disks and Active Galactic Nuclei.

ATCA measured flux of the Galactic centre magnetar, on 1 May (circles) and 31 May (stars) 2013 (Shannon & Johnston (2013). The measurements at 4.5 – 8.5 GHz were enabled by this upgrade.



Science Highlight

Upgraded ATCA used to probe magnetar at Galactic centre

The upgraded C/X receivers have been in routine operation for the entire year and are operating outstandingly well. The improved sensitivity of the broadband receivers has enabled new science by allowing the ATCA to detect weak emission into the distant Universe. The extended bandwidth and sensitivity have been particularly valuable for rapid follow-up, including spectral index measurements of transient events.

For example, the system has allowed astronomers to examine for the first time the magnetic field of a newly-discovered magnetar (a neutron star with a powerful magnetic field) at the centre of our Galaxy. Astronomers were able to detect pulsed emission and measure the polarization properties of the magnetar, located extremely close to Sagittarius A* at the centre of the Milky Way. These observations have given a direct probe of a magnetic field strength in the very core of the Galaxy. The measured flux across the 4.5 – 8.5 GHz band (and the 16 – 20 GHz band) is shown in the figure at left. The resultant paper (Shannon & Johnson, 2013) has already had high impact - being cited 13 times in 11 months.

Progress and current status

The final elements of the C/X receiver upgrade were completed in May 2014. In all, seven receivers were completed; six installed on the ATCA and one operational spare. The upgraded receiver systems are now part of routine scientific observations, and the 4cm receiver systems have 25% greater operating bandwidth and 40% lower system noise compared to the original 6/3cm receiver systems they replaced.

During 2013/14, the ATCA antennas were outfitted with all of the components necessary to allow real-time remote control and monitoring of radio-frequency signal levels from the receiver through to the Compact Array Broadband Backend system.

The existing ATCA C/X feed horns limit the performance of the system above 10.8GHz but replacement of these was outside the scope of the project. Evaluation of the performance of two prototype BAE Systems 4 – 12.25GHz feed horns is ongoing. The results of holography measurements indicate that the beam produced by the BAE Systems horn is better than that produced by the existing ATCA C/X feed horns. Astronomical evaluation of the performance of the feed systems is challenging, but ongoing. Continuation of this work is subject to funding and scientific priorities.



Henry Kanoniuk installing one of the prototype BAE systems 4-12.25GHz feed horns on an Australia Telescope Compact Array (ATCA) 4-12GHz receiver system. Image credit: Christophe Brem.

Commercial Highlights

The technology developed in the ATCA upgrade is in demand around the world:

- The Max Planck Institute for Radio Astronomy has placed an order for one of the 4 - 12GHz Ortho Mode Transducers (OMTs) developed as part of the 6/3cm upgrade.
- Discussions are underway for the provision of a 4 - 12GHz OMT and other waveguide components to Chalmers University. Interest has also been shown in using the 4 - 12GHz OMT in receiver systems that a private company, Omnisys, are seeking to develop for a Latvian radio astronomy observatory in partnership with Chalmers University.
- BAE Systems Australia has included the CSIRO 4 - 12GHz OMT as part of a submission to develop a multi-band receiver system for a large US antenna producer.

eResearch and High Performance Computing

Astronomy is a data-intensive discipline that faces technological challenges in dealing with rapidly growing datasets and the demand for complex and higher-resolution simulations. A driving force behind the international-competitiveness of the Australian astronomical community is access to High Performance Computing (HPC) facilities and the development of tools, hardware and services to fully exploit the Big Data returned from current and next-generation telescopes.

A simulated lightcone from the Theoretical Astrophysical Observatory at Swinburne University of Technology. Image credit: Max Bernyk

eResearch: High Performance Computing

The High Performance Computing (HPC) requirements of Australian astronomers are continuously pushing the limits of the available technology. There are currently three key supercomputing centres in Australia that provide dedicated national HPC access for Australian astronomers: the National Computational Infrastructure (NCI), iVEC, and Swinburne University of Technology (SUT). In 2013/14, AAL continued to support efforts in this space through the management of the Astronomy Supercomputer Time Allocation Committee (ASTAC) that uses a merit-based allocation process to assign time for astronomy projects at these three facilities. AAL has also supported the upgrade and operations of the GPU Supercomputer for Theoretical Astrophysics Research (gSTAR) at SUT using EIF, CRIS and NCRIS-2013 funds.

gSTAR

The Facility

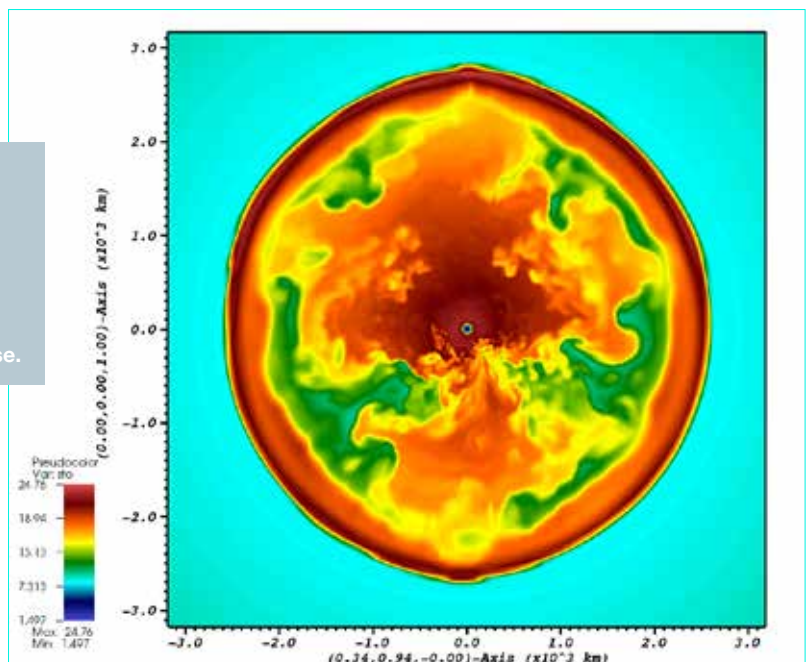
gSTAR provides the Australian astronomy community with a next-generation computing cluster based on graphics processing unit (GPU) technology. This technology offers an affordable path to a massive boost in processing power and helps keep Australian astronomers at the cutting-edge of theoretical research and able to efficiently process Big Data from next-generation telescopes. Specific gSTAR science drivers range from high-resolution simulations of galaxy formation to large-volume data processing.

The gSTAR facility places strong emphasis on user support, engagement and education, to give researchers and students the skills and support they need to fully exploit the advantages of the GPU architecture.

gSTAR is complemented by swinSTAR, a second phase of SUT's supercomputing system, funded primarily by SUT, but made available to the national astronomy community. In total there are 2220 CPU-cores and 167 GPUs. SUT has also added a separate 400TB storage area.

The overall capital value of the SUT supercomputing system is ~\$3M, and National astronomy researchers have access to a minimum 40% of the total compute capability and a minimum 200TB of storage. Access is through both a general access job queue and proposals to the merit-based allocation scheme overseen by ASTAC.

Monash astronomer Bernard Mueller has been using gSTAR to examine in 3D the evolution of intermediate mass stars through into their supernova explosion phase.



Progress and current status

gSTAR has become a very scientifically productive facility. In 2013/14, it provided the computational resources used in 47 refereed publications, 3 of which were in the highly prestigious *Science* or *Nature* journals.

Over the past year, gSTAR was also used in 6 ARC Future Fellowships and an ARC Discovery Project, and is being used to benchmark Square Kilometre Array (SKA) pulsar search algorithms and software as part of an SKA Pre-construction grant awarded to SUT. In addition, gSTAR acts as a pivotal component of the All-Sky Virtual Observatory (page 38), by hosting the Theoretical Astrophysical Observatory Node.

In 2013/14, NCRIS-2013 funding allowed SUT to add a “Projects and Engagement Support Leader” to the growing gSTAR team, which already includes a CRIS-funded software

support role and hardware support through Swinburne ITS. Consequently, gSTAR user engagement activities have ramped up, including roll-out of a new series of webinars and tutorials. Promotional activities for the facility included talks and displays at the major international Supercomputing 2013 conference in the USA. The first annual gSTAR User Survey was completed in 2013/14, with very positive feedback reflecting SUT’s strong user-focus.

An additional \$28K of EIF funding was provided by AAL in 2013/14 for the purchase of a gSTAR ‘data-sharing cluster’. This modest investment will yield big returns by enabling data generated by gSTAR projects to be readily shared to the wider world through a web-based interface. SUT has also approved the use of ~\$600K of its own funds to upgrade and expand the Lustre-based storage system from 1.8 to 3.0 petabytes.

gSTAR Key Performance Indicators FY2013/14

Publications

Number of facility-related refereed journal articles	47
Australian-based co-authors	87
International co-authors	188
Australian institutions	11
International institutions	72
Student co-authors	54

Usage

Uptime	96.3%
Total usage	11,042,000 CPU hours
Number of astronomy users of the facility	189
Australian-based users	161
International users	28
Students	86
Subscription rates	
Based on number of compute nodes in use	88%
Merit Allocation Scheme (time allocated compared to time available)	90%

Science Highlight

New Science from Old Data

The prodigious processing power of gSTAR allowed an Australian-led team to reprocess enormous volumes of data from the Parkes radio telescope to yield new insights into a new and potentially very powerful astronomical phenomenon known as “Fast Radio Bursts”, as reported in the journal *Science* (2013, DOI: 10.1126/science.1236789). These bursts might be caused by catastrophic events in the distant universe, and could help provide answers to fundamental questions such as how many electrons does the Universe contain. Australia is uniquely positioned to reveal the nature of these objects using our radioastronomy facilities Parkes, Molonglo and the Square Kilometre Array pathfinders.

Artist's composite of the CSIRO's 64m Parkes Radio Telescope showing an extragalactic radio burst appearing briefly, far from the Milky Way's disk. Image credit: CSIRO/Harvard/Swinburne Astronomy Productions



Astronomy Supercomputer Time Allocation Committee

AAL established ASTAC in 2011 to allocate dedicated computing resources for astronomy on the National Computational Infrastructure peak system and the Swinburne University of Technology (SUT) machine. ASTAC awarded time to 21 astronomy projects on these two supercomputing systems for 2013/14. Administrative duties of ASTAC were undertaken by SUT as of January 2014, as part of their activities under the NCRIS-2013 grant for gSTAR operations.

iVEC requested that ASTAC allocate time made available for national radioastronomy-related research on their new Galaxy supercomputer in the second half of 2014. ASTAC has previously allocated time on iVEC's Epic and Fornax machines, although in 2013/14 those machines were reserved for the operational requirements of the MWA and ASKAP radio telescopes.

eResearch: All-Sky Virtual Observatory

New astronomical telescopes are producing data in volumes never previously experienced in Australian astronomy. To gain maximum scientific benefit from this flood of information, datasets must become part of an astronomical data fabric that uses international standards and services to connect data to infrastructure and users. The All-Sky Virtual Observatory (ASVO | www.asvo.org.au) is a coordinated effort to build data infrastructure and services to link significant Australian astronomy datasets to the global Virtual Observatory network. Completed in early 2014, the first stage of ASVO was funded by National eResearch Collaboration Tools and Resources (NeCTAR) and the Department of Education, and built through a partnership involving AAL, Swinburne University, NCI/ANU and Intersect Australia Ltd.

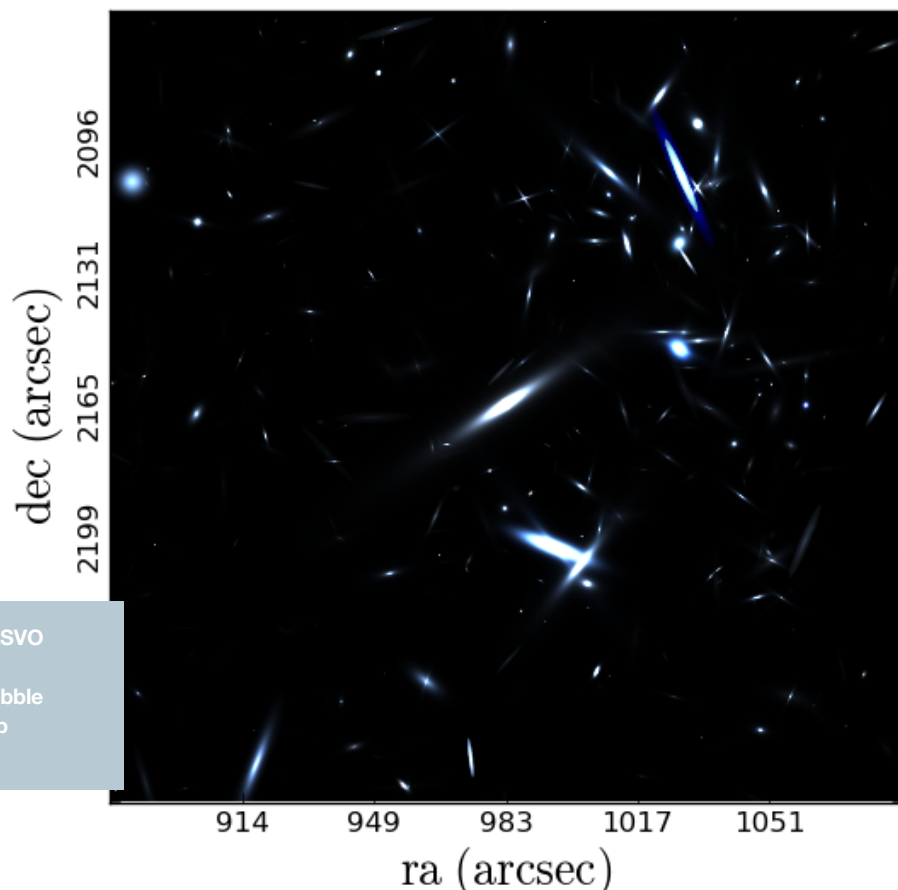
Progress and current status

Completed in 2013/14, ASVO version 1.0 comprises the following “Nodes”:

- *ASVO-TAO Node*: The Theoretical Astrophysical Observatory (TAO), deployed at Swinburne University of Technology and officially launched on 24th March 2014, houses a growing ensemble of complex simulation datasets and galaxy formation models, with value-add tools that enable researchers to easily create virtual universes to compare with real observations. A powerful feature of TAO is its telescope simulator that allows users to predict the observations expected from specific telescopes or instruments. The first three months of TAO operations saw very promising levels of early uptake, with the number of registered users rapidly rising to 150. Approximately half of the users are international researchers, indicating that the TAO promotional campaign has already been far-reaching, and that there may be a large world-wide user-base.
- *ASVO-SkyMapper Node*: Deployed at NCI/ANU this Node provides access to data from ANU's SkyMapper telescope, which is producing the most detailed and sensitive map of the southern sky at optical wavelengths, and will be a fundamental reference for astronomers around the world. ASVO-SkyMapper infrastructure was completed in April 2014, and the first public release of SkyMapper data is expected in early 2015.

To further expand ASVO and provide access to more datasets, AAL secured and allocated additional funds in 2013/14 to begin building two more ASVO Nodes: 1) ASVO-MWA: the first radioastronomy Node, which will support access to almost 10 petabytes of data from the Murchison Widefield Array telescope located in Western Australia, and 2) ASVO-AAT: which will provide access to key optical datasets from the Anglo-Australian Telescope (AAT) located in New South Wales.

Mock image of a proto-cluster created using the ASVO Theoretical Astrophysical Observatory. This image simulates what an observer might see from the Hubble Space Telescope's Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey (CANDELS).



International Collaboration in Emerging Fields



As astronomy research facilities increase in size, complexity and cost, the discipline has become highly collaborative. Minor partnerships in large international projects are often an effective way to gain access to cutting-edge facilities and build expertise in new areas of science. Australian astronomers and engineers realise the importance of participation in international collaborative projects, particularly where Australia can make unique and valued contributions.

Abraham Young and Craig Kulesa (U. Arizona) setting up the new HEAT telescope at Ridge A.
Image credit: Nic Bingham UNSW

International Collaboration in Emerging Fields: Antarctic Astronomy

The cold, dry and stable air above the high Antarctic Plateau provides the best atmospheric conditions of any Earth-based site for optical and infrared astronomical observations. Australian researchers are involved in a number of pioneering international projects to exploit the unique Antarctic environment, including the development and operation of a series of robotic observatories called PLATOs ("PLATeau Observatory") that have been deployed to several locations on the Antarctic plateau (Dome A, Dome Fuji, Ridge A) in collaboration with Chinese, Japanese, and US partners.

In the past year, AAL provided EIF, CRIS, and NCRIS-2013 funding to the University of New South Wales (UNSW) and Australian Astronomical Observatory (AAO) for the maintenance of PLATO-R (supporting the US-led High Elevation Antarctic Terahertz (HEAT) telescope); construction of instrumentation for Chinese-led AST3 project; and servicing and operation of PLATO-A (supporting Chinese Antarctic instruments). AAL funds have been augmented by internal funding from UNSW and AAO, and from an Australia-China Science and Research Fund Group Mission grant from the Australian Federal Government.

PLATO-R/HEAT

The telescope

UNSW's PLATO-R supports the HEAT telescope at Ridge A, Antarctica. HEAT is a 0.6-metre aperture terahertz telescope. Conditions on the Antarctic Plateau allow for ground-based terahertz observations which could otherwise only be achieved via high-altitude balloon or from space.

HEAT's main science driver is to map the Milky Way Galaxy at terahertz frequencies (THz) to give unique insight into the formation of stars. In particular, PLATO-R/HEAT can see emission from carbon atoms that is invisible to other telescopes.

Progress and current status

A key success from the last year has been the PLATO-R service mission completed in January 2014. This mission involved a complete replacement of the HEAT telescope to allow operation up to 1.5 THz, and a servicing of the PLATO-R power generation and control system. The mission was successful, with HEAT and PLATO-R embarking on their third year of operation at Ridge A. In early 2014, the first 1.5 THz observations were obtained. The data from HEAT's first two years of operation were made available to the Australian astronomical community in May 2014.

Science Goal

Mapping carbon in the Milky Way Galaxy

The HEAT telescope is constructing a carbon map of the Southern Milky Way, and making the first ground-based measurements of ionized carbon, the most luminous spectral line in the Milky Way, which can otherwise only be observed from airborne or space observatories. HEAT is constructing a spectroscopic map at terahertz frequencies, where the critical spectral emission features of the dominant forms of carbon are located (carbon atoms at 492 and 809 GHz, carbon ions at 1900 GHz, and the prominent carbon-bearing molecule CO, seen at regularly-spaced intervals starting at 115 GHz), and ionized nitrogen at 1.5 THz.

In May 2014, the PLATO-R/HEAT collaboration announced the public availability of Data Release 1 - data from the first two seasons at Ridge A (2012 through 2013). This includes nine strip maps slicing through the plane of the Galaxy as seen at right.



A US National Science Foundation proposal to extend the HEAT experiment into 2015 was successful, representing approximately \$1.5 million in new logistical support.

PLATO-R/PLATO-A Key Performance Indicators FY2013/14

Publications

Number of refereed journal articles with Australia co-authors	3
Number of conference proceedings papers	3
Australian-based co-authors	10
International co-authors	34
Australian institutions	5
International institutions	14
Student co-authors	2

Usage

Uptime	100%
Total usage (365 days x 24 hours per day x two facilities)	17,520 hrs
Number of users of the facility	52
Australian-based users	12
International users	40
Students	2
Number of institutions whose researchers used the facility	Australian 5 International 14

AST3/PLATO-A

The telescope

PLATO-A supports the AST3 project, an optical telescope facility being established by the Chinese Centre for Antarctic Astronomy at Kunlun Station, Dome A, Antarctica. The first of three AST3 telescopes was deployed to Dome A in the Antarctic 2011/12 summer. The telescopes are designed to be wide-field, high-precision survey instruments and the data will be used for a range of scientific programs, including searching for extra-solar planets and rapid detection of supernova explosions.

Progress and current status (AAL-funded projects)

1.7 terabytes of data from the AST3-1 telescope at Dome A was made available to Australian collaborators in 2013/14.

No traverse to Dome A was undertaken over the 2013/14 summer due to Chinese construction

of a new station midway between the coastal station - Zhongshan - and work over the last 12 months has thus focussed on preparing for the 2014/15 mission. In China, at the Nanjing Institute of Astronomical Optics and Technology, the second AST3 telescope is being prepared. Several subsystems, including the control system, the cooling system, and the detector Dewar, have been upgraded relative to AST3-1, with input from UNSW. Remote and low temperature operations have been extensively tested near the town of Mohe in northern China in early 2014.

At UNSW and the AAO, preparations are focussing on the servicing of the PLATO-A power module, and on the development and testing of two new site testing instruments that will measure the near infrared background. In parallel with these efforts, a new concept to design the third AST3 telescope to operate in the infrared Kdark band has been developed. This led to an ARC LIEF grant being submitted in early 2014.

International Collaboration in Emerging Fields: Pierre Auger Observatory

AAL is supporting Australian involvement in the \$150M Pierre Auger Observatory project by providing funding to the University of Adelaide to continue to operate its EIF-funded four cloud monitoring systems for the Observatory. Australian expertise in high energy astrophysics and, particularly, in the atmospheric techniques employed by the detectors at the Observatory have been highly valued in this international partnership.

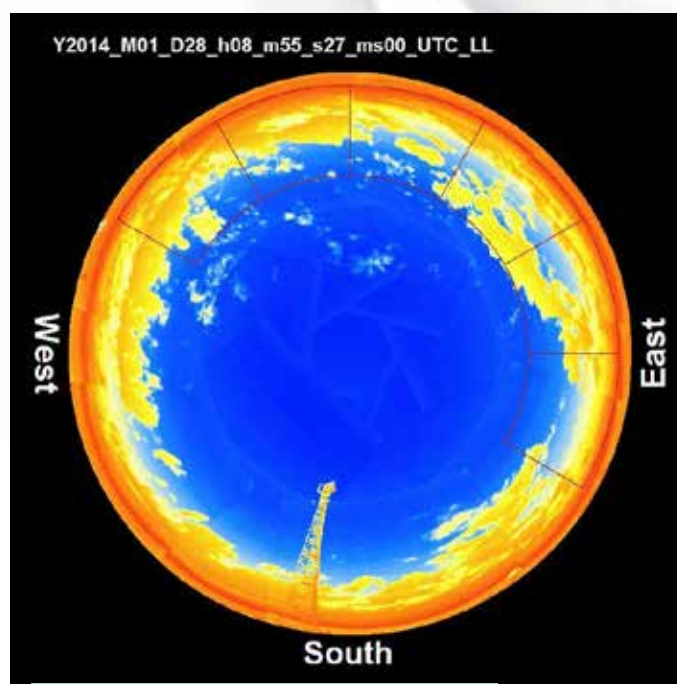
The Observatory

The Pierre Auger Observatory sits in the foothills of the Argentinean Andes mountains, observing high energy cosmic particles. It employs two main detection techniques: it has 1,660 large water Cherenkov radiation detectors which operate continuously and 27, 4 m diameter, UV telescopes which study the overall development of the cosmic ray cascades on clear moonless nights.

Interpreting data from these telescopes requires detailed knowledge of the cloud conditions over the whole 3000 square kilometre observatory. This is studied using an array of lasers, continuous star monitoring, and the Adelaide cloud cameras. These cameras provide detailed calorimetric energy information every five minutes, which is a vital component of the analysis chain.



A single night-time frame taken by an Adelaide infra-red camera at the Pierre Auger Observatory.



All-sky night-time mosaic of infra-red images using a scanning cloud camera at the Pierre Auger Observatory. The six framed areas correspond to the fields of view of six of the Observatory's Schmidt cameras. These images are produced at 5 minute intervals for use in real time by on-site observers.

Progress and current status

All four cloud cameras are operational in Argentina. They can be accessed remotely from Adelaide and are supported locally as necessary by a dedicated technician. Real-time full-sky images are available for observers in the dark lunar periods, and data specific to the fields of view of the UV cameras are retained for pixel by pixel cloud analysis. The cameras operate over a range of seasons with extremes of operating temperatures. Further development is currently being undertaken of calibration procedures to obtain true sky infra-red fluxes for camera temperatures beyond the manufacturer's calibrated range.

Publications

Antennas of CSIRO's ASKAP telescope at the Murchison Radio-astronomy Observatory in Western Australia. Image credit: CSIRO.

Publications in refereed journals in 2013/14 that made use of AAL-supported facilities and involve at least one Australian-based co-author. Bold face indicates Australian authors.

Gemini

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Pierre Auger

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Acronyms used in this report

AAAC	Antarctic Astronomy Advisory Committee	GALAH	GALactic Archaeology with HERMES
AAL	Astronomy Australia Limited	GLEAM	GaLactic and. Extragalactic MWA Survey
AAO	Australian Astronomical Observatory	GMOS	Gemini Multi-Object Spectrograph
AAT	Anglo-Australian Telescope	GMT	Giant Magellan Telescope
ACACA	Australia-China Astronomy Collaboration Award	GPU	Graphics Processing Unit
ACES	ASKAP Commissioning and Early Science	GST	Goods and Services Tax
AeRAC	Astronomy eResearch Advisory Committee	gSTAR	GPU Supercomputer for Theoretical Astrophysics Research
AGUSS	Australian Gemini Undergraduate Summer Studentship	HEAT	High Elevation Antarctic Terahertz (telescope)
ANU	The Australian National University	HERMES	High Efficiency and Resolution Multi-Element Spectrograph
ARC	Australian Research Council	HPC	High Performance Computing
ASA	The Astronomical Society of Australia	ICRAR	International Centre for Radio Astronomy Research
ASKAP	Australian Square Kilometre Array Pathfinder	iVEC	Interactive Virtual Environments Centre
ASTAC	Astronomy Supercomputer Time Allocation Committee	LIEF	Linkage Infrastructure, Equipment and Facilities (ARC grant)
AST3	Antarctic Schmidt Telescopes	MB	Megabytes
ASVO	All-Sky Virtual Observatory	MIKE	Magellan Inamori Kyocera Echelle
ATCA	Australia Telescope Compact Array	MoU	Memorandum of Understanding
ATNF	Australia Telescope National Facility	MRO	Murchison Radio-astronomy Observatory
AURA	Association of Universities for Research in Astronomy	MWA	Murchison Widefield Array
AusGO	Australian Gemini Office	NAS	National Academy of Sciences
BETA	Boolardy Engineering Test Array	NCA	National Committee for Astronomy
CASS	CSIRO Astronomy and Space Science	NCI	National Computational Infrastructure
CCD	Charge-coupled device	NCRIS	National Collaborative Research Infrastructure Strategy
CPU	Central Processing Unit	NCRIS-2013	National Collaborative Research Infrastructure Strategy 2013
CRIS	Collaborative Research Infrastructure Strategy	NeCTAR	National eResearch Collaboration Tools and Resources
CSIRO	Commonwealth Scientific and Industrial Research Organisation	OMT	Ortho Mode Transducer
DVC-R	Deputy Vice-Chancellor, Research	OOR	Overseas Optical Reserve
EIF	Education Investment Fund	OTAC	Optical Telescopes Advisory Committee
ELT	Extremely Large Telescope	PAF	Phased Array Feed
ESO	European Southern Observatory	PB	Petabytes
FAA	Fellow of the Australian Academy of Science	PLATO	Plateau Observatory
FAICD	Fellow of the Australian Institute of Company Directors.	PLC	Programmable Logic Controller
FAIP	Fellow of the Australian Institute of Physics	QE	Quantum Efficiency
FASA	Fellow of the Astronomical Society of Australia	RTAC	Radio Telescopes Advisory Committee
FIEAust	Fellow of the Institution of Engineers Australia	SKA	Square Kilometre Array
FIEChemE	Fellow of the Institution of Chemical Engineers	SME	Small and Medium Enterprise
FRACI	Fellow of the Royal Australian Chemical Institute	STAC	Science and Technology Advisory Committee
FRAS	Fellow of the Royal Astronomical Society	SUT	Swinburne University of Technology
FTE	Full time equivalent	swinSTAR	Swinburne Supercomputer for Theoretical Academic Research
FTSE	Fellow of the Australian Academy of Technological and Engineering Sciences	TAO	Theoretical Astrophysical Observatory
		TB	Terabytes
		THz	Terahertz
		UNSW	University of New South Wales
		UWA	University of Western Australia



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Located within the Centre for Astrophysics and Supercomputing, Swinburne University of Technology, Hawthorn, VIC 3122

Post: PO Box 2100, Hawthorn, VIC 3122

Chief Executive Officer

Mark McAuley
T: +61 3 9214 8036
E: mark.mcauley@astronomyaustralia.org.au

Executive Officer

Yeshe Fenner
T: +61 3 9214 5520
E: yeshe.fenner@astronomyaustralia.org.au

Office Manager

Catherine Andrews
T: +61 3 9214 5854
E: catherine.andrews@astronomyaustralia.org.au

Finance Manager

Sue Russell
T: +61 3 9214 8758
E: sue.russell@astronomyaustralia.org.au

Project Officer

Mita Brierley
T: +61 3 9214 8012
E: mita.brierley@astronomyaustralia.org.au

Project Administrator

Libby Armstrong
T: +61 3 9214 5854
E: libby.armstrong@astronomyaustralia.org.au