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CSIRO Australia Telescope National Facility

Annual Report
2014

CSIRO Australia Telescope National Facility Annual Report 2014

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This is the report of the CSIRO Australia Telescope National Facility for the calendar year 2014, approved by the Australia Telescope Steering Committee.

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Cover image: An antenna of the Australia Telescope Compact Array. Credit: Michael Gal

Inner cover image: Children and a teacher from the Pia Wadjarri Remote Community School, visiting CSIRO's Murchison Radio-astronomy Observatory in 2014. Credit: CSIRO

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Director's Report

Credit: Wheeler Studios

Dr Lewis Ball, Director, Australia Telescope National Facility

This year has seen some very positive results achieved by the ATNF staff, as well as some significant challenges. We opened a new office in the Australian Resources Research Centre building in Perth, installed phased-array feeds (PAFs) on antennas of our Australian SKA Pathfinder (ASKAP), and collected data with a PAF-equipped array for the first time ever in the world.

Ryan Shannon and Ron Ekers both won prestigious awards for their science, the ASKAP team won the top award in The Australian Innovation Challenge, and Emily Petroff, a PhD student at Swinburne University, became something of a celebrity as the lead in the first ever real-time detection of a Fast Radio Burst, one of the enigmatic short-lived radio bursts that have been intriguing astronomers for the past decade.

In the middle of the year we had to respond to an immediate reduction of CSIRO funding for radio astronomy, which necessitated some involuntary redundancies and the cancellation of a number of planned recruitments. This was a very difficult period, but thanks to the commitment of the staff the ATNF was able to navigate its way through it, with relatively little disruption apparent outside the organisation. However, to fit within the reduced budget we had to make significant changes to the operation of the Facility. Perhaps the most important of them was that astronomers can no longer run their observing sessions from the Compact Array control room, which previously had been the norm. While remote observing had been possible for years with the Compact Array, in 2014 it became the only mode of observing for the Compact Array, as it had become for Parkes in 2013. But although the change was triggered by a financial challenge, the new system has been extremely well implemented, and very positively received. In particular, the delivery of the Science Operations Centre in Marsfield with fully supported remote observing has received an excellent scorecard from the Australia Telescope Users Committee.

We began reducing CSIRO expenditure on the Mopra telescope some five years ago. This year's funding cut pushed us to take the final step along this path, and we will no longer support Mopra operations using CSIRO funds after the end of the 2015 millimetre-observing season.

The fact that nine of the 35 PhD students co-supervised by CASS staff are enrolled in overseas institutions demonstrates the international connectedness of astronomy and of ATNF science. This is of course consistent with the continued use of the ATNF telescopes by a very international scientific user base, as evident from the figures in the Time Allocation section of this report. The astronomers who use the ATNF telescopes continue to be very scientifically productive: they publish prolifically, and their papers affect the currents of scientific thought, as the citation figures show. The relative citation rate of scientific papers based on ATNF data is twice the global average for astronomy publications, a tremendous result showing that the ATNF provides excellent value and return on the investments of the Australian Government and CSIRO.

This report outlines a wide range of excellent science from the National Facility, and I am especially pleased to see a highlight from observations using the Tidbinbilla 70-metre telescope. Primarily dedicated to space tracking, and fully funded by NASA for that purpose, the Deep Space Network antennas are available for radio astronomy through the ATNF for up to five per cent of the year. They offer capabilities that complement those of the other ATNF telescopes, and can deliver excellent science.

Our commitment to staff wellbeing in all its dimensions—physical, mental and emotional—is very strong, and while we certainly don't get everything right in this regard we are determined to achieve positive outcomes and to continue to improve. ASKAP's record of zero lost-time injuries to date throughout the history of the construction project is tremendous, and the excellent health and safety incident counts across our activities are a tribute to the attention paid by staff to ensure that we all work in a safe manner. It is also very pleasing to note the creation of a Diversity and Inclusion Committee in CASS this year, and the receipt of a Bronze Pleiades Award from the Astronomical Society of Australia.

Finally, I think for me 2014 will be most memorable as the year that the team demonstrated the potential of an array of antennas fitted with phased-array feeds. The ASKAP Commissioning and Early Science (ACES) team brings together staff from across CASS and from a number of Australian universities. The ACES team used the Boolardy Engineering Test Array or BETA, comprising six ASKAP antennas fitted with the first-generation PAFs, to collect and combine data during 2014. This activity generated excitement that was palpable as I moved around CASS and talked to staff and to the wider astronomy community. Even the earliest commissioning results demonstrated the promise of the system, and when some initial science results became apparent from these early engineering tests the atmosphere was euphoric. ASKAP's performance is a tribute to all those who have worked so hard to conceive the system, design it, build it, and then figure out how to make it work. While completing the telescope will still require a lot of effort, in 2014 we saw the performance advances possible with the second-generation PAFs. I am very confident that the team will deliver a truly revolutionary telescope, one that will play a significant role in answering key questions in the Square Kilometre Array's science program.

Dr Lewis Ball

DIRECTOR,
AUSTRALIA TELESCOPE
NATIONAL FACILITY

Credit: Bureau of Meteorology

Dr Susan Barrell, Chair, ATNF Steering Committee

Chair's Report

The Steering Committee was pleased with the operation and achievements of the Australia Telescope National Facility (ATNF) during 2014 under the direction and leadership of Dr Lewis Ball, and welcomed the strong support it received from Lewis and his team. The Committee continued to provide independent advice to guide the strategic directions, performance and allocation of observing resources for the facility, with its consideration focussed principally on three main issues.

First, in response to budget pressures faced by CSIRO Astronomy and Space Science (CASS), the Committee encouraged the Director to explore options for retaining astronomy capability and more closely aligning it with CASS's long-term strategic priorities, specifically development of the Australian SKA Pathfinder (ASKAP) and the Square Kilometre Array (SKA), and to more tightly couple science activities to the development and delivery of ATNF's world-class facilities. Retaining the Bolton Fellowship program was seen as particularly valuable. The Committee commended the Director for consulting the user community, via the Australian Telescope Users Committee, in formulating the budget response. It endorsed the proposed operational changes at ATNF facilities, recommending that advice of the likely changes be shared with the community at the earliest opportunity.

Second, the Steering Committee congratulated CSIRO on the excellent progress made on ASKAP commissioning and construction, noting that the flow of results from ASKAP commissioning continues to build confidence and excitement in the astronomy community. It welcomed the early science outcomes that are already being prepared for publication. The Committee recognised the organisation's engineering achievements as well and was delighted to be informed that ASKAP had been awarded the top prize in the national Australian Innovation Challenge Awards.

The third issue the Steering Committee considered was the SKA strategy: in particular, how a CSIRO SKA entity would need to be structured and behave to successfully operate SKA Australia on behalf of the partners. The Committee noted that such an entity would need significantly more autonomy than CASS currently has and recommended that CSIRO develop, in close cooperation with the SKA Organisation and the Australian SKA Office, a structure and process for SKA operations. The Committee noted that emerging developments late in the year, in relation to the governance of national research infrastructure for astronomy, would need to be taken into account in further developing Australia's SKA strategy.

The Steering Committee reflected on the convergence of a number of resourcing, capability and strategic issues impacting the facility and affecting the broader radio-astronomy user community, and urged CSIRO to continue efforts to communicate its future path in radio astronomy, with ASKAP and SKA science as a clear priority.

Doctor Susan Barrell

**CHAIR,
ATNF STEERING COMMITTEE**

The ATNF in Brief

The Australian SKA Pathfinder. Credit: CSIRO

The ATNF in Brief

CSIRO's radio-astronomy observatories are collectively known as the Australia Telescope National Facility, or ATNF. Offering a unique view of the southern-hemisphere radio sky, this set of radio telescopes is a national research facility used by both Australian and international researchers. The ATNF is operated by CSIRO's Division of Astronomy and Space Science (CASS). This report covers ATNF-related activities of CASS over the 2014 calendar year.

THE CASS MISSION AND VISION

CSIRO Astronomy and Space Science (CASS) operates world-class facilities for radio astronomy, and for spacecraft tracking and communications, on behalf of Australia. These capabilities exploit our unique southern-hemisphere location and radio quietness, and contribute to the fundamental goal of understanding of the Universe.

CASS will continue to operate and maintain the Australia Telescope National Facility. It also aims to become the Australian operator of the international Square Kilometre Array (SKA) telescope, which will be sited in both Australia and Africa. CASS's top priority is now completing and operating its Australian SKA Pathfinder telescope. This is located at the Murchison Radio-astronomy Observatory in Western Australia, which will house the Australian component of the SKA.

The Canberra Deep Space Communication Complex (CDSCC) will continue to support the future of space exploration through state-of-the-art tracking and communications capability at Tidbinbilla, ACT, as part of a global 'follow the Sun' mode for NASA.

AN OVERVIEW OF THE ATNF

The Australia Telescope comprises receiving antennas, associated instrumentation, control systems and computing capability at four observatories, supported by staff and facilities at the CSIRO Radiophysics Laboratory in Marsfield, Sydney (the headquarters of CSIRO Astronomy and Space Science). Three observatories are near the New South Wales towns of Parkes, Narrabri and Coonabarabran, and a fourth (the Murchison Radio-astronomy Observatory or MRO) is located in the remote Mid West region of Western Australia.

The Parkes telescope. Credit: Cormac Purcell

The Parkes Observatory is home to the 64-m Parkes radio telescope, a single, fully-steerable antenna. It is equipped with receivers that operate in frequency ranges from 74 MHz to 26 GHz, with bands in the range from 700 MHz to 9 GHz being the most commonly used. This telescope has been operated successfully since 1961 and is famous as a national symbol of Australian scientific achievement. Instrumental upgrades, including a 13-beam focal-plane array and innovative backend signal-processing instrumentation, have maintained it as a state-of-the-art instrument.

The Compact Array. Credit: Cormac Purcell

Six identical 22-m antennas make up the Australia Telescope Compact Array (ATCA), an earth-rotation synthesis telescope located at the Paul Wild Observatory outside Narrabri. The ATCA is equipped with receivers that operate at frequencies between 1.0 GHz and 105 GHz, and its antennas ride on a six-kilometre track that allows multiple configurations and observing baselines. Recent upgrades with new receivers have given the Compact Array almost complete frequency coverage over the range 1.1–12 GHz and a substantial improvement in system-noise performance.

ASKAP antennas. Credit: Flornes Yuen

CASS's next-generation radio telescope, the Australian Square Kilometre Array Pathfinder (ASKAP), is currently being commissioned. When fully operational, it will become part of the Australia Telescope National Facility. ASKAP will be a wide field-of-view survey telescope made up of 36 antennas, each 12 metres in diameter, using new, innovative phased-array feeds designed and built by CSIRO. It is located at CSIRO's Murchison Radio-astronomy Observatory (MRO), a superbly radio-quiet area in the Mid West region of Western Australia, and will be a key demonstrator instrument for new technologies for the international Square Kilometre Array (SKA) project. The MRO Support Facility (MSF) in Geraldton supports the development and operation of the Murchison Radio-astronomy Observatory.

The Mopra telescope. Credit: Cormac Purcell

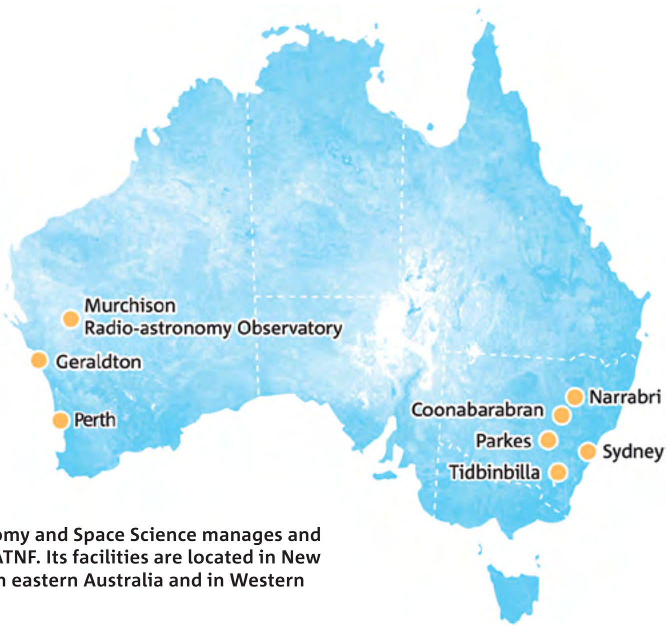
The Mopra radio telescope is a single 22-m diameter antenna near Coonabarabran, used primarily in the winter season for large-scale millimetre-wavelength mapping projects and as part of the Long Baseline Array.

CASS also manages the host country astronomical use of the 70-m and 34-m antennas at the CSIRO-administered Canberra Deep Space Communication Complex, located at Tidbinbilla (near Canberra). NASA/JPL makes available approximately 5 per cent of time on the 70-m antenna for astronomical research programs.

The ATNF radio telescopes can be used together as a Long Baseline Array (LBA), sometimes in conjunction with antennas operated by the University of Tasmania at Ceduna and Hobart, the Tidbinbilla 70-m antenna, and a 12-m antenna operated by AUT University at Warkworth, New Zealand. The technique of using widely separated telescopes in concert is known as very long baseline interferometry (VLBI).

During 2014, CASS continued to expand its office in Perth, Western Australia. As well as providing practical support for permanent and visiting CASS staff and visitors, this important presence allows CASS to interact closely with the radio-astronomy community in Western Australia, and with the State Government. The CASS office is within the Australian Resources Research Centre (ARRC), which is close to the Pawsey Centre, Curtin University and the International Centre for Radio Astronomy Research (ICRAR).

The Canberra Deep Space Communication Complex. Credit: CDSCC



CSIRO Astronomy and Space Science manages and operates the ATNF. Its facilities are located in New South Wales in eastern Australia and in Western Australia.

Mary D'Souza (at left), the Senior Mechanical Engineer at the Murchison Radio-astronomy Observatory (MRO) and the MRO Support Facility in Geraldton, with Jessica Chapman, ATNF Data Management Leader.

GOVERNANCE

The Australia Telescope is operated by CASS as a national facility under guidelines originally established by the Australian Science and Technology Council. Following an internal restructure in mid 2014, CASS moved into CSIRO's National Facilities and Collections (NF&C) group along with other national facilities that are owned and operated by CSIRO but used extensively by external researchers. Dave Williams is the Executive Director, National Facilities and Collections, reporting to the Minister for Industry and Science via the CSIRO Executive. CASS Director, Lewis Ball, is also the Director of the ATNF.

Divisional policy, strategic planning and operational management are the responsibility of the CASS Executive which comprises the Director (Lewis Ball), the Deputy Director (Sarah Pearce), Assistant Directors (Douglas Bock, Simon Johnston, Antony Schinckel, Tasso Tzioumis, Phil Crosby), CDSCC Director (Ed Kruzins), and Operations Manager (Warren Bax). During 2014, observers on the CASS Executive included: Michelle Storey (SKA Centre Executive Officer), Jessica Chapman (Data Management Leader) and Mark McKinnon (SKA Dish Consortium leader). During the year, CASS continued to implement its 2012–2015 Strategic Plan guided by the CASS/ATNF mission statement.

ATNF policy is shaped by the Australia Telescope Steering Committee (ATSC), an independent body that meets at least once a year to advise the Director about the broad directions of the ATNF's scientific activities and longer-term strategies for the development of the Australia Telescope. The Steering Committee appoints the Australia Telescope Users Committee (ATUC) and the Time Assignment Committee (TAC). ATUC represents the interests of the community of astronomy researchers who use the Australia

Telescope. The Committee provides feedback to the ATNF Director, discussing issues with, and suggesting changes to, ATNF operations. It also discusses and provides advice on the scientific merit of future development projects. ATUC meetings are also a forum for informing telescope users of the current status and planned development of ATNF facilities, and recent scientific results. The TAC reviews proposals and allocates observing time.

The ATSC, TAC and ATUC members for 2014 are listed in Appendix A.

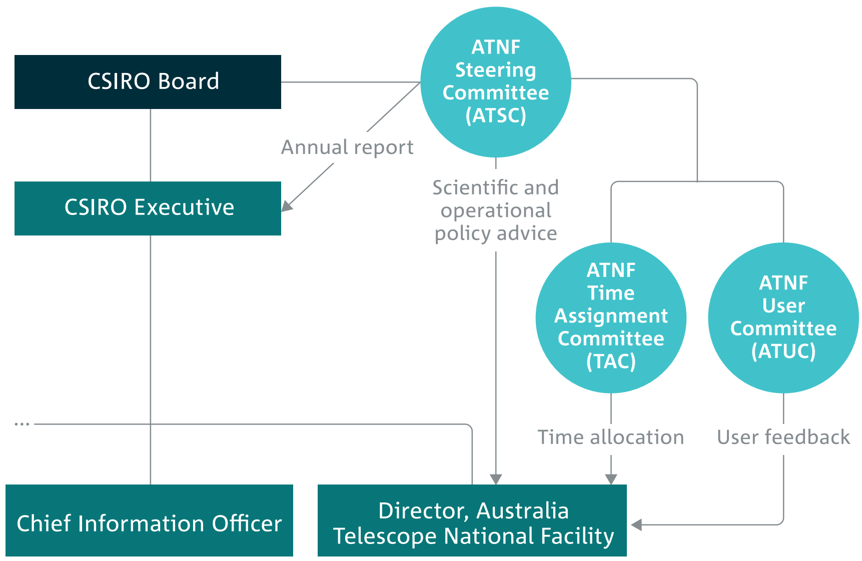
CASS MANAGEMENT CHANGES IN 2014

The only significant management change during 2014 was the appointment of Dr Tasso Tzioumis as Assistant Director, Engineering. He replaced Graeme Carrad, who retired.

FUNDING

CSIRO's funding was reduced in the Australian Commonwealth Budget of May 2014, and this flowed through to a significant reduction of appropriation for radio astronomy. CSIRO's substantial provision of capital funds for ASKAP were not affected, and the reduction was offset by a significant increase of external revenue associated with new commitments, primarily involving SKA-related activities. (CASS's space tracking activities are entirely funded by NASA/JPL and so were also not affected.)

These financial pressures required a rapid reduction in staff numbers relative to the planned level, including involuntary redundancies, and a lowering of other ongoing costs. Reductions in the scientific capability of the Parkes telescope and the Compact Array resulted from changes to operations in order to achieve savings, and the decision was taken to cease the use of CSIRO funds towards the operation of Mopra after late 2015. We discussed these changes extensively with the astronomical community, which provided useful guidance about its priorities.



RESEARCH AREAS

Astronomy and Astrophysics

The ATNF conducts world-class research in astrophysics, contributing to astronomy's position as Australia's highest-impact fundamental science.

CASS Technologies

The ATNF works to ensure that its telescopes remain at the leading edge of world technology, thus maximising the science outcomes from astronomy.

ASKAP

The ATNF is delivering the Australian Square Kilometre Array Pathfinder (ASKAP) telescope at the Murchison Radio-astronomy Observatory (MRO) in Western Australia.

ATNF Operations

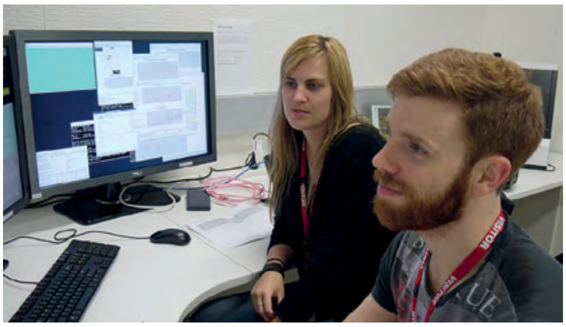
Operations staff provide specialist management of complex radio-astronomy facilities and Science Operations Centres for Australian and international researchers.

CSIRO SKA Centre

The Centre manages CSIRO's contribution to the SKA, including radio-quiet site preparation, pre-construction design and verification of the instruments, and engagement with stakeholders. The Centre leads Australia's bid to be the SKA Site Entity and SKA operator.

The Canberra Deep Space Communication Complex (CDSCC)

The CDSCC meets the Australian Government's obligations under the USA-Australia agreements for deep-space tracking and communications in Australia.



Visiting observers, Nichol Cunningham and Simon Purser (University of Leeds) operating the Compact Array from the Science Operations Centre at Marsfield. Credit: Helen Sim

THE AUSTRALIA TELESCOPE COMMUNITY

At the end of 2014 CASS had around 280 research scientists, engineers, and technical and administrative support personnel, of whom around 190 were primarily associated with the ATNF. (This number excludes casuals, contractors and students.) As part of a CSIRO re-structure, CASS welcomed eight staff who had previously been part of the Computational Informatics Division, but had been working primarily on CASS projects. Appendix C lists staff who, as of December 2014, worked for CASS activities related to radio astronomy.

The primary user base of the Australia Telescope is the Australian and international university community. Approximately 90 per cent of the Australia Telescope's users come from outside CSIRO and 80 per cent are from outside Australia. About 85 per cent of refereed publications based on ATNF facilities are collaborations between Australian and international researchers. Users gain access to our facilities on the basis of scientific merit and use them without charge. Overseas users typically win 40 to 50 per cent of telescope time (see page 19). Australian astronomers obtain reciprocal access to overseas facilities on the same principle. This 'open skies' policy follows the general practice of the international radio-astronomy community.

Co-supervised PhD student Vanessa Moss (University of Sydney) at the Compact Array. Credit: Vanessa Moss

The ATNF headquarters hosts a constant stream of astronomers from around the world who visit for periods of between a few days and a few weeks. Some of these visitors are observers passing through on their way to the observatories. Others are part of the Scientific Visitor Program, or are giving scientific colloquia. The Science Operations Centre provides desk space for visitors and a place where staff and visitors can meet and discuss their science. Such interactions are important for the international and collaborative nature of astronomical research carried out by CASS astronomers.

Research scientists and engineers are heavily involved in the training of postgraduate students, and this helps to strengthen the interactions between CASS staff and university colleagues. In 2014 CASS staff co-supervised 35 PhD students, 26 of whom were undertaking degrees at Australian universities. CSIRO provides direct financial support to most of these students, supplementing the funding they receive through their host universities. Most of the PhD students currently with CASS have an Australian Postgraduate Research Award.

THE WIDER ASTRONOMICAL COMMUNITY AND OTHER RELATIONSHIPS

The Australia Telescope Steering Committee provides the ATNF Director with strategic advice from the Australian and international research community. CSIRO staff provide similar input to other parts of the research community.

CSIRO is a full member of Astronomy Australia Ltd, an organisation established in early 2007 as a company with the principal objective of managing the National Collaborative Research Infrastructure Strategy (NCRIS) funds for astronomy.

CSIRO is also a member of CAASTRO (the ARC Centre of Excellence for All-sky Astrophysics). CAASTRO is a partnership and collaboration between several Australian and international universities and research institutions.

CSIRO is a corporate member of the Astronomical Society of Australia, and sponsors national events such as the 'Women in Astronomy' workshop and the ASA Annual Science Meeting, which in 2014 was held at Macquarie University in Sydney.

CASS manages CSIRO's largest external revenue agreement, which is with NASA/JPL, for space tracking and communications

The ATNF's Dr Lisa Harvey-Smith during shooting of a 3D video at the Murchison Radio-astronomy Observatory. The video will be used for CSIRO outreach.

services, and has other contracted links with the research and space community for the provision of instrumentation, technical designs, data and research outcomes.

Engagement with university partners is seen Engagement with university partners is seen as increasingly important and CASS will continue to pursue it actively, as a means of both broadening the ATNF resource base and ensuring the vitality of the Australian astronomy research community as a whole. This year, CSIRO and ICRAR (the International Centre for Radio Astronomy Research, which comprises Curtin University and the University of Western Australia) formed a strategic alliance in radio astronomy that is aimed at achieving mutual benefit as both organisations work towards the realisation of the Square Kilometre Array.

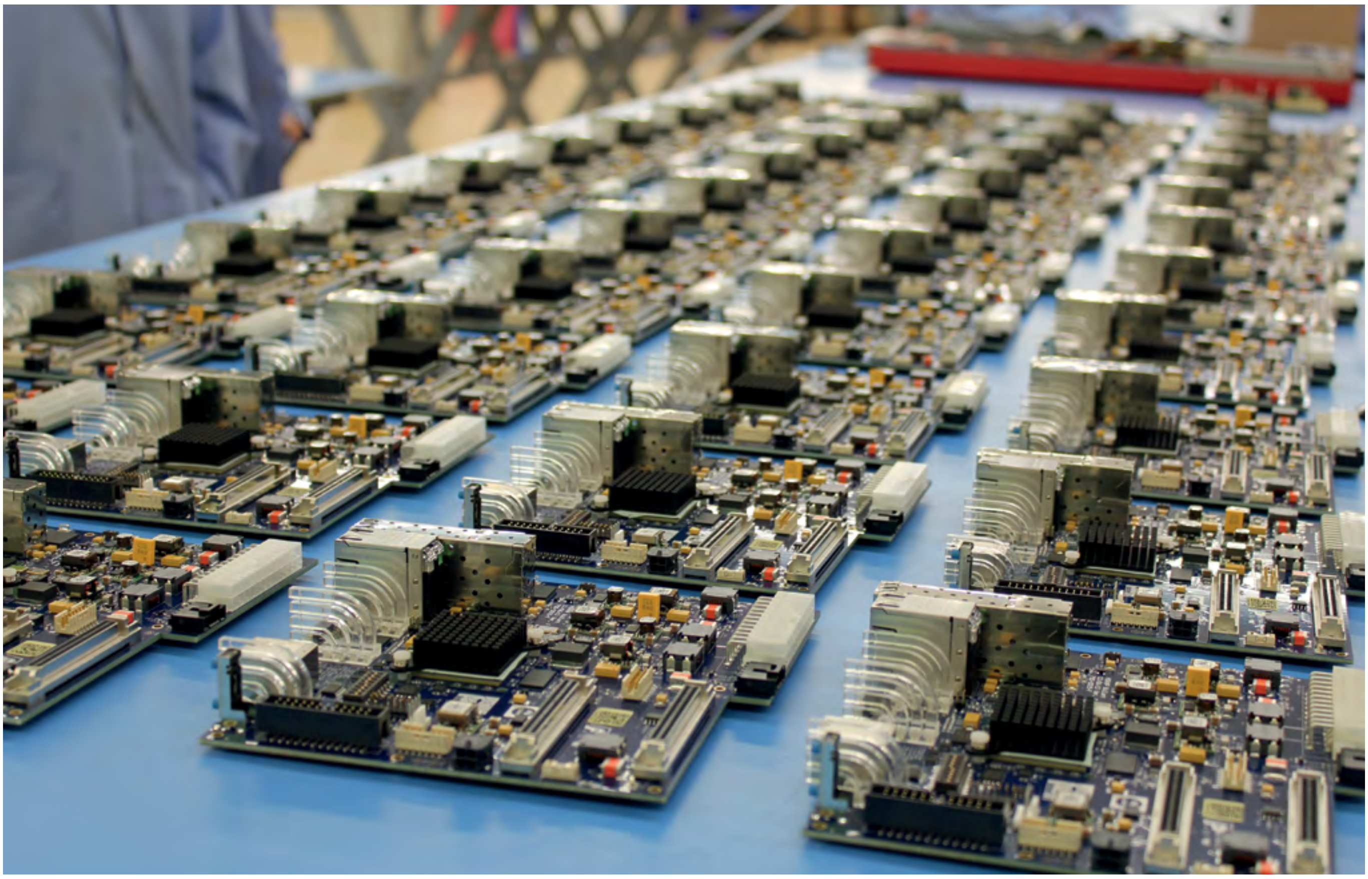
As a component of CSIRO's management of the Murchison Radio-astronomy Observatory (MRO), CSIRO has a Collaboration Agreement with the Western Australian Government, supporting collaboration between the State, CSIRO, and ICRAR. CSIRO cooperates with the local Wajarri Yamatji community, traditional owners of the land on which the MRO sits, under the terms of the Indigenous Land Use Agreement (ILUA) for the site. A project from the Sustainability Round of the Commonwealth Government Education Investment Fund (EIF) is assisting CASS and several Western Australian industry partners to provide sustainable power for astronomy facilities at the MRO and manage power use on the site.

CASS is party to a number of international alliances and collaborations, some formally established through collaborative agreements and others being informal. CSIRO is a member of RadioNet3, a collaboration to coordinate radio-astronomy facilities to benefit European astronomers. The CASS VLBI team's expertise has led to its inclusion in the (mainly European) 'NEXPReS' consortium, which is developing 'e-VLBI': real-time processing of the large volumes of data generated by VLBI experiments, made possible by high-speed optical fibre links between observatories around the world. CASS also works with Auckland University of Technology (Auckland, New Zealand) on trans-Tasman VLBI observing projects.

Dr Ant Schinckel, lead of the SKA Infrastructure Australia Consortium, presenting at the international SKA Engineering Meeting held in Fremantle, Western Australia, in September 2014. Credit: SKA Organisation

CSIRO's relationships with the international astronomical community are increasing in complexity as the SKA project progresses. Apart from membership of several consortia and governance planning groups in the SKA organisation, CSIRO has formal linkages with NRC-Canada, ASTRON in The Netherlands, the Australia–New Zealand SKA Coordination Committee (ANZSCC), INAF in Italy, and research groups in the USA, New Zealand, India, and China.

ASKAP has been developed and constructed with the help of industry. As the telescope completes commissioning and begins operations, industry will continue to be involved in maintaining it and the infrastructure that supports it. In 2014 CASS continued its association with firms connected with ASKAP and the SKA through research collaborations and, more strategically, the Australasian SKA Industry Consortium (ASKAIC).



ASKAP circuit boards at *Puzzle Precision*

CSIRO is working with *Puzzle Precision*, a high-quality electronic assembly service provider near Newcastle, New South Wales, to jointly develop and produce sophisticated electronic circuit boards and other components of the digital systems for the Australian SKA Pathfinder, ASKAP. The relationship began when the company manufactured a few dozen circuit boards for CASS's Australia Telescope Compact Array. *Puzzle Precision* is now doing thousands of units of work for ASKAP's innovative PAF receivers and associated digital systems. The ASKAP project has expanded the company's production base and enhanced Australia's ability to produce such systems. Credit: Flornes Yuen

AWARDS AND PRIZES

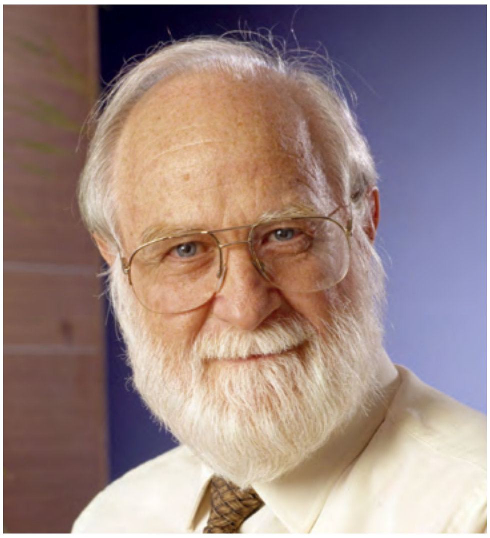
CASS astronomer Dr Ryan Shannon received CSIRO's John Philip Award for the Promotion of Excellence in Young Scientists for 2014. Ryan's award was based on work, published in the journal Science, that put stringent upper limits on the strength of the gravitational waves that are presumed to arise from a stochastic background of supermassive black holes. Ryan used the funding that came with the award to visit astronomical institutions in the USA, Europe and China.

CSIRO Fellow and first Director of CSIRO's Australia Telescope National Facility, Professor Ron Ekers, was awarded the 2014 Grote Reber Medal for his lifetime achievements in radio astronomy. The presentation was made at the General Assembly of the International Union of Radio Science (URSI) in Beijing in August 2014. The Grote Reber medal recognises Ron's scientific and technical contributions to radio astronomy, his outstanding leadership as first director of both the Very Large Array in the USA and the Australia Telescope National Facility, and his role as president of the International Astronomical Union.

In November CSIRO’s Australian SKA Pathfinder (ASKAP) telescope took out the top prize in the national Australian Innovation Challenge Awards (run by The Australian newspaper in association with Shell, with support from the Commonwealth Department of Industry). ASKAP’s phased-array feed receivers and associated digital systems were the key technologies leading to the win: the judges described the telescope as “one of those advances that keeps Australia on the global innovation map”. ASKAP also topped the awards’ Manufacturing, Construction and Infrastructure category.

Also in 2014, the Australian Academy of Science announced that it would award its prestigious 2015 Pawsey Medal for the physical sciences to CASS’s Dr Naomi McClure-Griffiths, for her work on the structure and processes of our Galaxy.

Dr Ryan Shannon receiving the John Philip Award from CSIRO Chief Executive Megan Clark. Credit: CSIRO



Professor Ron Ekers. Credit: CSIRO

The Grote Reber medal

ASKAP Project Director Ant Schinckel with ASKAP's trophy for the Australian Innovation Challenge Awards. Credit: Wheeler Studios

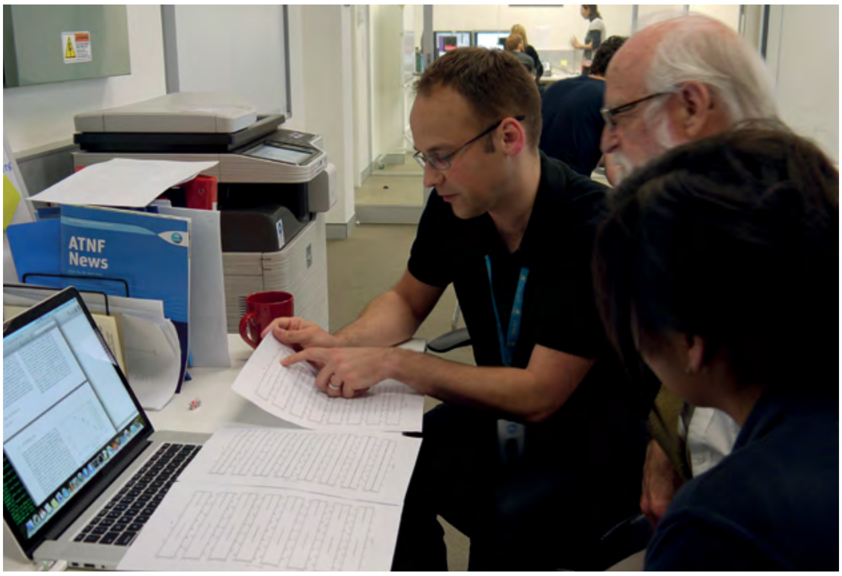
CONFERENCES AND WORKSHOPS

This year the ATNF organised three international meetings:

- the *8th Square Kilometre Array (SKA) calibration and imaging workshop* (held in Kiama, New South Wales, in March). This workshop focused on algorithms, software and computing needed to meet the needs of the SKA
- the seventh in the Southern Cross series of annual meetings, *Powerful AGN Across Cosmic Time* (held in Port Douglas, Queensland, in July). This dealt with active galactic nuclei (AGN) in the local Universe, the origin of the first black holes, and the influence of black-hole jets on their environments
- *The Periphery of Disks* (held in Sydney in November). This conference covered theoretical and observational evidence of how galaxy disks evolve and how their evolution shapes their parent galaxies.

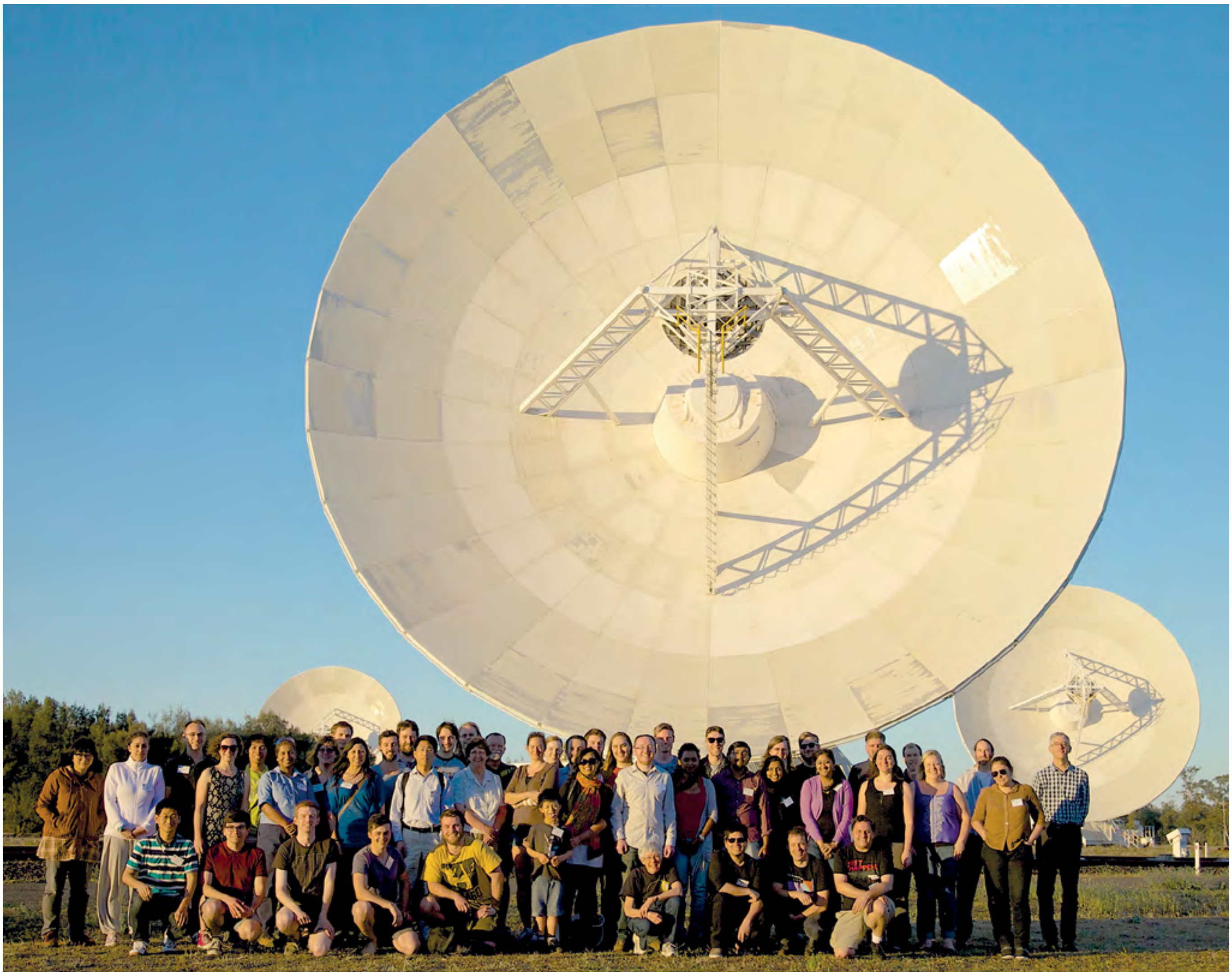
CASS ran its regular five-day Radio School—a course of lectures on radio astronomy, hands-on tutorials and telescope tours—at the Compact Array in September. The 18 presenters were drawn from CASS, the US National Radio Astronomy Observatory, and the Universities of Sydney and Tasmania; the 35 students came from ten Australian universities and the Universities of Canterbury (New Zealand), Hong Kong, and Guangzhou (China).

CASS astronomer James Allison discussing observations with colleagues Ron Ekers and Vanessa Moss. Credit: Helen Sim



Participants at the *Periphery of Disks* conference at Sydney's Powerhouse Museum.

Participants at CASS's 2014 Radio School



Performance Indicators

The Australia Telescope Compact Array. Credit: Cormac Purcell

Performance Indicators

SCHEDULED AND SUCCESSFULLY COMPLETED OBSERVING TIME

The key performance indicators for the Compact Array and the Parkes radio telescope are that at least 70 per cent of time should be allocated for astronomical observations, and that the time lost during scheduled observations from equipment failure should be below five per cent. For the Compact Array and Parkes, up to ten per cent of time is made available as 'Director's time'. This is time that is initially not allocated in the published version of the schedule, but, if not allocated at the discretion of the Director, is later made available for approved observing projects.

Proposing astronomers are required to conduct their observations themselves. For the Compact Array, this required first-time observers to travel to the observatory for their scheduled time: from October 2014 this was changed so that first-time observers were required to observe from the Marsfield Science Operations Centre (SOC) rather than the observatory. Once qualified, observers can make subsequent observations remotely (from locations other than the SOC). Re-qualification, through another trip to the SOC, is required annually. The SOC has been the default location for Parkes observing since September 2013. Under the current operations model for Mopra, the National Astronomical Observatory of Japan, the University of New South Wales and the University of Adelaide became responsible for training and qualifying observers who used those institutions' share of observing time.

The telescope usage figures are similar to those for recent years. Most of the time lost to equipment failure at Parkes was due to a problem with the rear shutter of the master-equatorial room, which took the telescope off-line for several days. Time lost to weather is higher for Mopra than for the other telescopes as most Mopra observing is conducted in the 3-mm band, which is sensitive to atmospheric conditions.

CASS astronomer Keith Bannister observing from the Science Operations Centre (SOC) at Marsfield. This year the SOC became the default location for observing with the Compact Array. Credit: Flornes Yuen

RESPONSE TO RECOMMENDATIONS BY THE USER COMMITTEE

The Australia Telescope User Committee (ATUC) is an advisory group that represents the users of ATNF facilities in the ATNF decision-making process. Its members are listed in Appendix A. The committee normally meets twice a year, and after each meeting it presents a list of recommendations to the ATNF Director. ATUC considers matters raised by the user community, current operations, and priorities for future developments. In 2014 ATUC met twice, in June and November.

Most ATUC recommendations are accepted and implemented. Following the June meeting, ATUC made 12 recommendations to the ATNF. Of these, seven were accepted and four were taken for further consideration; one could not be adopted, as it was outside of CASS's control. Following the November meeting, ATUC made 22 recommendations to the ATNF. Of these, 19 were accepted, two were taken for further consideration, and in one case ATUC was advised that the recommendation would not be adopted. ATUC reports to the ATNF Director, and the Director's replies, can be found at http://www.atnf.csiro.au/management/atuc/index.html.

TIME ALLOCATION ON AUSTRALIA TELESCOPE FACILITIES

Observing time on ATNF telescopes is awarded twice a year to astronomers on the basis of the merits of their proposed research programs, as judged by the Time Assignment Committee (TAC). Two six-month observing semesters are scheduled each year, from October to March (OCTS) and from April to September (APRS). This year 138 proposals were received for the summer semester (October 2013 to March 2014) and 196 for the winter semester (April to September). Demand is higher in winter because the weather is better for higher-frequency (millimetre-wavelength) observations with Mopra and the Compact Array.

For the period from 1 October 2013 to 30 September 2014, a total of 207 proposals were allocated time on ATNF telescopes (each proposal is counted only once each calendar year even though some are submitted twice). One hundred and twenty-one (121) proposals were given time on the Compact Array, 48 on Parkes, eight on Mopra and 30 on the Long Baseline Array. The 'oversubscription' rate (the factor by which proposals exceed the telescope time available) was 1.9 for the

Compact Array for the winter season and 1.5 for the summer season; around 1.3 for Parkes; and greater than two for the Long Baseline Array. Observing programs allocated time on ATNF facilities are listed in Appendix D.

Proposals requesting service observations with the Canberra Deep Space Communication Complex DSS-43 (70-m) and DSS-34 (34-m) antennas at Tidbinbilla, which are part of the NASA Deep Space Network, are also accepted. Seven CDSCC projects were observed during the year.

Figures 1 and 2 show the time allocated to observing teams on the Compact Array and Parkes as a percentage of the total allocated time, determined by affiliation of the team leader. Figures 3 and 4 show the time allocated to observing teams on the Compact Array and Parkes as a percentage of the total allocated time, determined using the affiliations of all team members. In these plots the time allocated to each proposal has been divided evenly between all authors on the proposal. Counting all authors on the proposals, CASS staff were allocated about 20 per cent of observing time during the year for the Compact Array and 23 per cent for the Parkes telescope. As discussed on page 18, only limited time was available for Mopra as a part of the National Facility.

ATNF telescopes support a broad range of studies in Galactic (ISM, pulsar, X-ray binaries, star formation, stellar evolution, magnetic fields), extragalactic (galaxy formation, ISM, Magellanic Clouds, cosmic magnetism) and cosmological science. The research programs involve astronomers from many institutions in Australia and overseas. The proposals received each semester typically include about 600 authors: on average, about 50 are from CASS, 80 are from other Australian institutions and 470 are from 175 overseas institutions, in 26 countries. The three overseas countries with the greatest numbers of proposers are the USA, UK and Germany.

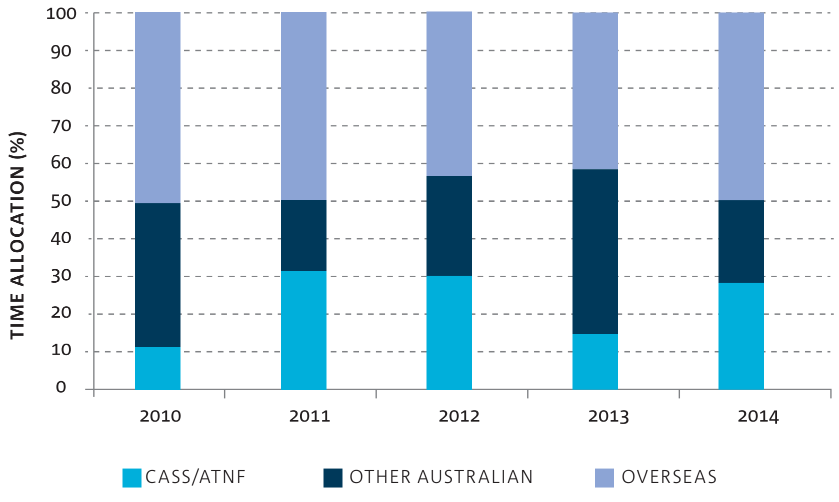


FIGURE 1:
Compact Array time allocation by primary investigator, October 2009 – September 2014. For each year the time allocation is for 12 months from October to September.

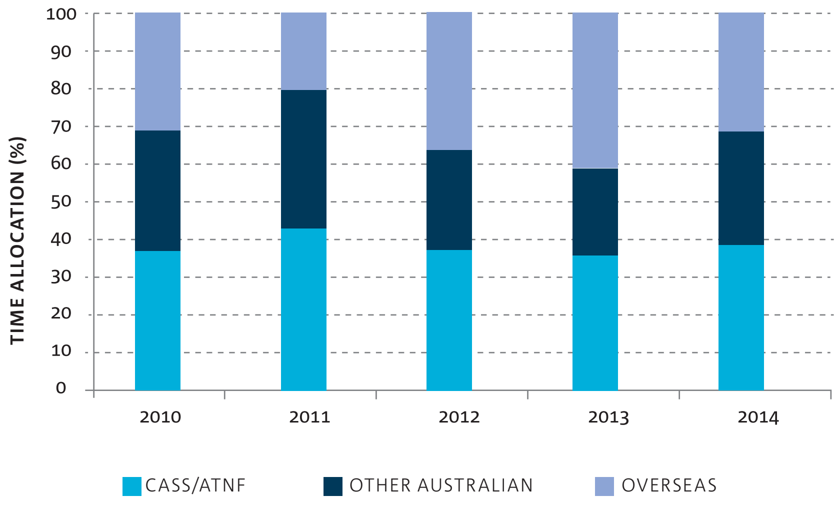


FIGURE 2:
Parkes time allocation by primary investigator, October 2009 – September 2014. For each year the time allocation is for 12 months from October to September.

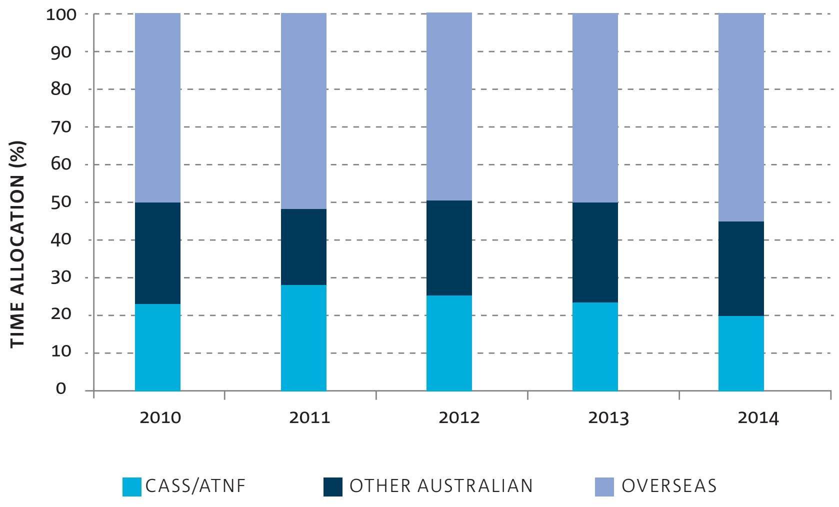


FIGURE 3:
Compact Array time allocation by all investigators, October 2009 – September 2014. For each year the time allocation is for 12 months from October to September.

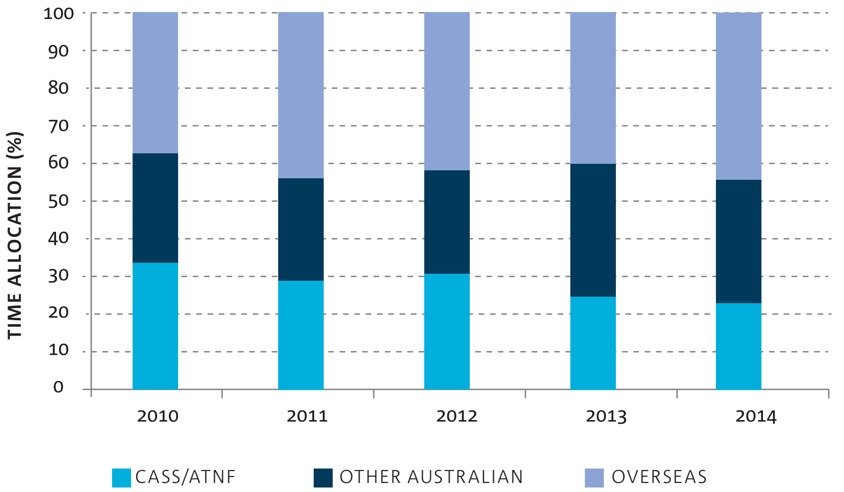


FIGURE 4:
Parkes time allocation by all investigators October 2009–September 2014. For each year the time allocation is for 12 months from October to September.

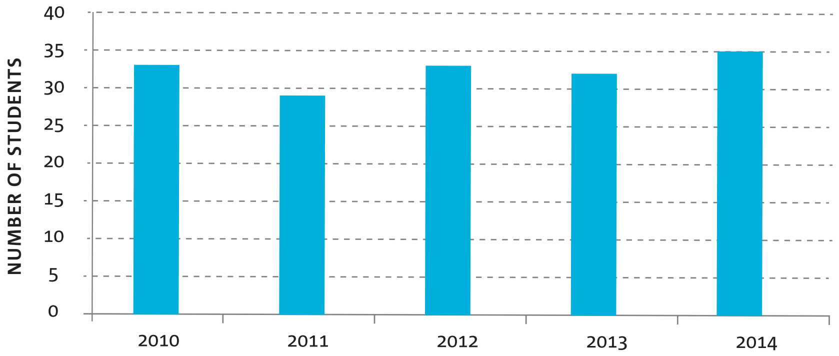


FIGURE 5:
Numbers of postgraduate students affiliated with CASS.

TEACHING

As of December 2014, 35 PhD students were being co-supervised by CASS staff. Their affiliations and thesis titles are given in Appendix E. Seven students were awarded PhDs during the year: their theses are listed in Appendix F.

Figure 5 shows the numbers of PhD students affiliated with CASS. Figure 6 shows the institutions at which CASS-affiliated students were enrolled in 2014. Nine students, a quarter of the total, were with overseas institutions.

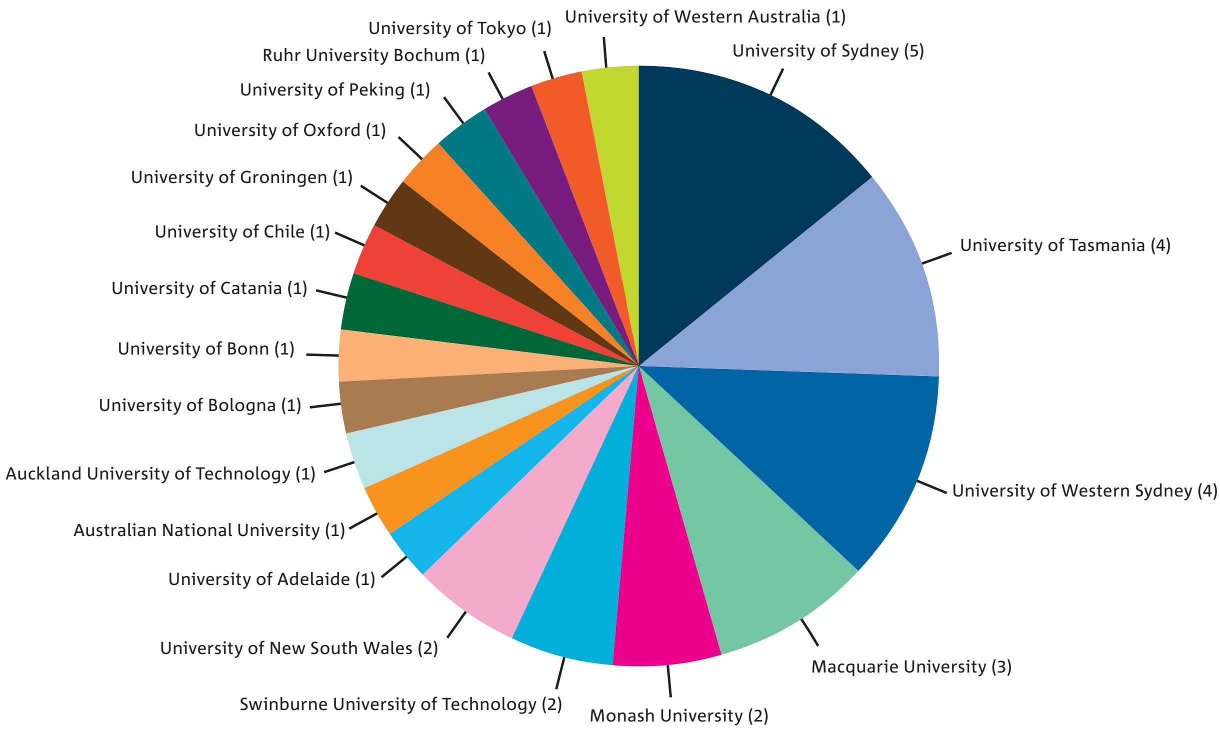


FIGURE 6:
Postgraduate student affiliations 2014.

PUBLICATIONS AND CITATIONS

Figure 7 shows the number of publications in refereed journals that include data from, or are related to, ATNF facilities: the Compact Array, Mopra, Parkes, VLBI and Tidbinbilla. The count includes publications relating to the scientific goals or development of ASKAP but not IAU telegrams, abstracts, reports, historical papers or articles for popular magazines. This year 130 papers using data from the National Facility were published in refereed journals. Seventy-four (57 per cent) included a CASS author or authors.

In 2014 there were 149 refereed publications by CASS staff, including scientific papers with data from other facilities, somewhat lower than the exceptionally high number published in the previous year (183). In total, 205 refereed papers—both those using National Facility data and other papers by CASS staff—were published during the year. They are listed in Appendix G, which also lists 38 conference papers that were either derived from ATNF facilities or include CASS authors.

Figure 8 shows publication numbers for each facility. A small number of papers with data from more than one facility are counted more than once.

Astronomy is Australia's leading physics discipline in terms of relative citation rate, and one of only two physics disciplines that performs above the European average (*Benchmarking Australian Science Performance*, Office of the Chief Scientist, 2013). One of the reasons for astronomy's success is its high level of international collaboration, which has been shown to positively influence citation performance in most disciplines. Some 88.6 per cent of CSIRO's Space Science publications are generated through international collaborations. This is the highest number for all areas of CSIRO.

Across CSIRO, citation performance is measured by the 'new Crown Index'— the average number of citations per paper, normalised to a baseline determined from the global average for all publications in a similar set of journals. (In astronomy the baseline is determined from papers published in refereed journals.) The index is calculated at least a year after the date of publication, to allow citations to accrue. For National Facility and other CASS staff papers published in 2013 the new Crown Index, calculated over 235 refereed publications, is 2.0. This means that on average, papers published by CASS staff (including papers with National Facility data) receive twice as many citations per paper as the global average for refereed astronomy papers.

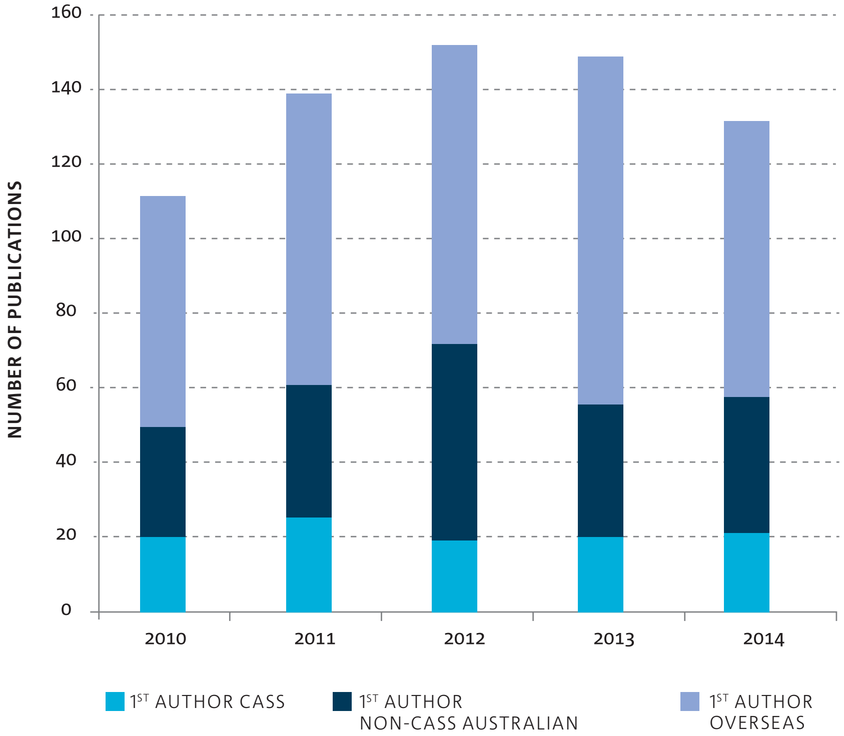


FIGURE 7:
Publications that include data from, or are related to, ATNF facilities (Compact Array, Mopra, Parkes, VLBI, Tidbinbilla and ASKAP), published in refereed journals during 2010–2014.

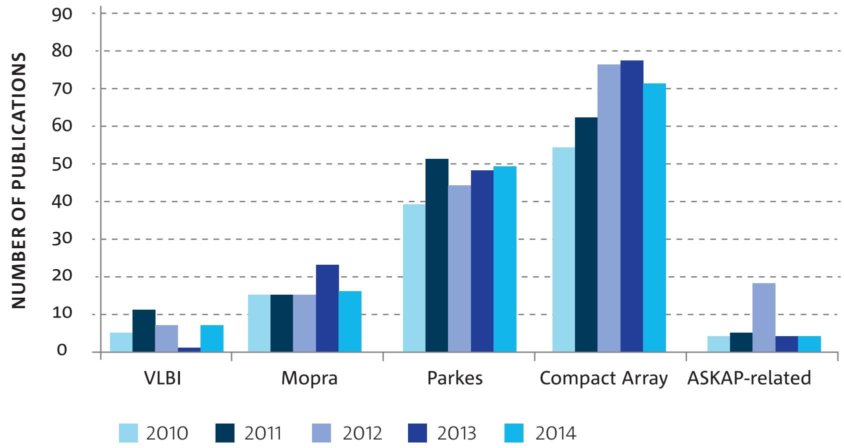
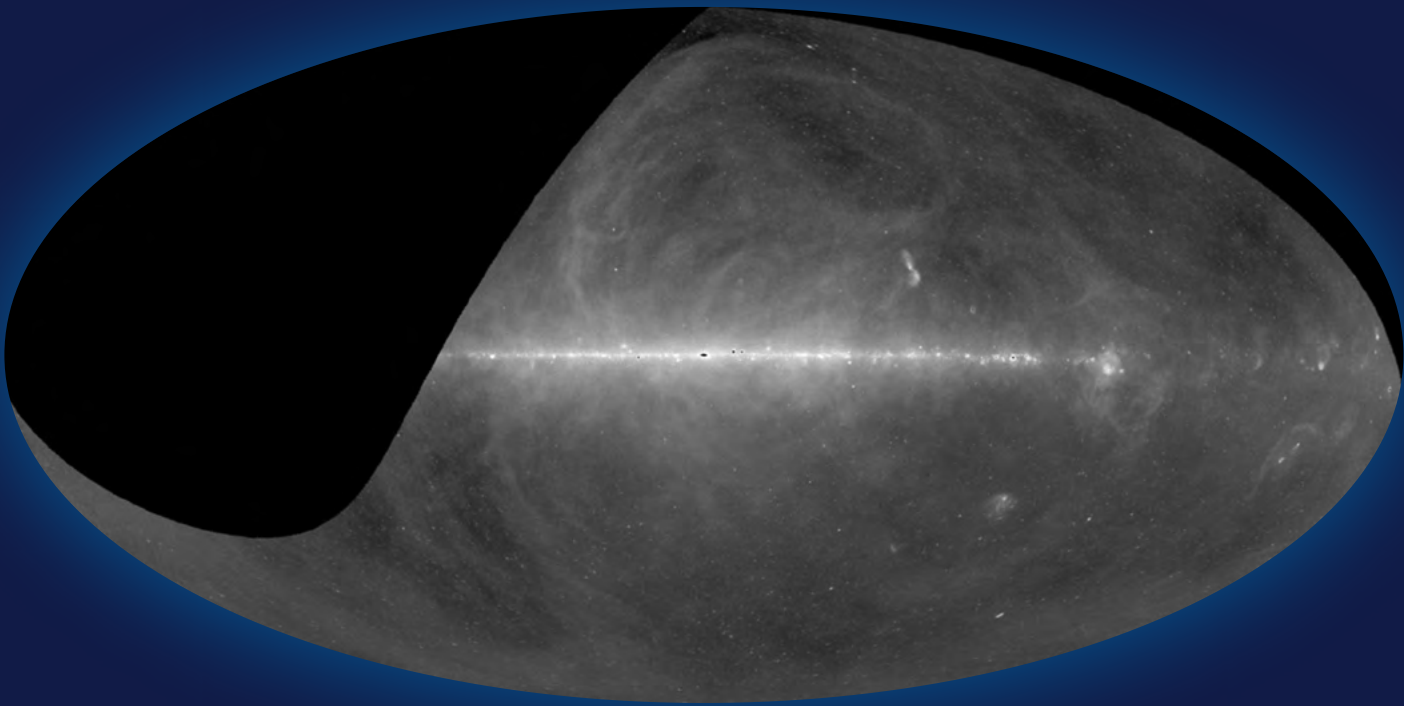


FIGURE 8:
Publications that include data from, or are related to, the Compact Array, Mopra, Parkes, VLBI and ASKAP in 2010–2014.

USER FEEDBACK

Past practice has been to ask observers using ATNF telescopes to complete a user-feedback questionnaire. However, in recent years fewer observers have completed the questionnaires, and in 2014 so few responses were received that they are not statistically reliable.



Science Highlights

A new 1.4-GHz radio continuum map of the southern sky, generated with the Parkes telescope. Credit: Mark Calabretta

Into the 'redshift desert' with BETA

Our telescope users come from many countries and range from postgraduate students to established researchers

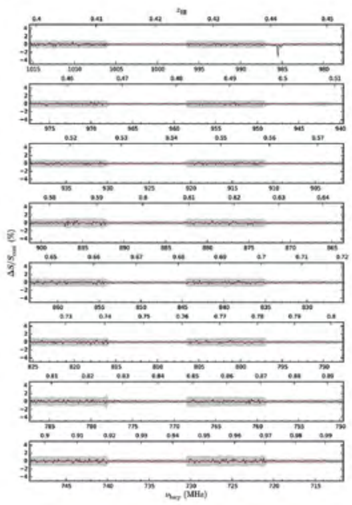
James Allison (CASS)

Hydrogen is the most abundant element of baryonic (non-dark) matter in the Universe. In its cool atomic form (H I) it fuels star formation and efficiently feeds the activity around supermassive black holes. Astronomers routinely map H I gas in nearby galaxies through emission from its 21-cm line at radio wavelengths, and they detect it in the distant Universe by observing the optical Lyman-alpha transition towards thousands of quasars. But in the intervening epoch—spanning seven billion years or half the Universe's history—H I in individual galaxies is hard to directly observe from the ground.

Fortunately, while the 21-cm emission is too faint to detect at large distances, 21-cm absorption by cold H I gas can be observed almost independently of redshift: detection depends only on the brightness of the background radio sources and the opacity of the foreground gas. Using ASKAP, we have made our first 'blind' detection of H I—that is, one not guided by a pre-existing optical redshift—in PKS B1740-517, a young gigahertz peaked spectrum source.

This is a game-changer for H I-absorption surveys. Surveys are limited by the available bandwidth, frequency range and sensitivity of the telescopes used, and, crucially, by radio-frequency interference at these telescopes. As a result, most previous surveys have been able to target only the radio galaxies and quasars for which there is an optical (spectroscopic) redshift for the source or intervening galaxy, to which we may 'tune' our radio telescopes. Two Square Kilometre Array precursor telescopes, CSIRO's Australian SKA Pathfinder and South Africa's MeerKAT, have both wide bandwidths and radio-quiet environments, and will be able to carry out the first 'blind' surveys for H I gas in the 'redshift desert'. Such searches look set to find ten times the number of galaxies now known from H I absorption.

Follow-up observations made with the Gemini South Telescope show that the H I absorption seen in PKS B1740-517 is intrinsic to the host galaxy, suggesting that we are seeing the radio source interacting with its immediate environment. This provides valuable insight into the conditions under which radio-loud active black holes are fuelled and influence the subsequent evolution of their host galaxy.



The ASKAP spectrum towards PKS B1740–517, showing H I redshift against observed frequency (barycentric corrected). The spectrum covers 711.5–1015.5 MHz. An absorption line is visible at νbary = 985.5 MHz, equal to an H I redshift of z = 0.4413. The grey region indicates rms spectral noise, multiplied by a factor of 5: this is higher in parts of the band for which not all of the correlator was available for observations. (From Allison *et al.* 2015)

The Australian SKA Pathfinder

PUBLICATION

Allison, J. R. *et al.* "Discovery of H I gas in a young radio galaxy at z = 0.44 using the Australian Square Kilometre Array Pathfinder". MNRAS, 453, 1249–1267 (2015).

CHIPASS: new value from old surveys

Mark Calabretta (CASS)

“The end product was a 1.4-GHz continuum map of unprecedented resolution and fidelity....”

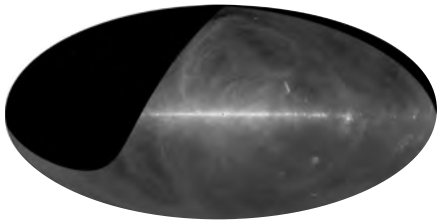
The HIPASS (H I Parkes All-Sky Survey) and ZOA (Zone of Avoidance) surveys were carried out with the Parkes telescope between 1997 and 2005. Although designed as blind surveys of extragalactic 21-cm H I line emission, they continue to bear fruit for other purposes. We have recently used them to construct a 1.4-GHz continuum map of the southern sky, CHIPASS.

At the time the surveys were run it was understood that they contained a wealth of 1.4-GHz continuum data, and little work was needed to generate compact-source continuum maps matching each of the HIPASS and ZOA spectral cubes. A few such maps were produced and found to be crowded with point sources. This provided a strong incentive to create a complete map. The process of creating the map led to a series of incremental improvements to software that would later be important for other projects, such as GASS, the Parkes Galactic All-Sky Survey.

Eventually an all-sky, compact-source continuum map was produced. It was replete with extragalactic point sources and large-scale structures such as the Galactic plane itself, Centaurus A, the Large Magellanic Cloud, and the North Polar Spur. However, so much information was missing at low spatial frequencies that it was difficult to make proper sense of the map, particularly of the strange structures emanating from the Galactic plane. This problem had already been addressed in the Parkes High Velocity Cloud survey, an off-shoot of HIPASS, and when the solution used there (a different bandpass estimator) was applied, a very different image of the sky emerged. But it too had problems, mainly arising from the short scan lengths.

Fortuitously though, and to a remarkable extent, HIPASS and ZOA complemented each other so that high-quality corrections could be derived from within the surveys themselves. (For details, see Calabretta *et al*. 2014).

The end product was a 1.4-GHz continuum map of unprecedented resolution and fidelity, unlikely to be surpassed in the foreseeable future. The process of creating it has also left a legacy of improvements to the Parkes multibeam processing software.



The final CHIPASS map. The map and associated data products can be accessed at www.atnf.csiro.au/research/CHIPASS. (From Calabretta *et al*. 2014)

The Parkes telescope

PUBLICATION

Calabretta, M.R. *et al*. “A new 1.4 GHz radio continuum map of the sky south of declination +25°”. PASA, 31, e007 (2014).

Southern hydroxyl survey set to boost maser numbers

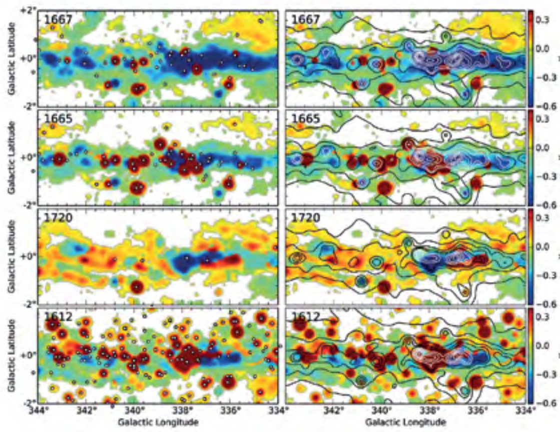
Joanne Dawson (CASS and Macquarie University)

"About half the masers were new detections, which implies that SPLASH will substantially boost the number of ground-state OH masers known in the southern galactic plane."

The hydroxyl radical, OH, is found throughout our Galaxy's interstellar medium, and in the molecular gas clouds of star-forming regions. In diffuse gas it is a necessary precursor to the formation of CO. Strong OH masers are associated with supernova remnants, evolved stars, and forming high-mass stars. Having a strong Zeeman splitting factor, OH masers are also a unique tool for measuring magnetic fields in the Galaxy.

Previous large-scale surveys of diffuse OH have been under-sampled, limited in latitude coverage, and have often lacked the sensitivity to detect any but the strongest sources. We have now taken a big step forward with the Southern Parkes Large-Area Survey in Hydroxyl (SPLASH), an unbiased, and fully sampled survey of the southern Galactic plane and Galactic Centre in all four ground-state transitions of the hydroxyl (OH) radical. SPLASH is also an unbiased search for maser sources in these transitions. The survey will provide short-spacing data for a future project that will use the Australia Square Kilometre Array Pathfinder (ASKAP) telescope to image H I, diffuse OH and OH masers in the 1612-, 1665-, and 1667-MHz lines throughout the Galactic plane, Magellanic Clouds and Magellanic Stream.

This year we completed the survey observations and also published the first results from the SPLASH pilot region, which covered 334° < l < 344° in Galactic longitude and $|b|$ < 2° in Galactic latitude. We detected OH widely throughout this region, in all four of its transitions. We also detected 196 masers and maser candidates, again in all four transitions. About half of the masers were new detections, which implies that SPLASH will substantially boost the number of ground-state OH masers known in the southern Galactic plane.



Combined peak-emission and peak-absorption maps for all four ground-state OH lines in the SPLASH pilot region, created by plotting the most extreme value of the brightness temperature (4σ detections) at each spatial position. White circles in the left-hand panels mark masers and maser candidates. Contours in the right-hand panels show the continuum brightness temperature at the line rest frequency: their levels run from 10.0 to 20.0 K at intervals of 2.5 K, then from 20.0 to 50.0 K at intervals of 5.0 K. The map colours have no physical significance. (From Dawson *et al.* 2014)

The Parkes telescope

PUBLICATION

Dawson, J.R. *et al*. "SPLASH: the Southern Parkes Large-Area Survey in Hydroxyl – first science from the pilot region". MNRAS, 439, 1596–1614 (2014).

Is CO related to radio jets?

Bjorn Emonts (Centro de Astrobiologia, Madrid)

High-redshift radio galaxies (HzRGs) are massive galaxies in the early Universe, each with a supermassive black hole at its centre that pours out jets of radio-emitting particles. Unkempt and clumpy when viewed at optical wavelengths, they appear to be undergoing frequent mergers with neighbouring galaxies. They also often show signs of massive star formation.

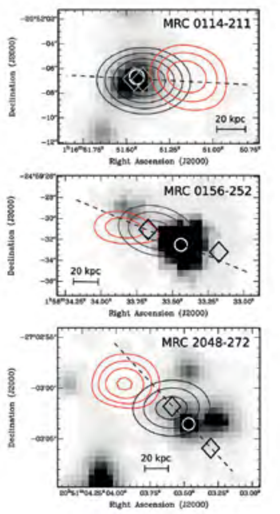
Cool molecular hydrogen gas, H_2, fuels both star formation and the activity of the central black holes. To study the star-formation history of the Universe, we are therefore interested to know how much H_2 is present in HzRGs, and how it is distributed. Molecular hydrogen can't be detected directly at low temperatures, but its presence is revealed by a 'tracer' gas, carbon monoxide (CO). This emits a number of spectral lines, some of which can be observed at millimetre wavelengths.

Researchers began looking for CO in high-redshift galaxies in the 1990s. At first they found none. But that was a function of the state of technology at the time: as millimetre-wave receivers improved, CO began to appear. We recently used the Compact Array to look for the CO(1–0) transition in 13 high-redshift radio galaxies ($1.4 < z < 2.8$). This is the first survey to use a representative sample of HzRGs (that is, one not selected by infrared or submillimetre emission).

We detected CO in five of the 13 galaxies. In two (MRC 0152-209 and MRC 1138-262), much of the CO(1–0) emission coincided with bright optical and infrared emission from the radio galaxy, but there was also emission, spread across tens of kiloparsecs, that seems to be outside the galaxy.

The CO(1–0) emission detected from the other three galaxies (MRC 0114-211, MRC 0156-252 and MRC 2048-272) was more surprising: in each one, it is located along the radio axis, on the side of the brightest radio emission, and beyond the outer radio hotspot. This distribution suggests that the CO(1–0) emission is associated with the radio jet.

Compact Array observations made a decade ago were interpreted as suggesting that the radio jet triggers star formation, leading to the formation of CO. But it could also be that the jet carries CO from the inner parts of the galaxy into the halo; alternatively, the CO could be tidal debris from the host galaxy or a companion, and the radio jet is bright in that region because it is hitting a dense interstellar medium. All three suggestions have testable predictions, and further studies should yield an answer.



Spatial distribution of the CO(1–0) emission associated with MRC 0114–211, MRC 0156–252 and MRC 2048–272. The red contours show the CO(1–0) emission and the black contours the 7-mm radio continuum. The background plots are Spitzer/IRAC 4.5µm images; the white circle shows the location of the radio galaxy from HST/NICMOS imaging; and the diamonds indicate the location of the radio hotspots in high-resolution radio imaging. The dotted line is the extrapolated axis of the radio jet. (From Emonts *et al*. 2014)

The Australia Telescope Compact Array

PUBLICATION

Emonts, B.H.C. *et al*. "CO(1–0) survey of high-z radio galaxies: alignment of molecular halo gas with distant radio sources". MNRAS, 438, 2898–2915 (2014).

A new candidate for a chemical clock

Claire-Elise Green (co-supervised PhD student – UNSW. Credit: Grant Turner/ Mediakoo/UNSW)

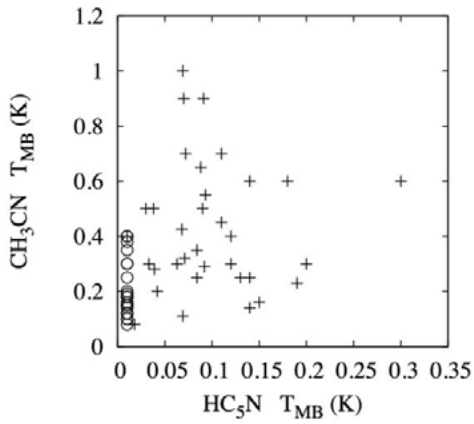
High-mass stars form in molecular clouds. The process begins when dense clumps of cold gas and dust inside clouds collapse under their own gravity and form cold (<10 K) cores. Over the next 50,000 years or so, heating from the central protostar, and continuing collapse, heats the core to 200 K. Molecules that were previously frozen on to dust grains now evaporate and react together, creating a time-dependent chemistry that gives us a way to track the progress of star formation. Details of this ‘chemical clock’ are still incomplete, however.

“Cyanodiacetylene has been readily detected in cold molecular clouds but has proved elusive in warm gas.”

We recently used the Tidbinbilla 70-m antenna, located at the Canberra Deep Space Communication Complex, to search for cyanodiacetylene (HC_5N) in 79 hot molecular cores, all associated with methanol masers. Cyanodiacetylene has been readily detected in cold molecular clouds but has proved elusive in warm gas. Early models of hot-core chemistry suggested that its abundance would be low, but more recent work has predicted that HC_5N can form and exist in hot cores, even if fleetingly. And we did, indeed, detect HC_5N in 35 of the hot cores in our sample.

The abundance of HC_5N is predicted to peak around $10^{4.3}$ years after the onset of core collapse and then fall, reaching a steady low abundance by 10^6 years, suggesting that the cores in which we detected HC_5N are between 10^4 and 10^6 years old. This is corroborated by the cores’ association with methanol masers, which are themselves chemical clocks, and which are thought to occur in a window between 10^4 and 4.5×10^4 years after the onset of core collapse.

Methyl cyanide (CH_3CN), a tracer of hot, dense cores, was present in 34 of the 35 cores showing evidence of HC_5N. The changing ratio of HC_5N and CH_3CN has been proposed as a chemical clock: by detecting both species together in several sources, we have shown that this proposition could be feasible.



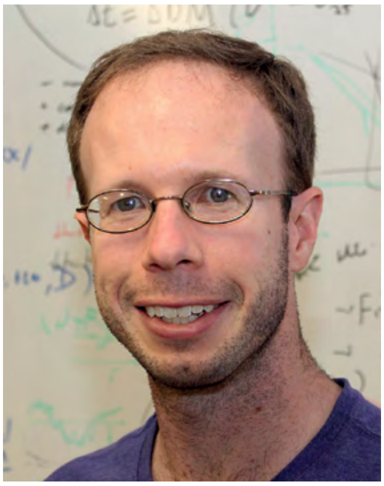
Peak brightness temperature of HC_5N against that of CH_3CN. The crosses represent HC_5N detections, the circles represent HC_5N non-detections: the main-beam peak-brightness-temperature upper limit is 0.018 K, the 1σ detection limit. (From Green *et al.* 2014)

The 70-m antenna at the Canberra Deep Space Communications Complex

PUBLICATION

Green, C.-E. *et al.* “New detections of HC_5N towards hot cores associated with 6.7 GHz methanol masers”. MNRAS, 443, 2252–2263 (2014).

The peek-a-boo pulsar J1717–4045



Matthew Kerr (CASS)

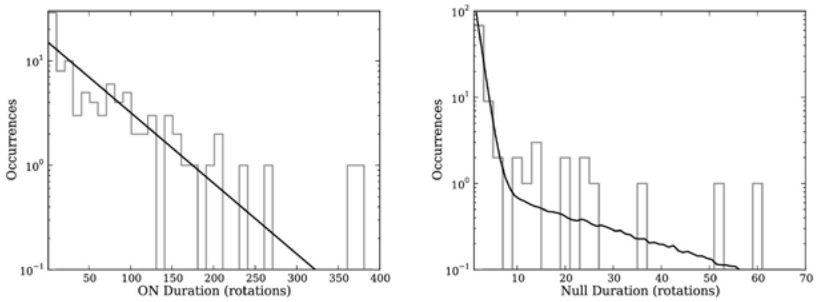
Most pulsars emit a steady stream of radio pulses. Some, however, skip beats, and some cease producing pulses altogether for weeks or months at a time. This behaviour is thought to be caused by changes in the pulsar's magnetosphere (its enveloping magnetic field).

Most pulsars that switch between 'on' and 'off' states do so over months or even decades, which makes it challenging to catch them in the act. To better understand how and why the magnetosphere changes, we need to study pulsars that change on time scales of hours or days.

One such object is PSR J1717-4054 (or 1717 for short), a pulsar discovered with the Parkes telescope in 1992. It switches on and off over a few hours. This behaviour endeared it to students in the PULSE@Parkes outreach program (described on page 39), who made nearly 90 'snapshot' observations of it. An analysis of the student data showed that, on average, 1717 turns on after 72 minutes of 'silence', and turns off again after about 18 minutes.

Follow-up observations with Parkes revealed some surprises. The pulsar sometimes stayed 'off' for much longer than expected—over four hours, in one case—and even when 'on', it nulled (missed one or more pulses). Furthermore, the nulls fells into two groups: shorter (usually just one missing pulse) and longer (10–60 pulses missing).

This complicated behaviour is difficult to explain. Is the magnetosphere 'dead' during long nulls? Or is it still 'alive' but producing only faint emission? Are there transient phenomena associated with the onset of intermittency and long nulls? We hope to be able to answer these questions with the new ultra-wideband receiver, described on page 44, that is planned for the Parkes telescope.



Duration of non-nulling (grey, left) and nulling (grey, right) intervals during pulsar J1717's active periods. The non-nulling durations are shown with the best-fitting exponential distribution over-plotted in black. The model shown in black in the right-hand panel is the mean value from simulations from a two-state Markov model. (From Kerr *et al*. 2014)

The Parkes telescope

"The pulsar sometimes stayed 'off' for much longer than expected."

PUBLICATION

Kerr, M. *et al*. "The three discrete nulling time-scales of PSR J1717–4054". MNRAS, 445, 320–329 (2014).

A trigger for a radio AGN?

Filippo Maccagni (PhD student – Kapteyn Astronomical Institute and ASTRON)

"If two galaxies merge, the cold gas belonging to both may lose angular momentum and form an 'efficient' accretion disk around the black hole."

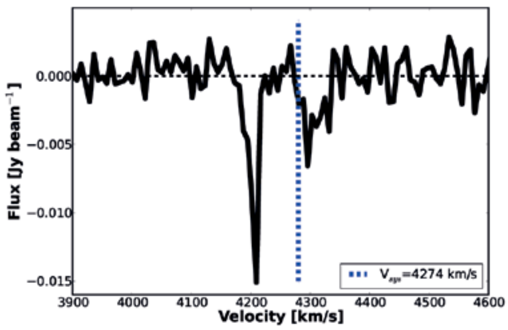
When a supermassive black hole at a galaxy's centre accretes material, it becomes an active galactic nucleus (AGN), emitting radio jets and other radiation. Radio-loud AGN can be divided into two types: high-excitation, which show strong optical emission, and low-excitation, where most of the energy from the accretion is channelled into the radio jet. This distinction is thought to correspond to the efficiency of the accretion process, with high-excitation sources having more efficient accretion processes. A source can be classified as high- or low-excitation by examining the ratio of its X-ray to radio luminosity.

The different types may arise from the way the AGN is triggered. If two galaxies merge, the cold gas belonging to both may lose angular momentum and form an 'efficient' accretion disk around the black hole. 'Inefficient' accretion, on the other hand, may occur when hot gas in a galaxy's halo condenses to form cold clouds, which then collide with the interstellar medium, lose angular momentum, and tumble to the galaxy's centre: there they sporadically feed the black hole, resulting in a low-excitation AGN. Is there evidence for this picture? To find out, we observed PKS B1718-649, a young, H I-rich radio source, with the Compact Array.

Previous observations of this source suggested that its radio activity was triggered only very recently, around 10^2 years ago. We found that the galaxy has a warped disk and an asymmetric plume of H I, hinting at a past interaction with a neighbour. But the H I in the galaxy's disk has settled into a regular orbit, meaning that the interaction must have occurred at least 10^9 years ago, too far in the past to have triggered the radio emission.

As well as H I in emission we see two H I absorption components, neither of which is at the systemic velocity of the disk. These probably come from two small H I clouds, which may be part of a population. We see evidence for similar clouds in other galaxies, such as NGC 315 and 3C 236.

From the ratio of its X-ray to radio luminosity, PKS B1718-649 is a low-excitation source. Making reasonable assumptions about the size of the clouds and their rate of infall, we calculate that clouds of this type could sustain the radio emission of PKS B1718-649. It looks likely that this AGN was indeed triggered by H I clouds.



H I profile of PKS B1718–649 obtained from the ATCA data. The two absorption systems are clearly visible. The narrow line is located at velocity 4200 km s-1, blue-shifted with respect to the systemic velocity (4274 km s-1, blue dashed line). The broad component is double peaked and found at velocity 4300 km s-1. (From Maccagni *et al*. 2014)

The Australia Telescope Compact Array

PUBLICATION

Maccagni, F.M. *et al*. "What triggers a radio AGN? The intriguing case of PKS B1718–649". A&A, 571, A67 (2014).

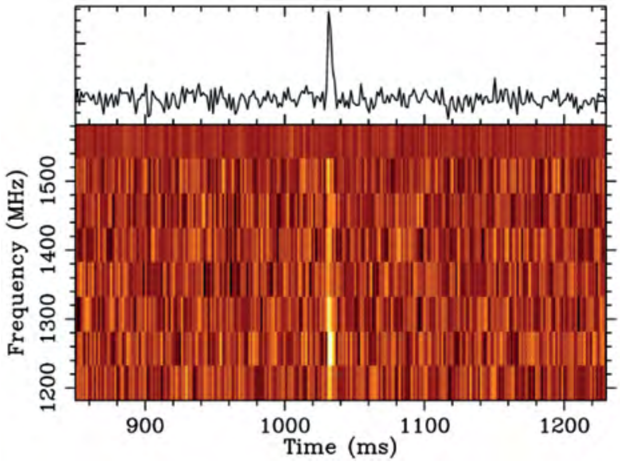
The first real-time Fast Radio Burst

Emily Petroff (co-supervised PhD student – Swinburne University of Technology)

In the last decade radio pulsar surveys at Parkes and Arecibo have revealed a new class of objects: 'fast radio bursts' or FRBs. All FRBs discovered to date have been single radio pulses lasting about a millisecond. The electron column density (dispersion measure) towards the sources is high, suggesting that FRBs originate at cosmological distances (and/or in extreme environments). Although relatively few FRBs have been found, they appear to have a dependence on Galactic latitude, shying away from the Galactic plane.

If FRBs were found to repeat, that would strongly constrain their possible progenitors, and so last year we began using Parkes to search the fields of previous FRB events for repeat bursts, using a real-time transient pipeline. On 14 May UTC we were observing the field of FRB 110220 when a new FRB appeared in the central beam of the Parkes multibeam receiver. This pulsar's redshift ($z < 0.4$) was significantly different from that of the first FRB found in the field, meaning we were not seeing a repeated burst. This observation was not only the first real-time detection of an FRB but also the first to record the polarisation of the signal (which was circular, not linear).

Detecting the FRB in real time allowed us to immediately pursue it with a dozen telescopes, working at many wavelengths. We were looking for any sources in the field that either brightened or dimmed by more than two magnitudes between epochs, but saw no such variations at X-ray, near-infrared, optical, or radio wavelengths. As a result, we were able to place limits on the magnitude of any potential afterglow for FRB 140514 and rule out certain progenitors: a local superluminous supernova, a nearby ($z < 0.3$) type Ia supernova, or a slow transient. Additional observations allowed us to rule out long gamma-ray bursts. The mystery of FRBs continues, but our polarisation data and afterglow limits are a significant step towards solving it.



The pulse profile and dynamic spectrum of FRB 140514 with pulse width 2.8 ms, dedispersed to DM = 562.7 pc cm^{-3} and summed to eight frequency channels across the band. Frequency channels between 1520 and 1580 MHz have been excised to remove radio interference. (From Petroff *et al.* 2015)

The Parkes telescope

"This observation was not only the first real-time detection of an FRB but also the first to record the polarisation of the signal..."

PUBLICATION

Petroff, E. *et al.* "A real-time fast radio burst: polarization detection and multiwavelength follow-up". MNRAS, 447, 246–255 (2015).

Putting the squeeze on WIMPs

Marco Regis (University of Turin)

"Searching for (such) radiation is a major part of the effort to identify dark matter."

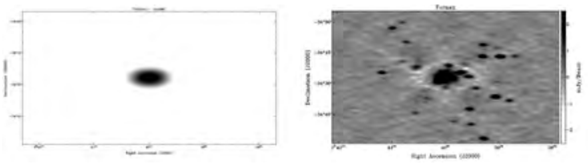
Astronomers first noticed the effects of dark matter on galaxy motions in the 1930s, and few now doubt its existence. Decades of work have revealed where dark matter is found and how much of it the Universe contains. But its identity is still unknown. A favoured candidate for dark matter is 'weakly interacting massive particles' or WIMPs, as-yet undetected fundamental particles.

WIMPs are predicted to be their own antiparticle, meaning that a pair could annihilate and produce radiation and/or high-energy particles, particularly electrons and their antiparticles, positrons. Moving through magnetic fields, these electrons and positrons would create a specific form of electromagnetic radiation ('synchrotron' radiation), at many wavelengths. WIMP annihilation should also generate gamma-rays directly. Searching for such radiation is a major part of the effort to identify dark matter.

A promising place to look is in the tiny galaxies called dwarf spheroidals. These are known to be rich in dark matter, but have little gas and are forming few or no stars: they therefore generate little radiation that could obscure a WIMP signal. Several teams have used gamma-ray telescopes to look for such a signal in nearby dwarf spheroidals: while not detecting one, they have been able to constrain the annihilation rate for dark matter. We recently used the Compact Array to search for WIMP-generated radio synchrotron emission in six dwarf spheroidals. This is the first such search to be made with a radio interferometer.

Using an interferometer allowed us to generate both high- and low-resolution images, which probed small (~arcsecond) and large (~arcminute) scales respectively. The low-resolution images are the most sensitive to diffuse emission (the dark-matter signal). They are inherently confusion-limited, but we reduced confusion by using the high-resolution images to identify and subtract background sources. As well as analysing the six dwarf spheroidals individually, we made a combined-likelihood analysis of the set: this would have revealed any excess emission the inner few arcminutes of the galaxies. We did not detect a signal, but were able to constrain the dark-matter annihilation rate.

The tightest bounds on dark-matter annihilation still come from gamma-ray studies, but future radio instruments will make huge strides in this area. CSIRO's Australian SKA Pathfinder will both achieve much higher sensitivity and find a great many more dwarf spheroidals (as will future optical surveys). The Square Kilometre Array (SKA) itself will improve on this by orders of magnitude.



Left: expected signal for a WIMP with mass M χ = 100 GeV and annihilation rate $\langle \sigma_{\alpha} v \rangle = 10^{-25} cm^3/s$ in the Fornax dSph. In this example, we consider a Burkert profile, $B_0 = 1 \mu G$, and neglect spatial diffusion. Right: map obtained by adding the theoretical emission of the left panel to the visibilities of observational data, and then performing calibration and imaging as for the original map. (From Regis *et al*. 2014)

The Australia Telescope Compact Array

PUBLICATION

Regis, M. *et al*. "Local Group dSph radio survey with ATCA (III): constraints on particle dark matter". JCAP, 10, A016 (2014).

ASKAP spies dark clouds in IC 1459

Paolo Serra (CASS)

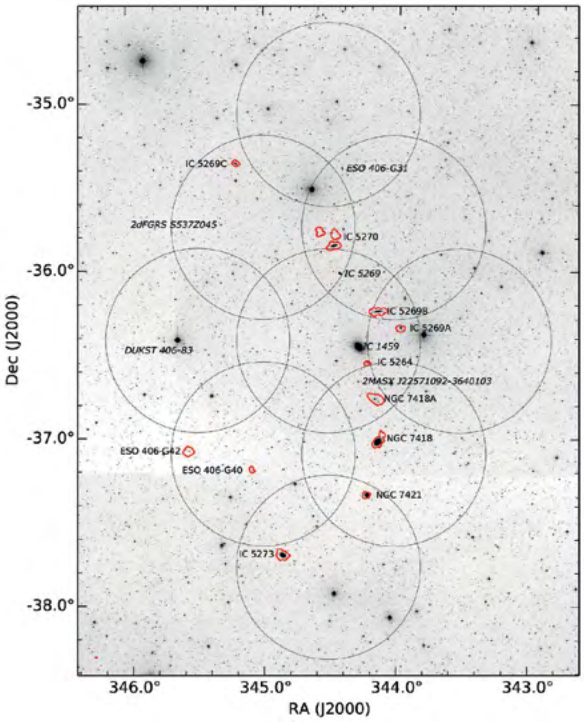
Galaxy evolution is very largely a tale of how galaxies gain and lose gas, and how efficiently they convert that gas into stars. The first part of the story, the gains and the losses, includes the gas accretion and stripping that can occur when a galaxy jostles with its neighbours. We have begun to look at such interactions for nearby galaxies, as part of the commissioning process for the Australian SKA Pathfinder (ASKAP).

Our first observation, of the galaxy group IC 1459 (at a distance of 30 Mpc), revealed H I in 11 galaxies inside the group. For six of them this is the first high-resolution H I image ever taken, and our data reveal new clues about the dynamic environment in which they live.

The most exciting of these systems is IC 5270, a spiral galaxy on the northern outskirts of the galaxy group. This galaxy is forming stars at a relatively high rate and so detecting H I within its stellar disc was not surprising. But we also found, unexpectedly, two gas clouds nearby (30 and 60 kpc from the galaxy respectively), each with more than a billion solar masses of H I. The clouds are 'dark'—that is, they appear to contain no stars—making it unlikely that they are dwarf galaxies. Instead, they appear to be the densest, brightest gas clumps of a hydrogen 'tail' from IC 5270. The tail may be tracing gas stripped from the galaxy as it makes its way to the centre of the group; if so, IC 5270 must have recently lost about a third of its initial gas.

We detected a third cloud of H I, of similar mass, near another member of the group, NGC 7418. The cloud is at the northwest edge of the galaxy's H I disc but is clearly a separate gas system, kinematically distinct from the disc rotation. As with the clouds near IC 5270, we could find no obvious stellar counterpart: again, the cloud appears not to be a dwarf companion of NGC 7418. It too may be embedded in an underlying distribution of diffuse gas.

High-resolution observations of H I are an important tool for studying galaxy evolution. These early ASKAP observations promise great things for WALLABY (the ASKAP H I All-Sky Survey), which will use the full ASKAP telescope to make images at twice the resolution, over three-quarters of the sky.



ASKAP H I contours (in red) overlaid on the DSS2-red image of the IC 1459 group. The H I contour level corresponds to a column density of 10^{20} cm^{-2}, equivalent to 0.35 Jy beam^{-1} km s^{-1}. The PSF of the H I image is represented by the red ellipse in the bottom-left corner. The grey circles indicate the position of the nine beams: they have a diameter of 1.1°, equal to the beams' FWHM at 1.4 GHz. Normal and italic fonts indicate H I detections and non-detections, respectively. (From Serra *et al.* 2015)

The Australian SKA Pathfinder

PUBLICATION

Serra, P. *et al*. "ASKAP H I imaging of the galaxy group IC 1459". MNRAS, 452, 2680–2691 (2015)

Operations

The Parkes telescope. Credit: Cormac Purcell

The ATNF performs a number of functions and activities that are essential to running the National Facility but not specific to individual sites or technology projects.

Spectrum Management

To detect very faint cosmic radio signals, radio telescopes have to be extremely sensitive. But this makes them highly susceptible to radio-frequency interference (RFI), radio signals generated by human activities. To make radio observations possible, radio telescopes must be protected from RFI. A small fraction of the radio spectrum is reserved worldwide for 'passive services' such as radio astronomy, but more general 'spectrum management' is becoming increasingly important because new telescopes such as the SKA will attempt to access most of the radio spectrum.

International regulation of the spectrum is the responsibility of the International Telecommunication Union (ITU); the international treaty called the 'Radio Regulations' is updated every few years via the World Radio Conference (WRC). In Australia spectrum regulation is handled by the Australian Communications and Media Authority (ACMA).

CSIRO strives to protect the radio-astronomy spectrum in general. This requires a good working relationship with ACMA (and through it, with the ITU and other regional and international forums), and with the Department of Defence and other major users of the radio spectrum. CSIRO also works to gain more specific protection for radio observatories. In recent years these efforts have led to the establishment of a 'Radio Quiet Zone' around the Murchison Radio-astronomy Observatory in Western Australia and 'Radio Notification Zones' around other radio observatories.

Workers at the Murchison Radio-astronomy Observatory watching an equipment lift.

Our spectrum-management activities include:

- active, direct engagement with major Australian spectrum users such as the Department of Defence, NBN Co, broadcasting and telecommunication carriers, to harmonise spectrum use, coordinate operations and minimise RFI
- participating in national spectrum planning and protection activities through ACMA, ITU study groups and the WRC
- participating in regional and international meetings held by the ITU. Specifically ITU Working Party 7D (Radio Astronomy) in Study Group 7 (Science Services) and Working Party 3M (Point-to-point and Earth-Space propagation) in Study Group 3 (Radiowave Propagation) are both chaired by CSIRO officers. CSIRO also provides a vice-chairman for Study Group 3
- participating in IUCAF (Scientific Committee on the Allocation of Frequencies for Radio Astronomy and Space Sciences), an inter-union committee of the IAU, URSI and COSPAR. IUCAF has had a significant impact on relevant ITU deliberations
- participating in the Radio Astronomy Frequency Committee in the Asia Pacific region (RAFCAP), which promotes awareness of radio astronomy and protection of the radio spectrum in the Asia Pacific. RAFCAP works closely with the regional spectrum management group, the Asia Pacific Telecommunity. The current RAFCAP chairman is from CSIRO.

Highlights of this work in 2014 were:

- preparing for the next World Radio Conference in 2015. CSIRO took part in activities, led by ACMA, that aimed to give guidance for Australia's position for all items on the meeting agenda. CSIRO also participated in ITU meetings that reviewed studies relevant to the agenda items
- leading the ITU-R studies in Working Party 7D and Working Party 3M
- organising and participating in the IUCAF-sponsored 'School on Spectrum Management in Radio Astronomy', held at the Joint ALMA Observatory in Santiago, Chile, in April 2014. CASS organised most aspects of the meeting and provided speakers for many of the lectures
- representing radio-astronomy interests in the Department of Communications' review of spectrum management framework.

Outreach and Education

VISITORS CENTRES

Parkes

The Parkes Observatory Visitors Centre continues to be a popular stop for travellers in the central west of NSW, with 68,427 people visiting this year. Among them were 1,893 tour-group visitors (from seniors, club and special-interest groups) and 1,183 students and teachers. Visitor numbers have fallen since 2011, but this reflects trends recorded for central NSW (which includes Parkes): from 2011–2012 to 2013–2014 the number of visitors staying overnight in the region fell, as did the total number of nights they stayed.

Highlights of year were:

- the annual David Malin Astrophotography Awards and exhibition, presented as part of the Central West Astrofest
- a photographic display to celebrate the 45th anniversary of the Apollo 11 moon-landing mission in July
- school-holiday programs of hands-on science activities for children aged 7–15 years.

This year the visitors centre shop expanded its range of stock and increased its sales. Revenue from the shop, the online store and the 3D theatre was $602,640 (gross), an increase of $15,140 on the previous year.

Compact Array

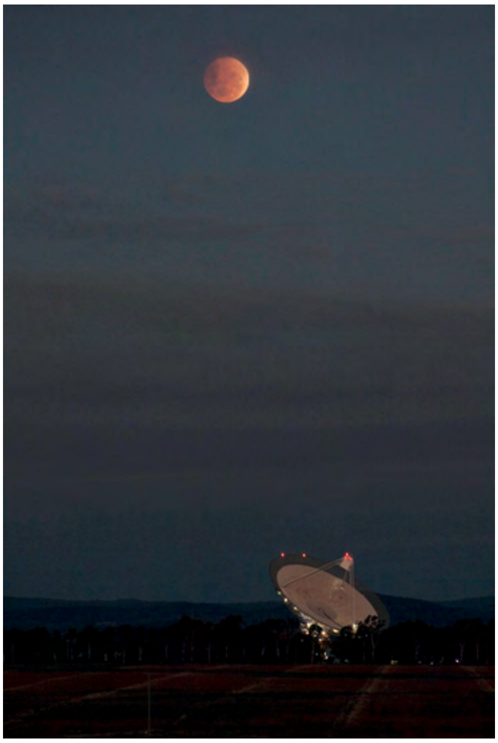
This year the Australia Telescope Compact Array hosted 10,971 casual visitors and 28 pre-arranged group tours (totalling around 700 people). The centre operates primarily as a stand-alone, self-guided facility, with some support provided by observatory staff and visiting astronomers. As noted on page 2, this year remote observing became the standard mode of using the Compact Array. As a result, there will be very few visiting astronomers, and fewer staff on site, and we will not be able to offer as many detailed talks and tours as in the past.

Canberra Deep Space Communication Complex

Education programs at CDSCC cover a broad range of science, technology, engineering and mathematics subjects, with a focus on their uses in space exploration and astronomy. Education staff were reduced from two to one this year. To keep the role manageable, we had to limit the number of programs offered: we catered for 9,022 students and teachers in 2014, which was 19 per cent fewer than in 2012. Nevertheless, teachers we surveyed remain very positive about our programs, and we have repeat bookings as far ahead as 2018. The total number of visitors in 2014 was 61,051, 9.6 per cent down on 2013.

TABLE 1:
Visitor numbers

	2010	2011	2012	2013	2014
Parkes Observatory	95,104	96,609	92,876	84,698	68,427
Canberra Deep Space Communication Complex	70,044	77,350	68,710	67,554	61,051
Paul Wild Observatory (Narrabri) (rounded figure)	–	–	10,500	12,500	11,600



The lunar eclipse of 15 April 2014, seen from near the Parkes telescope. Credit: John Sarkissian

OUTREACH

In addition to ATNF outreach that took place at the observatory visitors centres:

- staff gave around 100 public talks to teachers, students, industry and community groups at events in New South Wales, Queensland, Victoria and Western Australia, and Japan
- staff at Parkes, Perth and Narrabri took part in several events in their local communities, including 'science days' at local public schools, the annual Elvis festival at Parkes, and the Perth Astrofest.

COMMUNICATIONS

In 2014 CSIRO changed the way it handles, records and evaluates communications activities, putting greater emphasis on social media and integrated communication campaigns. This year it issued two media releases related to the ATNF: "Rocks around the clock: asteroids pound tiny star" (in February), and "A telescope is born" (in June).

The central ATNF website, which had recorded a million visits in 2013, saw 50 per cent more this year. CASS also contributed to the central CSIRO website (www.csiro.au) and to CSIRO's social media channels, Facebook, Twitter, and the Universe@CSIRO and News@CSIRO blogs. An ATNF-related social media campaign about October's lunar eclipse was one of CSIRO's most successful for the year: it generated six radio and six online stories, and achieved a Facebook reach of almost 175,000 and a Twitter reach of 145,000.

Communication related to the Australian SKA Pathfinder project continues to be handled by CASS. In 2014 we generated 46 issues of the ASKAP weekly newsletter, two issues each of the bulletins ASKAP Update and ASKAP Commissioning Update, several fliers and briefing documents, and provided support for public talks, visits to the Murchison Radio-astronomy Observatory, and exhibits at conferences.

EDUCATION

The key education activities this year were:

- a three-day *Astronomy from the Ground Up!* teacher workshop at Parkes Observatory in May
- ten other teacher-workshop sessions in New South Wales, Victoria, South Australia and Queensland
- several CASS staff working with schools through the Scientists in Schools program
- CASS partnering with the Australian Astronomical Observatory and Las Cumbres Observatory Global Telescope Network and six universities in the *Opening Real Science: Authentic mathematics and science learning for Australia* project funded for the next three years. *Opening Real Science* targets trainee and current teachers and focuses on incorporating real science into the classroom
- establishing a mentoring scheme to link CASS staff with students at the Pia Wadjarri Remote Community School in the Murchison region of Western Australia
- thirteen sessions of PULSE@Parkes, an education program in which students control the Parkes telescope over the Internet and use it to observe pulsars. Two hundred and seventy-five (275) students and more than 60 teachers were involved. Highlights of this program in 2014 were:
    - ◊ the first observing session held in the Parkes radio telescope with students from Parkes High School
    - ◊ a 10-day visit to Japan for two staff, funded by a grant from the Australia-Japan Foundation, to run five PULSE@Parkes sessions.

Undergraduate Vacation Scholars

CASS hosted eight Undergraduate Vacation Scholars and one engineering placement over the 2014–2015 summer. Each student worked on a research project supervised by CASS staff. All were based at Marsfield and visited the Compact Array to perform observations. The students presented their work at a CASS symposium in February 2015.

CASS staff mentoring students at the Pia Wadjarri Remote Community School in the Murchison region of Western Australia.

Students from Mount Stromlo High School during a PULSE@Parkes session run at the Canberra Deep Space Communication Complex. Credit: Rob Hollow

Health, Safety and Environment (HSE)

The prevention of injury, illness and harm to the environment is a high priority for CASS.

Training sessions on HSE issues were well attended this year. The number of reported injuries (14) was similar to that of the previous two years: only one injury, a shoulder dislocation, required reporting to an external body (Comcare).

We carried out twenty-three reviews of HSE-related issues within CASS. Again, this is similar to the number of reviews in the past two years (27 in 2013 and 21 in 2012).

TABLE 2:
ATNF Health and Safety training sessions 2014

CLASSROOM TRAINING	
Advanced resuscitation	17
Apply first aid	11
Apply first aid refresher	6
Asbestos awareness and management	34
HSE for leaders, module 1	3
HSE for leaders, module 2	4
HSE principles of contractor management	15
Ergonomic assessment overview	3
RK code rehabilitation case management	1
ONLINE TRAINING	
Basic ergonomics	2
GOLDFFX eLearning	2
Mental health awareness for managers	59
Preventing bullying and harassment	15
Principles of safe lifting and carrying	1

Human Resources

STAFFING LEVELS

The commissioning of the Australian SKA Pathfinder (page 47) led to an increase in Operations and CASS Engineering staff; CASS's Perth office also grew, to five staff by the year's end. But overall staff levels rose only slightly. The CSIRO Interim Recruitment Arrangements, which came into effect in 2013, were still in force this year: they meant that only 'mission critical' roles could be filled. Recruitment was largely offset by cessations, particularly redundancies arising from budget cuts. Twenty-one staff ceased employment in 2014 as a result of resignation (4), retirement (1), term employment ending (5), redundancy (10) and transfer to other agencies (1). Some of these staff have been appointed as Honorary Fellows and are passing on their skills and knowledge by mentoring others.

Bob Kaletsch, a Senior Electrician at the Parkes Observatory. In 2014 Bob spent time at the Murchison Radio-astronomy Observatory, helping to prepare for the installation of the second-generation phased-array feeds on ASKAP.

TABLE 3:
CASS health and safety incidents, 2012–2014.
Abbreviations: (1) E Incidents = environmental incidents (2) H&S = health and safety (3) LTI = lost-time injuries: injuries that resulted in the loss of one or more whole days after the date of the injury (4) MTI = medical-treatment injury: an injury requiring medical treatment other than solely first-aid.

PERIOD	E INCIDENTS	H&S INCIDENTS	LTI	MTI
Jan 2012 to Dec 2012	0	16	4	3
Jan 2013 to Dec 2013	1	10	1	3
Jan 2014 to Dec 2014	1	14	1	0

TABLE 4:
ATNF staff levels

GROUP	TOTAL STAFF 2012*	TOTAL STAFF 2013*	TOTAL STAFF 2014*
ASKAP/Project specialists	17	12.5	10
Astrophysics	24	27	23
Engineering	46	36	41
Management	9	7	7
Operations	55	71	78
Support	8	6.5	6.5
Total	160	160	169.5

*Total staff in December excluding casuals, contractors, affiliates or students.

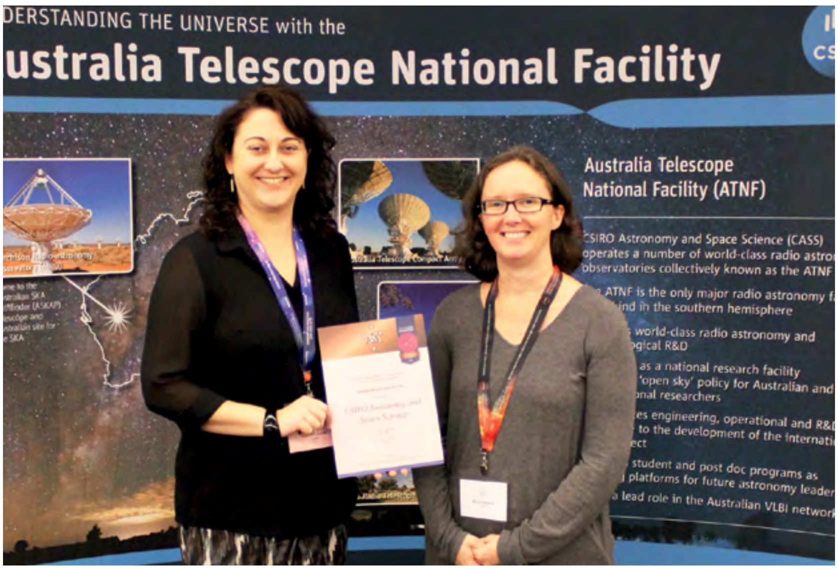
DIVERSITY AND INCLUSION

CSIRO has an enterprise-wide focus on diversity and inclusion, and is continuing to roll out its 2012–15 Diversity and Inclusion plan. One of the plan's aims is to increase Indigenous participation in CSIRO. As part of ATNF's contribution we have continued our relationship with two Indigenous cadets in Astrophysics and Engineering. In addition, in 2014 we recruited an Aboriginal Liaison Officer, Leonie Boddington, and a trainee Administration Assistant, Jayde Clayton.

In 2014 CASS formed a Diversity Committee, which will identify, implement, and monitor issues and initiatives related to diversity and equity, to ensure that all staff are treated fairly and equitably. Chaired by Dr Jill Rathborne, the committee is itself diverse, with members from different sites, research programs and levels of the organisation.

One of the committee's first tasks was to prepare CASS's entry for the inaugural Pleiades Awards. Modelled on the UK's Athena SWAN scheme, the Pleiades Awards have been created by the Astronomical Society of Australia to recognise organisations that take active steps to advance the careers of women. Organisations had to submit a case to be judged, and were assessed against criteria that involved monitoring the conduct of the organisation, making plans for improvement, and publicly demonstrating a commitment to best practice in the field. In December 2014 CASS received a Bronze award in this inaugural scheme.

The ATNF's Aboriginal Liaison Officer, Leonie Boddington



CASS's Jill Rathborne (left) and Deputy Director Sarah Pearce with the Pleiades award CASS received in 2014. Credit: Flornes Yuen

Observatory and Project Reports

Second-generation phased-array feeds for ASKAP under assembly.
Credit: Flornes Yuen

Parkes

The Parkes telescope enjoyed another productive year in 2014. Most observing time was used for pulsar-timing projects and searches for pulsars and Fast Radio Bursts. A large survey of the Galactic plane, SPLASH (the Southern Parkes Large Area Survey in Hydroxyl, described on page 26), was completed after running for several years.

Two large blocks of time were scheduled during the year for major maintenance works and upgrades. During a two-week period in February, we worked on the receiver translator in the focus cabin, uninterruptible power supplies in the telescope tower, and the structure of the tower itself; characterised the radio-frequency interference (RFI) environment at the top of the focus cabin; and installed a 3.8-m antenna on site for RFI monitoring and mitigation. In August we used a two-week shutdown to install a new electrical switchboard for the Observatory. The only significant unscheduled downtime occurred in July, when a roller door on the master-equatorial room failed; however, this took the telescope off air for less than a week.

CASS has been considering options for the next generation of Parkes receivers. After examining the science outcomes, the technical challenges, the 'fit' with operational plans, and the resources available to undertake their fabrication, commissioning and operation, CASS has decided that it is in a position to tackle a 700 MHz–4 GHz, or ultra-wideband low-frequency receiver. Support from the astronomy community will be needed to ensure sufficient resources are available for the project to be completed. Some of the funding for developing the ultra-wideband receiver was secured in November from the Australian Research Council, and work on the system will start in 2015.

Installing the new electrical switchboard at Parkes

Compact Array

This year the Marsfield Science Operations Centre (SOC) became the default location for Compact Array observations. First-time observers, and observers seeking to re-qualify for remote observing, must observe from the SOC, and the Duty Astronomer is now based in Marsfield also. A web camera with a fish-eye lens was installed on top of the Narrabri control building to provide remote observers with a better feel for observing conditions at the site. We also installed a new Radio Frequency Interference (RFI) monitor: this scans in both frequency and azimuth to determine the condition of the spectrum between 800 MHz and 3 GHz. After this system proved successful at the Compact Array a similar one was deployed at Parkes.

The Compact Array masers, used to supply the reference frequency for the array, were refurbished in June by technicians from Vremya, the Russian company that built them. The upgraded masers now match the newer one installed at the Murchison Radio-astronomy Observatory a couple of years ago.

This year the Compact Array and Mopra took part in trials by the National Time and Frequency Network consortium, which is funded by the Australian Research Council, to test the distribution of time and frequency signals over an optical-fibre network. The work has implications for the Square Kilometre Array, as being able to transfer time and frequency signals from a central location, using the same optical-fibre network that carries data to the correlator, would do away with the need for atomic clocks at each site. The trials have tested several set-ups, such as looping the Compact Array maser signal to Mopra and back before using it at the Compact Array.

In April we tracked down a subtle bug that had led to spectral-line data sometimes being mislabelled in the first correlator cycle of some scans when the 1-MHz zoom mode of the Compact Array Broadband Backend was being used. A full description of the problem, and a means of addressing it, were posted on the Compact Array Forum webpages, and we informed the principal investigators of projects that might have been affected.

In 2012–2013 the original receivers on the Compact Array for the 6- and 3-cm bands (covering 4.5–6.5 GHz and 7.5–10.5 GHz respectively) were replaced with a suite covering 4–12 GHz. In 2014 we finalised this project and submitted a report to the funding organisation, Astronomy Australia Limited.

The new RFI monitor at the Compact Array

The Compact Array. Credit: Cormac Purcell

Mopra

The National Astronomical Observatory of Japan, the University of New South Wales and the University of Adelaide contribute to the funding of Mopra's operations, and in return are allocated blocks of observing time. Some observing time, reserved as 'National Facility time', is used for single-dish programs and Mopra's participation in Long Baseline Array projects. In May, we announced that CSIRO would cease funding Mopra. Discussions have begun with parties interested in taking over operation (or ownership) of the telescope after the current agreements end in 2015.

Following the January 2013 bushfire, we made photogrammetric measurements of the dish's surface, to check that its accuracy had not been compromised by the fire's heat. Those tests revealed no adverse effects, but reports of reduced observing efficiency at 3-mm wavelengths, coupled with experience gained in commissioning ASKAP antennas, prompted us to make further holographic measurements of the surface. The initial attempts were affected by phase instability, but the final observations were very productive, and allowed us to improve the dish's rms surface accuracy from 260 microns to 160 microns.

Long Baseline Array

In 2014, Long Baseline Array (LBA) observing blocks were positioned, as far as possible, to meet requests from the RadioAstron space-VLBI mission. RadioAstron observations involving ATNF telescopes take place several times a month: requests for support are received only a month or two before the observations are made, and support must be supplied on a 'best efforts' basis. The Compact Array and Mopra have 'answered the call' fairly frequently. Parkes has done so about six times a year, when its H–OH receiver is on the telescope. This receiver covers 1.6 GHz, the frequency of the spacecraft's L-band receiver (which was provided by the ATNF two decades ago, and is still going strong).

In recent years a single ASKAP dish, with a traditional single-pixel feed, has supported some LBA observations. In June we took this connection a step further by detecting fringes between Parkes and an ASKAP antenna equipped with a phased-array feed (PAF). The source observed was a standard VLBI calibrator, PKS 0537–441. The necessary resampling and reformatting of PAF data meant that only a small part of the ASKAP data stream was accessible, but as an initial 'proof of concept' the exercise was a great success.

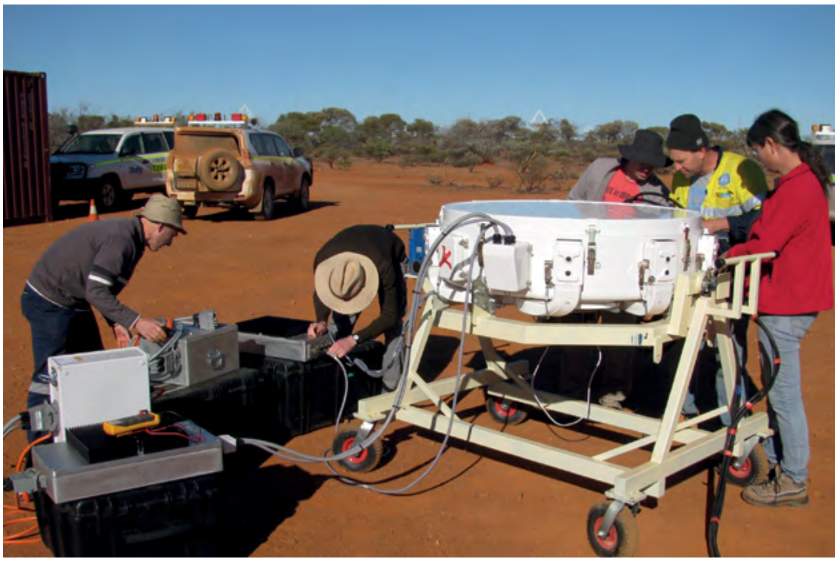
The Mopra telescope. Credit: Cormac Purcell

Australian SKA Pathfinder (ASKAP)

CSIRO's highest priority in radio astronomy is to successfully deliver ASKAP. The telescope will carry out high-quality science, especially in areas that will be further investigated with the SKA, and in the course of the project we are creating new technology that will advance radio astronomy.

In 2013 we built and installed first-generation phased-array feeds (PAFs) on six of ASKAP's 36 antennas. In 2014 we used this six-antenna array to make commissioning observations, completed and tested a prototype of the second-generation PAFs, and assembled and tested the first production versions.

ASKAP commissioning activities are partly supported by funding from the National Collaborative Research Infrastructure Scheme (NCRIS), administered by Astronomy Australia Limited.



Staff at the Murchison Radio-astronomy Observatory preparing a prototype second-generation phased-array feed for ASKAP for testing.

ASKAP antennas. Credit: Maxim Voronkov

ATNF staff working on an ASKAP antenna

A Redback-3 board, a digital signal-processing platform for ASKAP's second-generation phased-array feeds. The Redback boards are built into a beamformer chassis, the first of which was completed in April 2014. L-R: Andrew Brown (Redback board design), Matt Shields (production) and Raji Chekkala (chassis design).

Members of the ACES team at work.
L-R at rear: Maxim Voronkov, Aidan Hotan, David McConnell.
L-R at front: Paolo Serra, James Allison, Martin Bell.
Credit: Flornes Yuen

ACES TEAM EXPANDED

The ASKAP Commissioning and Early Science (ACES) team was created in late 2013, bringing together staff from ATNF Operations, the ASKAP project, and ATNF Astrophysics. In 2014 we expanded the team by seconding staff from the Universities of Sydney, Melbourne and Western Australia, and Curtin University.

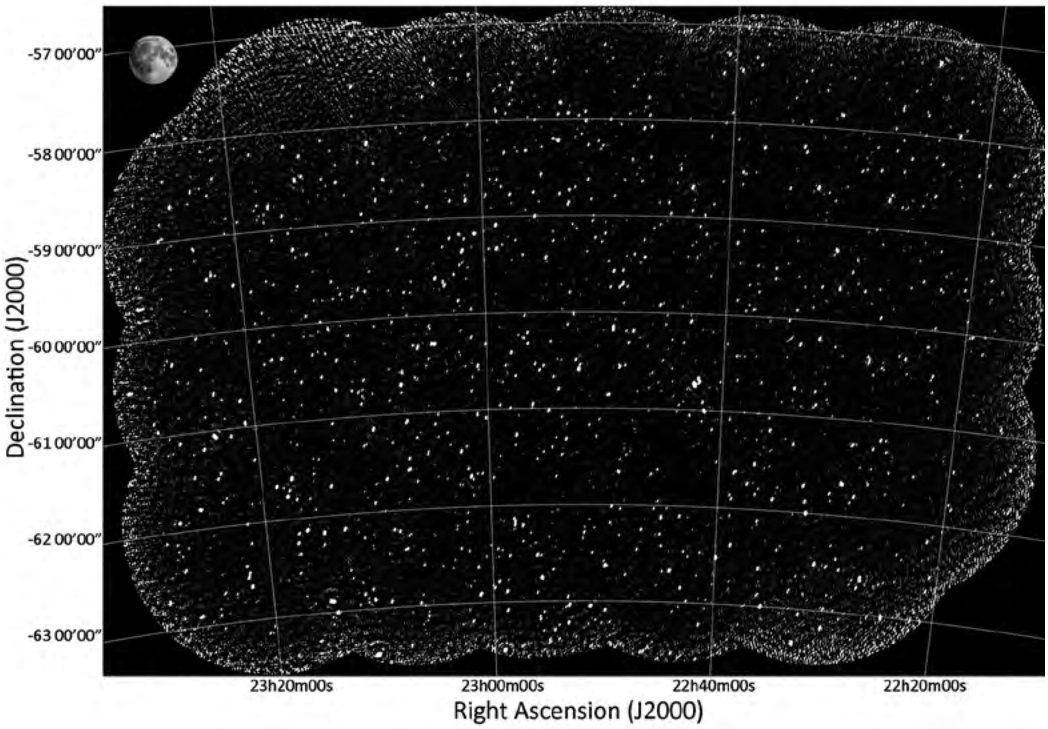
COMMISSIONING OBSERVATIONS

In February this year the ASKAP hardware correlator at the MRO, which originally handled two simultaneous three-antenna sub-arrays, was reconfigured to process data from a six-element interferometer. The correlator and the six antennas it serves—those fitted with first-generation PAFs—form the Boolardy Engineering Test Array, BETA.

Using BETA, the ACES team this year made several significant commissioning observations. The first, achieved in February, was a continuum image created with six BETA antennas. This was followed by:

- *a continuum image of an ASKAP test field near the south celestial pole, made with nine overlapping beams and showing a number of distant galaxies*. The image quality showed that the phased-array feeds used on BETA remained stable over the 12 hours it took to make the image
- *a 'snapshot' of HI (neutral hydrogen gas) in the galaxy NGC 253*. Made over just 11 hours, this image captured both the intensity of the radio waves and the rotational velocity of the galaxy
- *an image of H I in the galaxy group IC 1459*. This revealed massive 'dark' clouds of H I near the galaxy IC 5270. (See page 33 for more details.)
- *a spectrum across the 300-MHz instantaneous bandwidth of ASKAP that revealed an H I absorption line in the direction of the galaxy PKS B1740-517*. This was the first 'blind' detection of H I (that is, one not guided by previous optical observations) in this redshift range. (See page 24 for more details.)
- *an image covering 50 square degrees in the constellation Tucana—an area of the sky equivalent to 250 full moons—which captured 1750 radio sources*
- *detection of a known intermittent pulsar, using a technique designed for finding transient radio sources*.

These results make plain the value of ASKAP's novel features: the wide field of view we get from its phased-array feeds, its configurable beam patterns, and its third 'roll' axis, which eliminates the problem of the primary beam rotating. They have laid the groundwork for some of the ten Survey Science Projects planned for ASKAP's first five years of operation.



An image covering 50 square degrees of sky, made with the Boolardy Engineering Test Array, BETA (six ASKAP antennas installed with first-generation phased-array feeds). The image was made from five observations, of between seven and 12 hours each, of two areas in the constellation Tucana (the Toucan), with the nine BETA beams arranged to create a square 'footprint'. It reveals about 2,300 sources above a sensitivity of 5σ (σ ~ 0.5 mJy). Gathering the data took about two days: had BETA been fitted with single-pixel feeds instead of phased-array feeds, it would have taken nine times longer.
Credit: Ian Heywood and the ASKAP Commissioning and Early Science team

EARLY SCIENCE PROGRAM

ASKAP Early Science is an observing program that will begin when an array of 12 ASKAP antennas has been fitted with second-generation phased-array feeds and brought into operation. The priorities of the Early Science program are to demonstrate ASKAP's capabilities, do high-impact science, and generate data that can be used to improve analytic techniques. In October we held an ASKAP Community Workshop, attended by some 50 participants from the ASKAP Survey Science Projects, to update the community on ASKAP commissioning and discuss the options for transitioning from ASKAP-12, which will be used for the Early Science Program, to the full array.

DATA PROCESSING AND ARCHIVING

ASKAP data will be processed by a real-time computer ('Galaxy') at the Pawsey Supercomputing Centre in Perth. In 2014 the ASKAP Computing team worked on calibration and imaging of data taken with ASKAP antennas, and refined processing pipelines by running simulated observations. Because typical ASKAP datasets will be so large, up to two terabytes each, new simulation software had to be developed to accurately model the telescope and handle its images. Information gained from the simulations will be used to plan ASKAP observations.

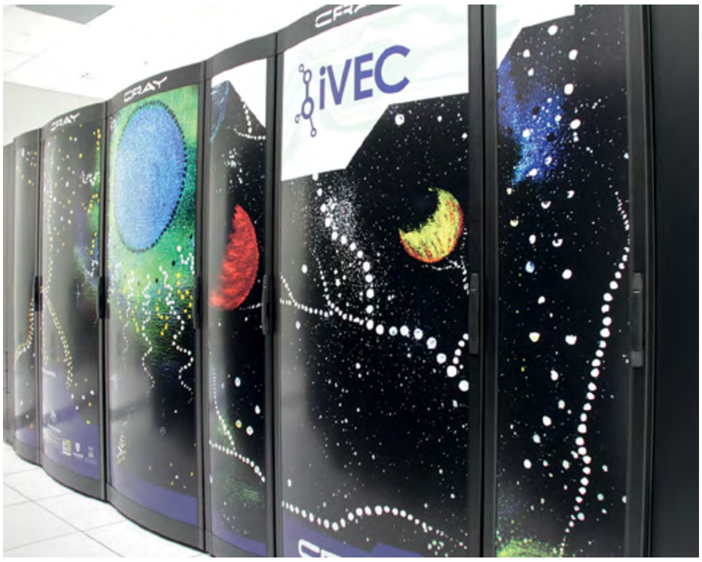
The Pawsey Supercomputing Centre will also house the CSIRO ASKAP Science Data Archive (CASDA), which will be the main facility for storing, managing and distributing science-ready data products from ASKAP. Up to 16 terabytes of ASKAP data will enter the archive each day, and up to five petabytes of processed data will need to be stored each year. The CASDA team, drawn from the ATNF, CSIRO Information Management and Technology, and the Pawsey Centre, was set up in 2013. In 2013 and early 2014 the team worked on confirming system requirements, and designing and verifying the proposed system architecture. It is now building the first working version of the CASDA system and testing it with a group of science users.

NEXT-GENERATION PHASED-ARRAY FEEDS

While the BETA system was being commissioned with the first generation of CSIRO phased-array feeds (PAFs), we continued to develop the next generation, aiming to make the new PAFs more efficient in use and simpler, cheaper and quicker to build.

Tests on a prototype second-generation PAF at Parkes in 2013 had shown a system noise-temperature close to 50 K across the entire ASKAP frequency band (0.7–1.8 GHz). The tests were made on a 40-element array: the full-sized PAF, with 188 elements, was expected to perform somewhat better at the lower end of the frequency range when installed on an ASKAP antenna.

The ASKAP Central Processor, 'galaxy', at the Pawsey Supercomputing Centre



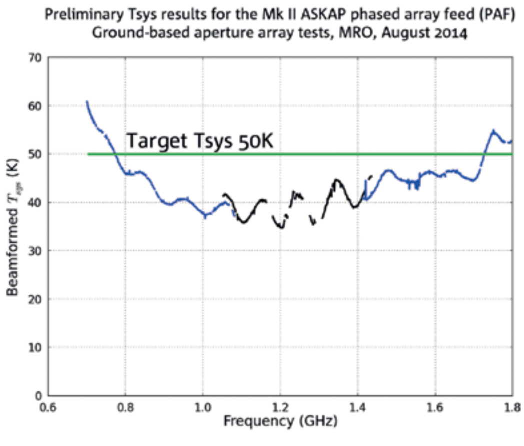
The prototype second-generation PAF set up in an RF-shielded room at CASS headquarters in Sydney. In tests all 188 radio-frequency signals were successfully transported from the PAF to the digital backend, located in an adjacent room.

We made the first successful ‘end-to-end’ test on the second-generation prototype PAF in March this year, at Marsfield. In September we delivered this prototype to the Murchison Radio-astronomy Observatory (MRO) and tested it and its associated electronics on the ground. In ‘hot’ (absorber box) and ‘cold’ (sky) observations, the test system successfully captured 188 radio signals, each with 600 MHz of bandwidth, and transported them over 1.4 km of optical fibre to the digital backend in the MRO Control Building. As before, the system-temperature results were good, and showed that the new PAFs would outperform their predecessors. After being tested on the ground the prototype PAF was installed on ASKAP antenna 29 and tested in situ. Above 1400 MHz it was twice as sensitive as the first-generation PAFs and had four times the survey speed. The minimum T_{sys}/η was 78 K at 1230 MHz, and T_{sys}/η was 95 K or better across the 835–1800 MHz range.

Antenna 29 with its new prototype second-generation PAF, and the installation team.

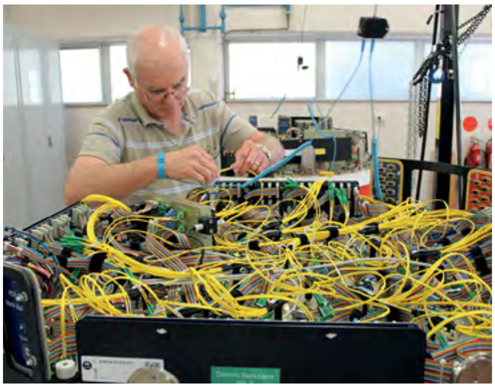
In June we secured funding to allow second-generation PAFs to be installed on 30 ASKAP antennas. Under an agreement between Astronomy Australia Limited (AAL) and CSIRO, AAL will allocate $6M for ASKAP early operations and CSIRO will provide a matching contribution to construct, install and commission six additional second-generation PAFs, bringing the total number of funded new PAFs to 30. As of the end of the year, four pre-production PAFs and three frontends were awaiting final assembly.

The set-up used for the ‘hot’ observation of an absorber box during ‘on ground’ tests of the prototype second-generation PAF at the MRO.



‘On ground’ system-temperature tests of the prototype second-generation PAF at the MRO. The 'ripple' across the band is a common artefact of the measuring process; the gaps are due to the removal of unphysical data.

The prototype second-generation PAF going onto ASKAP Antenna 29.



ATNF staff member Les Reilly assembling a second-generation PAF at Marsfield.

ATNF engineer Suzy Jackson explaining the ASKAP correlator to visitors at the MRO.

Square Kilometre Array (SKA)

The international Square Kilometre Array, to be located in Australia and Africa, will be the world's largest radio telescope. The SKA project has ten member countries (as of 2014, Australia, Canada, China, Germany, Italy, New Zealand, South Africa, Sweden, The Netherlands and the United Kingdom) and more than 100 companies and research institutions across 20 countries are now working to design the telescope. Construction is set to start in 2018 and early science observations in 2020. CSIRO's Murchison Radio-astronomy Observatory (MRO) will be the Australian site for the SKA, and CSIRO has been involved in the project for more than a decade. The CSIRO SKA Centre, headed by the CASS Deputy Director, Dr Sarah Pearce, coordinates SKA-related activities within the organisation.

SKA SCIENCE

In June this year more than 250 scientists came together at a conference hosted by the international SKA Organisation, *Advancing Astrophysics with the Square Kilometre Array*. The 135 papers arising from that meeting are to be published, collectively presenting the new 'science case' for the SKA: ATNF staff contributed to 25 of them. Eleven ATNF staff participate in the SKA's ongoing Science Working Groups, helping to shape the SKA's science goals in areas from cosmology and the evolution of galaxies to pulsars and exoplanets.

CONSORTIUM ROLES

In 2013 the SKA Organisation allocated research and development 'work packages' for the SKA to international consortia comprising both science institutes and commercial organisations. These consortia are charged with producing designs of SKA components and sub-systems that can be sent to tender. CSIRO leads two—the SKA Dish Array Consortium, (which is designing the SKA dishes) and the Infrastructure–Australia Consortium (which is designing and costing SKA infrastructure)—and is a member of another five.

In the first quarter of 2014 the consortia members, including CSIRO, focused on defining the system requirements and demarcations between each consortium. Following this, all consortium agreements were completed and signed. The consortia submitted their initial costings to the SKA Organisation in October and then began preparing documents for the Preliminary Design Reviews, to be held in early 2015.

RADIO QUIET ZONE POLICY AND STAKEHOLDER RELATIONS

Radio astronomy at the Murchison Radio-astronomy Observatory is protected by the Australian Radio Quiet Zone (WA). This year, the CASS Radio Quiet Zone (RQZ) team continued to provide technical advice to the Australian SKA Office, industry stakeholders and the Australian Communications and Media Authority (ACMA) on the impact of various activities within the RQZ; briefed the SKA Office on the RQZ policy and radio-frequency interference requirements; provided technical advice to governments on the Australian SKA Office RQZ work plan; and worked with ACMA and governments on the proposed revisions to the Radiocommunications Assignment and Licensing Instruction (RALI) MS32, which applies to the Australian Radio Quiet Zone (WA).

Australia's Foreign Minister, Julie Bishop, and the UK's Science Minister, David Willetts, among a party visiting the MRO in March.

SITE ESTABLISHMENT

This year CSIRO continued to provide technical advice on site issues to the Australian SKA Office and input to the Hosting Agreement for the SKA. It also worked with the Commonwealth Department of Industry and the international SKA Office on the best way to provide power at the MRO for SKA Phase 1. Environmental surveys of the MRO, required before SKA Phase 1 can be built, were completed in September.

ATNF engineer Scott Munting at work at the MRO.

ATNF Management Team

ATNF DIRECTOR AND DIRECTOR CSIRO ASTRONOMY AND SPACE SCIENCE

Lewis Ball

DEPUTY DIRECTOR

Sarah Pearce

ASSISTANT DIRECTOR, OPERATIONS

Douglas Bock

ASSISTANT DIRECTOR, ASKAP

Antony Schinckel

ASSISTANT DIRECTOR, ENGINEERING

Tasso Tzioumis

ASSISTANT DIRECTOR, ASTROPHYSICS

Simon Johnston

ASSISTANT DIRECTOR, WESTERN AUSTRALIA

Phil Crosby

OPERATIONS MANAGER

Warren Bax

Appendices

The Compact Array. Credit: Cormac Purcell

A: Committee membership

ATNF Steering Committee in 2014

CHAIR

Dr Susan Barrell, Bureau of Meteorology

MEMBERS

Ex-officio

Professor Warrick Couch, , Australian Astronomical Observatory

Dr Euan Sangster, CSIRO Information Management and Technology (acting)

Dr David Williams, CSIRO National Facilities and Collections

Astronomers

Professor Steven Tingay, Curtin University

Professor Mark Wardle, Macquarie University

Professor Stuart Wyithe, University of Melbourne

International advisers

Professor Neal Evans, University of Texas at Austin, USA

Dr Di Li, National Astronomical Observatories, Chinese Academy of Sciences

Professor Raffaella Morganti, ASTRON, The Netherlands

Broader community

Mr Noel Wainwright, Lockheed Martin

Australia Telescope User Committee in 2014

CHAIR

Professor John Dickey, University of Tasmania (until August 2014)

Associate Professor Virginia Kilborn, Swinburne University of Technology (from August 2014)

SECRETARY

Dr Joanne Dawson, CASS and Macquarie University (October 2014–May 2017)

Dr Nick Seymour, CASS/Curtin University (October 2013–May 2014)

MEMBERS

Dr James Allison, University of Sydney/CASS (October 2011–May 2014)

Dr Minh Huynh, University of Western Australia (Oct 2012–May 2015)

Dr Evan Keane, Swinburne University of Technology (Oct 2014–May 2017)

Associate Professor Virginia Kilborn, Swinburne University of Technology (Oct 2011–May 2014)

Dr James Miller-Jones, Curtin University (Oct 2014–May 2017)

Dr Stephen Ord, Curtin University (Oct 2011–May 2014)

Dr Paolo Serra, CSIRO Astronomy and Space Science (Oct 2014–May 2017)

Dr Stas Shabala, University of Tasmania (Oct 2014–May 2017)

Dr Ryan Shannon, CSIRO Astronomy and Space Science (Oct 2011–May 2014)

Dr Tobias Westmeier, University of Western Australia (Oct 2012–May 2015)

STUDENT MEMBERS

Mr Craig Anderson, University of Sydney (October 2013–May 2014)

Ms Claire-Elise Green, University of New South Wales (Oct 2014–May 2015)

Mr Vasaant Krishnan, University of Tasmania (Oct 2014–May 2015)

Emily Petroff, Swinburne University of Technology (October 2013–May 2014)

The Australia Telescope Steering Committee appoints the members of the Australia Telescope User Committee. New members usually start their three-year term with the October/November meeting in their first year and finish their term after the May/June meeting in their last year. Students are appointed for one year (two meetings). Dates of the first and last meetings are given.

Australia Telescope Time Assignment Committee in 2014

CHAIR

Professor Michael Drinkwater, University of Queensland

MEMBERS

Ex-officio

Dr Douglas Bock, CSIRO Astronomy and Space Science (Assistant Director, Operations)

Dr Philip Edwards, CSIRO Astronomy and Space Science (Head of Science Operations)

Dr Jill Rathbone, CSIRO Astronomy and Space Science (TAC Executive Officer)

TAC members

Dr James Allison, CSIRO Astronomy and Space Science (from October 2014)

Dr Hayley Bignall, International Centre for Radio Astronomy Research

Dr Steve Curran, University of Sydney (until October 2014)

Dr Joanne Dawson, CSIRO Astronomy and Space Science and Macquarie University

Dr Alan Duffy, Swinburne University of Technology

Dr Duncan Galloway, Monash University

Dr George Hobbs, CSIRO Astronomy and Space Science

Professor Gerhardt Meurer, International Centre for Radio Astronomy Research

Dr Emma Ryan-Weber, Swinburne University of Technology

B: Financial summary

The table below summarises the revenue and expenditure applied to CSIRO's radio astronomy activities, also including related activities resourced from the CSIRO ICT Centre.

	Year ending 30 June 2011 (A$'000)	Year ending 30 June 2012 (A$'000)	Year ending 30 June 2013 (A$'000)	Year ending 30 June 2014 (A$'000)
Revenue				
External	7,181	13,726	4,213	10,179
Appropriation	36,419	35,623	35,668	41,803
Total revenue	43,600	49,349	39,881	51,982
Expenses				
Salaries	14,046	14,884	16,688	17,723
Travel	1,080	1,093	1,432	1,325
Other operating	5,028	5,081	5,143	7,157
Overheads*	12,914	13,055	12,725	14,709
Corporate support services	0	0	0	0
Depreciation and amortisation	3,953	4,081	4,628	7,095
Doubtful debt expense	0	0	0	0
Total expenses	37,021	38,194	40,616	48,009
Profit/(Loss) on sale of assets	0	0	0	0
Operating result	6,579	11,155	–735	3,973

NOTES:

*Overheads include corporate support services and business-unit support services.

External revenue for the years ending 30 June 2011 and 30 June 2012 was affected by one-off agreements related to funding for the ASKAP project.

C: Staff list

ALL STAFF WHO WORKED FOR CASS ON RADIO ASTRONOMY RELATED ACTIVITIES AS OF DECEMBER 2014

This list includes casual staff and Honorary Fellows, but not students or contractors.

MARSFIELD		
Allen	Graham	Engineering
Allison	James	Astrophysics
Amy	Shaun	Operations
Ball	Lewis	CASS Director and ATNF Director
Banfield	Julie	Astrophysics
Bannister	Keith	Astrophysics
Barker	Stephen	Engineering
Bateman	Tim	Engineering
Beresford	Ron	Engineering
Bock	Douglas	Assistant Director, Operations
Bourne	Michael	Engineering
Bowen	Mark	Engineering
Breen	Shari	Astrophysics
Broadhurst	Steven	Operations
Brothers	Michael	Engineering
Brown	Andrew	Engineering
Boyle	Brian	Project Specialist
Bunton	John	Engineering
Carretti	Ettore	Operations
Castillo	Santiago	Engineering
Chapman	Jessica	Operations
Chekkala	Raji	Engineering
Cheng	Wanxiang	Engineering
Chippendale	Aaron	Engineering
Chow	Kate	Project Specialist
Chung	Yoon	Engineering
Contreras	Yanett	Astrophysics
Cooper	Paul	Engineering
Craig	Daniel	Operations
Dawson	Joanne	Astrophysics
Death	Michael	Engineering
Doherty	Paul	Engineering
Drazenovic	Vicki	Operations

Dunning	Alexander	Engineering
Edwards	Leanne	Operations
Edwards	Philip	Operations
Ekers	Ron	Fellow
Ferris	Richard	Engineering
Forsyth	Ross	Engineering
Franzen	Thomas	Astrophysics
Gough	Russell	Engineering
Green	James	Astrophysics
Hampson	Grant	Engineering
Harvey-Smith	Lisa	Astrophysics
Haskins	Craig	Operations
Hellbourg	Gregory	Engineering
Heywood	Ian	Astrophysics
Hill	Alex	Astrophysics
Hobbs	George	Astrophysics
Humphreys	Ben	Operations
Huynh	Minh	Engineering
Indermuehle	Balthasar	Operations
Jackson	Carole	Project Specialist
Jeganathan	Kanapathippillai	Engineering
Johnson	Megan	Astrophysics
Johnston	Simon	Assistant Director, Astrophysics
Kanoniuk	Henry	Engineering
Kerr	Matthew	Astrophysics
Kesteven	Michael	Engineering
Kiraly	Dezso	Engineering
Koribalski	Bärbel	Astrophysics
Kosmynin	Arkadi	Operations
Leach	Mark	Engineering
Li	Li	Engineering
Lie	Jennifer	Engineering
Mackay	Simon	Engineering
Macleod	Adam	Project Specialist
Maher	Tony	Operations
Manchester	Dick	Fellow
Marquarding	Malte	Operations
McClure-Griffiths	Naomi	Astrophysics
McConnell	David	Operations
McIntyre	Vincent	Operations
McKinnon	Mark	Business Strategy
Mitchell	Daniel	Operations
Moncay	Ray	Engineering
Neuhold	Stephan	Engineering
Norris	Ray	Astrophysics
O’Sullivan	John	Fellow

O’Toole	Sally	Engineering
Pearce	Sarah	CASS Deputy Director
Phillips	Chris	Operations
Pope	Nathan	Operations
Rathborne	Jill	Astrophysics
Reilly	Les	Engineering
Reynolds	John	Project Specialist
Roberts	Paul	Engineering
Rowlinson	Beatrix	Astrophysics
Sanders	Aaron	Engineering
Schinckel	Antony	Assistant Director, ASKAP
Serra	Paolo	Astrophysics
Seymour	Nicholas	Astrophysics
Shannon	Ryan	Astrophysics
Shields	Matthew	Engineering
Shimwell	Timothy	Astrophysics
Storey	Michelle	Policy Strategy
Tam	Kam	Operations
Toomey	Lawrence	Operations
Troup	Euan	Operations
Tuthill	John	Engineering
Tzioumis	Tasso	Assistant Director, Engineering
Voronkov	Maxim	Operations
Whiting	Matthew	Operations
Wilson	Warwick	Fellow
Wilson	Carol	Policy Strategy
Wong	Ivy	Astrophysics
Wu	Xinyu	Operations
Wark	Robin	Operations
Wieringa	Mark	Operations
MARSFIELD RESEARCH SUPPORT		
Bax	Warren	Operations Manager
Broadhurst	Sue	Reception
Clampett	Keith	Stores
D’Amico	Andy	Stores
Gray	Amanda	Administration
Hartmann	Carmel	Administration
Hollow	Robert	Communications and Outreach
Kachwalla	Elsa	Reception
Largent	Marcia	Health, Safety and Environment
Merrick	Sarah	Finance
O’Loughlin	Vicki	Administration
O'Toole	Sally	Reception
Poshoglian	Meg	Reception
Soo	Susan	Administration
Tesoriero	Julie	Administration

Wright	Andrew	Human Resources
Yuen	Flornes	Communications and Outreach
NARRABRI		
Bateman	John	Operations
Brem	Christoph	Operations
Brodrick	David	Operations
Hill	Michael	Operations
Hiscock	Brett	Operations
Lennon	Brett	Operations
Madden	Brian	Operations
McFee	John	Operations
Mirtschin	Peter	Operations
Munting	Scott	Operations
Rex	Jordan	Operations
Stevens	Jamie	Operations
Sunderland	Graeme	Operations
Tough	Bruce	Operations
Wilson	John	Operations
Wilson	Tim	Operations
NARRABRI RESEARCH SUPPORT		
Dodd	Susan	Operations
Forbes	Kylee	Operations
Hiscock	Jennifer	Operations
Johnson	Brian	Property Services
Kelly	Pamela	Operations
McFee	Margaret	Operations
McPherson	Liza-Jane	Operations
Prestage	Joslin	Operations
Shields	Mick	Health Safety and Environment
Wilson	Christine	Operations
PARKES		
Brady	Scott	Operations
Crocker	Jonathan	Operations
D'Mello	Glen	Operations
Hoyle	Simon	Operations
Hunt	Andrew	Operations
Kaletsch	Robert	Operations
Lees	Tom	Operations
Lensson	Erik	Operations
Mader	Stacy	Operations
Preisig	Brett	Operations
Reeves	Ken	Operations
Ruckley	Timothy	Operations
Sarkissian	John	Operations
Smith	Malcolm	Operations

PARKES RESEARCH SUPPORT		
Marshall	Margaret	Operations
Milgate	Lynette	Communications and Outreach
Trim	Tricia	Communications and Outreach
Unger	Karin	Communications and Outreach
Veale	Roxanne	Communications and Outreach
Wilson	Beverley	Communications and Outreach
GERALDTON		
Armstrong	Brett	Operations
Boddington	Robin	Project Specialist
Cox	Thomas	Operations
D'Souza	Mary	Operations
Harding	Alex	Operations
Jackson	Suzy	Operations
McConigley	Ryan	Operations
Morris	John	Operations
Pena	Wilfredo	Health, Safety and Environment
Puls	Lou	Operations
Reay	Michael	Operations
Simpson	Godfrey	Project Specialist
PERTH*		
Brooks	Kate	Project Specialist
Crosby	Phil	Assistant Director, Western Australia
Guzman	Juan Carlos	Software Development
Hotan	Aidan	Project Specialist
CANBERRA		
Zamora-Pullin	Kobi	Astrophysics
CANBERRA DEEP SPACE COMMUNICATION COMPLEX		
Horiuchi	Shinji	Astrophysics
Nagle	Glen	Communications and Outreach

*Marilyn Drake, the administrative assistant for CASS's Perth office, is a contractor

D: Observing programs

Observations allocated by the Time Assignment Committee

A small number of 'Target of Opportunity' observations are not listed. Proposal cover sheets are available through the ATNF proposal application system, OPAL (http://opal.atnf.csiro.au).

OBSERVATIONS MADE WITH THE AUSTRALIA TELESCOPE COMPACT ARRAY

October 2013 to September 2014

OBSERVERS	PROGRAM	NO.
Stevens, Edwards, Wark, Wieringa	ATCA calibrators	C007
Staveley-Smith, Gaensler, Tzioumis, Ng, Zanardo,	Supernova remnant 1987A	C015
Ryder, Smith, Böttcher, Kotak, Polshaw	The 1978 supernova in NGC 1313	C184
Johnston, Kerr, Shannon, den Hartog	Unpulsed transient emission from the PSR B1259–63 system	C326
Coriat, Tzioumis, Corbel, Fender, Brocksopp	Radio jets in recurrent and new black hole X-ray transients	C989
Corbel, Tzioumis, Fender, Kaaret, Orosz, Tomsick	Large scale radio/X-ray jets in microquasars	C1199
Green, Caswell, Gray, Fuller, Ellingsen, Pestalozzi, Thompson, Breen, Avison, Voronkov	Completing the catalogue of accurate positions of methanol masers from the Methanol Multibeam Survey	C1462
Ryder, Stockdale, Van Dyk, Panagia, Amy, Immler, Burlon	NAPA observations of core-collapse supernovae	C1473
Edwards, Macquart, Lovell, Ojha, Kadler, Hungwe, Stevens, Blanchard, Mueller, Wilms, Boeck	ATCA monitoring of gamma-ray loud AGN	C1730
Van der Plas, Maddison, Wright, Casassus, Menard, Ubach, Perez	Observing planet formation in the disk around HD 97048	C1794
Eckart, Sjouwerman, Straubmeier, Kunneriath, Garcia-Marin, Valencia-S., Moser, Bursa, Karas, Borkar, Zajacek	Monitoring the effect of a dust source flying by SgrA* in 2014	C1825
Voronkov, Caswell, Green, Sobolev, Ellingsen, Goedhart, Gaylard, van der Walt, Maswanganye, Parfenov	Understanding periodic flares of the methanol masers	C1929
Agliozzo, Trigilio, Buemi, Leto	Radio detection of Luminous Blue Variable nebulae in the Magellanic Clouds	C1973
Birkinshaw, Worrall	PKS B2152–699: jet deflection and boosted X-ray emission	C2034
Corbel, Edwards, Sadler, Ojha, Thompson, Gehrels, Tingay, Cheung, Wieringa, Grenier, Chaty, Dubus, Cameron, Abraham , Schinzel	ATCA follow-up of unidentified flaring Fermi gamma-ray sources	C2051
Titmarsh, Caswell, Ellingsen, breen, Voronkov	Water-maser follow-up of the Methanol Multibeam Survey	C2186
Kilborn, Meurer, Bekki, Drinkwater, Sweet	Tidal dwarf galaxy candidates in the J1051–17 group	C2440
Possenti, Burgay, Israel, Wieringa, Rea, Esposito	Continuum radio emission from magnetars in outburst	C2456
Rebolledo, Gaensler, Burton, Brooks, Garay, Green, Miller-Jones, Purcell, Breen, Voronkov, O'Sullivan, Smith, Reiter	Carina Parkes–ATCA radio centimetre-wavelength survey (CARPARCS)	C2489
Miller-Jones, Migliari, Diaz-Trigo	Probing the disc wind-jet connection in black-hole transients	C2514
Umana, Norris, Trigilio, Leto, Ingallinera, Agliozzo, Franzen	Stellar radio emission in the SKA era:the SCORPIO project	C2515
Miller-Jones, Tzioumis, Maccarone, Jonker, Nelemans, Sivakoff	Constraining black hole formation with triggered LBA astrometry	C2538
Reeves, Koribalski, Sadler, Allison	A search for HI absorption in gas-rich galaxies from HIPASS	C2573
Miller-Jones, Altamirano, Soria, Tingay, Moin, Sivakoff, Krimm	Jet–disc coupling in black-hole X-ray binary outbursts	C2601
Petrov, Murphy, McConnell, Edwards, Sadler, Taylor, Mahony, Kovalev, Schinzel	ATCA observations of Fermi unassociated sources	C2624
Hill, Gaensler, McClure-Griffiths, Moss	Disruption of a magnetised high-velocity cloud	C2666
Norris, Wall, Mao, Condon, Vernstrom, Seymour	Are diffusesources responsible for the ARCADE excess emission?	C2669
Hancock, Gaensler, Murphy, Bell, Burlon, de Ugarte Postigo	ATCA observations of the brightest, shortest and highest-redshift GRBs	C2689

OBSERVERS	PROGRAM	NO.
Michalowski, van der Werf, Hjorth, Castro Cerón, Malesani, Gentile, Baes, Xu, Rossi, Savaglio, Stephane, D'Elia, Palazzi, Hunt, Burlon, Kamphuis, Klose, Nicuesa Guelbenzu	The atomic-gas survey of gamma-ray-burst host galaxies	C2700
Hancock, Gaensler, Murphy, Kulkarni, Schmidt	The GRB–SNe central engines as revealed by relativistic SNe	C2707
Burlon, Gaensler, Murphy, Hancock, Bell, Bannister, Greiner, Klose, Ghirlanda, Nardini	The quest for short gamma-ray-burst radio afterglows	C2721
Collier, Filipovic, Norris, Chow, Huynh, Banfield, Tothill, Sirothia, Shabala	Sequencing the earliest stages of AGN development using faint ELAIS GPS/CSS sources	C2730
Asaki, Dodson, Miyoshi, Tsuboi, Oka, Horiuchi, Nishiyama, Yonekura, Kato, Takaba, Miyamoto, Takahashi, Saida, Takekawa, Sekido, Kameya	First-phase observations of the enormous flare due to vast mass infall onto the Sgr A* black hole	C2738
Hodgson, Bignall, Ellingsen, Fuhrmann, Godfrey, Shabala, Krichbaum, Savolainen	Micro-arcsecond structure in blazar PKS 1257-326	C2745
Denes, Kilborn, Koribalski, Wong	HI-deficient galaxies in low- and intermediate-density environments	C2758
Koribalski, Lenc, Dettmar, Westmeier, Kamphuis	What's the matter with NGC 253's outer disk and halo	C2771
Johansen, Breen, Migenes, Stephens	A search for 6.7-GHz methanol masers toward YSO candidates in the LMC	C2773
Sadler, McConnell, Edwards, Pracy, Croom, Ching, Shabala	The birthrate of radio galaxies across cosmic time	C2779
Behar, Tzioumis, Laor	Millimeter observations of radio-quiet AGN accretion disks	C2787
Tothill, Filipovic, Walsh, Norris, Stark, Marrone, Crawford, Huynh, McIntyre, Vieira, Holzapfel, Murphy, Malkan, Collier, Seymour, O'Brien, Spilker	The ATCA–SPT survey of southern extragalactic sky	C2788
Lacy, Mao, Sajina, Evans, Glikman, Urrutia, Hodge, Petric, Kimball	CO(1-0) in luminous type-2 quasars selected in the mid-IR	C2794
Jordan, Bains, Lo, Jones, Muller, Cunningham, Burton, Brooks, Green, Fuller, Barnes, Ellingsen, Urquhart, Morgan, Rowell, Walsh, Loenen, Baan, Hill, Purcell, Breen, Peretto, Jackson, Voronkov, Lowe, Longmore	Accurate maser positions for MALT-45	C2797
Ellingsen, Macquart, Bignall, Beasley, Breen, Reynolds, Imai, Keller, Bekki, Krishnan, Cioni	Measuring the proper motions of the Large and Small Magellanic Clouds	C2798
Huynh, Norris, Emonts, Swinbank, Ivison, Coppin, Smail, Smolcic	Physical conditions of gas in high-redshift ($z > 4.4$) ALMA-detected submillimetre galaxies	C2815
Gelfand, Coatman, Dahal, Dolan	Radio emission from SWIFT J0003.3–5254: relic of particle acceleration in a merging galaxy cluster?	C2830
Trigilio, Buemi, Umana, Leto	Is alpha Centauri revealed by the new generation of radio telescopes?	C2836
Wilcots, Hess, Nielsen	The H I content of the Antlia cluster: the fate of gas in cluster assembly	C2852
Gonidakis, Chapman, Diamond	The location of vibrationally excited water masers in late-type stars	C2853
Fukuda, Fukui, Torii, Sano, Yoshiike	Detailed 21-cm observations towards the non-thermal X-ray supernova SN 1006	C2857
Ott, Henkel, Edwards, Meier, Walter, Brunthaler, Mao, Peck, Impellizzeri, McCoy	Monitoring the new nuclear water maser in Centaurus A	C2869
Walsh, Gomez, Jones, Cunningham, Green, Dawson, Ellingsen, Breen, Imai, Lowe, Brown	SPLASH: accurate OH maser positions	C2872
Salome-Combes, Salome	High-density tracers in Centaurus A's outer filaments	C2873
Sun, Lenc	Magnetic fields in nearby spirals	C2874
Ravi, Shannon, Melatos	Imaging candidate wind nebulae around millisecond pulsars	C2875
Strader, Miller-Jones, Maccarone, Chomiuk	The ATCA survey for black holes in southern globular clusters	C2877
Staveley-Smith, Subrahmanyan	A search for fine-structure lines from Galactic H II regions	C2878
Chen, Ellingsen, Baan, Li, An, Qiao	First search for Class I methanol megamasers	C2879
Lagrange, Maddison, Augereau, Freudling, Lecavelier des Etangs, Dent	The origin of the β Pictoris stable gas	C2880

OBSERVERS	PROGRAM	NO.
Shakouri, Johnston-Hollitt	Investigating the wideband variability of the circularly polarised source PMNM 212554.5–510530	C2881
Motogi, Walsh, Hirota, Niinuma, Sugiyama, Fujisawa, Yonekura, Honma, Sorai	High-sensitivity survey of a pole-on disk-jet system around high-mass YSOs II	C2883
Emonts, Sadler, Norris, de Breuck, Carilli, Mahony, van Moorsel, Villar martin, Humphrey	The nature of cold molecular halo gas in a z=2 proto-cluster radio galaxy	C2885
Williams, Zweibel, Wilcots, Mao, Lundgren	Using Faraday-rotation measure to study the formation of galactic-scale coherent magnetic fields	C2886
Alves, Green, Falgarone, Boulanger, Bracco, Arzoumanian	The magnetic field in the Musca dark cloud	C2887
Possenti, Wieringa, Pellizzoni, de Martino	Investigating the unique LMXB XSS J12270–4859	C2888
Banfield, Koribalski, Johnston-Hollitt, Wong, Serra, Schnitzeler, Dehghan	Mapping the intracluster medium of Abell 3627	C2891
Aravena, Weiss, de Breuck, Marrone, McIntyre, Vieira, Murphy, Aguirre, Bothwell, Hezaveh	Resolved CO imaging in two unique gravitationally lensed galaxies at z > 2	C2892
Allison, Sadler, Ellingsen, Curran	The relationship between H_2O megamaser emission and H I absorption in active galaxies	C2893
Serra, Koribalski, Popping, Smith, Davies, Cortese, Catinella, Fuller	An ATCA H I survey of Fornax	C2894
Carretti, Lenc, Koribalski, Staveley-Smith, Ekers, Heesen, Crocker, Beck	Fermi Bubble–like structures in external galaxies	C2895
Ng, Deller, Wang, Moin	J1549: the first infrared pulsar-wind bow shock?	C2896
Hancock, Miller–Jones, Kaplan, Bell, Bannister, Kudryavtseva	ATCA observations of MWA transients and variables	C2897
Bignall, Macquart, McCallum, Cimo, Jauncey, Gurvits, Reynolds, Schnitzeler, Hodgson, Kovalev, Shabala	ATCA monitoring in support of RadioAstron–LBA observations of high-brightness-temperature AGN	C2898
Wong, Koribalski, Meurer, Zwaan, Bekki, Garcia-Appadoo, Vlahakis	Triggered star formation and feedback in the ring galaxy NGC 922	C2900
Sano, Fukui, Torii, Tachihara, Fukuda, Yoshiike	Resolving shocked H I toward the SNR RX J1713.7–3946	C2901
Sivakoff, Miller-Jones, Bahramian, Heinke, Arnason	Rapid classification and monitoring of transient X-ray binaries in Galactic globular clusters	C2902
Tanna, Whiting, Curran	A record-breaking sightline: five DLA-strength 21-cm absorbers towards the quasar MG J0414+0534	C2904
Dunne, van der Werf, Massardi, White, Serjeant, Michalowski, Thompson, Birkinshaw, Andreani, Stevens, Omont, Smith, Ivison, Thomson, Eales, Ibar, Benford, Dannerbauer, Leeuw, Temi, Negrello, Clements, Bussmann, Maddox, De Vis, Vlahakis, Verma, Dye, Riechers	Redshift detection of the most distant lensed starbursts	C2905
Ellingsen, Breen, Hofner	Radio continuum emission from the youngest high-mass star-formation regions	C2906
Takekoshi, Kohno, Tamura, Minamidani	CO and continuum observations toward a strongly lensed submillimetre galaxy behind the Small Magellanic Cloud	C2907
Fujii, Muller, Fukui, Dawson, Onishi, Kawamura, Mizuno, Minamidani	Dense molecular clump formation in the collisional region of the LMC supergiant shells	C2908
Tamura, Hatsukade, Kohno, Nakanishi, Iono, Minamidani, Kawabe, Ikarashi, Umehata, Izumi, Taniguchi, Makiya	ATCA identification of an extremely red starburst galaxy beyond a rich cluster, Abell S0592	C2909
Taniguchi, Hatsukade, Kohno, Nakanishi, Tamura, Iono, Tsukagoshi, Kawabe, Shimajiri, Ikarashi, Umehata, Izumi, Makiya	Redshift search of a z~5 ultra-bright starburst galaxy	C2910
O'Sullivan, Gaensler, Banfield, Stil, Croom, Farnes	Testing the magnetic-flux paradigm of AGN jets	C2913
Bannister, Johnston, Walker, Stevens	ATESE: an ATCA survey for extreme scattering events	C2914
Akahori, Fujita, Ozawa, Nakanishi, Kato, Gu, Nakazawa, Takizawa, Okabe, Makishima	The first deep 16-cm observation of CIZA J1358.9–4750	C2916
McClure-Griffiths, Dickey, Dawson, Green, Stanimirovic, Heiles, Li, Murray	Dark molecular gas in the Milky Way	C2918

OBSERVERS	PROGRAM	NO.
Wang, Koribalski, Serra	Mapping the H I in up-bending disk galaxies	C2921
Massardi, Ekers, de Zotti, Toffolatti, Lopez-Caniego, Liuzzo, Bonavera, Bonaldi, Casasola, Mignano, Paladino, Burigana, Trombetti, Tucci	Polarimetric multifrequency observations of a complete sample of radio sources	C2922
Soria, Godfrey, Lou	Quasi-periodic oscillations of Jupiter's inner radiation belt	C2925
Ott, Jones, Staveley-Smith, Weiss, Henkel, Edwards, Burton, Menten, Schilke, Zhang, Longmore, Yusef-Zadeh, Meier, Miller-Jones, Walsh, Morris, Lang, Beuther, Contreras, Goldsmith, Crocker, Corby, Anderson, Ginsburg, Bally, Battersby, Mills, Rosolowsky, Kruijssen, Bihr, Morabito	Survey of water and ammonia in the Galactic Centre (SWAG)	C2927
Loinard, Menten, Urquhart	Giant factory caught contaminating the environment: dust and molecules expelled by eta Carinae	C2930
MacGregor, Maddison, Wilner, Lestrade, Thilliez, Andrews	Structure in the eps Eridani debris disk	C2931
Tsai, Norris, Jarrett, Emonts	Molecular gas in an AGN binary candidate, W2332–5056	C2932
Schnitzeler, Kramer, Eatough, Champion, Shannon, Lee, Noutsos, Spitler, Falcke	The strength and structure of the magnetic field within 40 parsec of the Galactic Centre	C2933
Birkinshaw, Worrall	PKS B1416–493: a high-resolution map of an intermediate-power radio source interacting with a dense external medium	C2936
Muller, Lovell, Edwards, Beelen	The molecular absorption toward PKS 1830–211 at 7 mm and 3 mm	C2937
Horesh, Hancock, Kulkarni, Strom, Gal-Yam, Patat, Goobar, Sullivan, Sternberg, Maguire, Cao	A different class of Ia supernovae?	C2939
Buemi, Trigilio, Cerrigone, Umana, Leto, Ingallinera, Agliozzo	The radio morphology of Wray 17–96	C2941
Buemi, Trigilio, Cerrigone, Umana, Leto, Ingallinera, Agliozzo	A close look at the heart of Luminous Blue Variable nebulae	C2943
Coriat, Tzioumis, Fender, Woudt, Dusoye	Investigating the jet particle content and magnetic field structure of SS 433 using circular polarisation	C2946
Suarez, Gomez, Green, Miranda, Bendjoya	Monitoring the real-time birth of a planetary nebula	C2949
Sanhueza, Miller-Jones, Guzman, Jackson, Contreras	Testing models of high-mass star formation in pre-stellar high-mass cluster-forming clumps	C2950
Kanekar, Menten, Briggs, Carilli	A blind 7-mm survey for molecular absorption at high redshift	C2951
Gomez, Miranda, Suarez, Bendjoya, Uscanga, Rizzo	Interferometric confirmation of three water-fountain candidates	C2954
Greiner, Tingay, Moin, Wieringa, Klose, Schady, van Eerten	Testing the gamma-ray-burst fireball scenario	C2955
Stephens, Miller-Jones, Jackson, Sanhueza, Whitaker, Camarata	Two high-mass cores at different evolutionary stages	C2961
Brown, Dickey, Dawson, Anderson, Jordan, Bania, Balser	Radio recombination lines from H II regions in the southern Galaxy	C2963
Hancock, Kulkarni, Horesh	Exploring the early radio emission from core-collapse supernovae	C2964
Bannister, Johnston, Walker, Stevens	Daily monitoring of ATCA extreme scattering events	C2965
Voronkov, Caswell, Ellingsen, Breen	Class I methanol masers with regular structures	C2966
Burlon, Gaensler, Murphy, Hancock, Ghirlanda, Salvaterra, Ghisellini, Tagliaferri	Late-time observations of candidate high-z GRBs	C2968
Burlon, Gaensler, Murphy, Hancock, Ghirlanda, Salvaterra, Ghisellini, Tagliaferri	Late-time observations of candidate high-z GRBs	C2969
Dawson, McClure-Griffiths, Jones, Dickey, Cunningham, Walsh, Heiles, Gibson, Brown	Probing the Galactic ISM in OH absorption	C2976
Allison, Edwards, Sadler, Curran, Tingay, Reeves, Shabala	The neutral gas environment of compact radio galaxies	C2977
Franco, Chapman, Vlemmings, Tafoya, Chavarria, Perez-Sanchez	Mapping the surprisingly high velocity submillimetre H_2O masers of water-fountain nebulae	C2978

OBSERVERS	PROGRAM	NO.
Aravena, Weiss, de Breuck, Stark, Crawford, Marrone, Tothill, McIntyre, Vieira, Carlstrom, Greve, Chapman, Fassnacht, Murphy, Malkan, Aguirre, Bothwell, Spilker, Gullberg, Hezaveh, Bethermin, Gonzalez, Ma, Strandet, Seymour	Resolved CO imaging in bright gravitationally lensed galaxies at z=2–6	C2983
Murray, Wong, McClure-Griffiths, Dickey, Dawson, Stanimirovic, Heiles, Richter, Lindner, Hernandez, Lee, Liszt, Gallagher, Putman, Babler	The dark molecular gas content of the Magellanic Clouds	C2984
Breen, Caswell, Green, Dawson, Ellingsen, Voronkov, Titmarsh	Monolithic collapse of high-mass molecular cores	C2986
Fissel, Jones, Cunningham, Friesen, Olmi, Giannini, Lorenzetti, Massi, Lowe, Devlin, Netterfield, Novak, Pascale, Ashton, Dober, Galitzki, Lourie, Poidevin, Soler, Stanchfield, Tucker, Elia, Zhi-Yun, Ward-Thompson	Do magnetic fields provide support against the gravitational collapse of starless cores in Vela C?	C2988
Yamaguchi, Kawachi, Fujita	A multi-epoch and spectral study for the gamma-ray binary PSR B1259–63	C2990
Moss, McClure-Griffiths, Dawson, Stanimirovic	Targeting molecular gas using HCO^+ in Galactic high-velocity clouds	C2991

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Staveley-Smith, Wong, Calabretta, Westmeier, Popping	HIPASS redux	P248
Bhat, Verbiest, Bailes, van Straten, Gough	Studies of relativistic binary pulsars	P361
D'Amico, Possenti, Manchester, Johnston, Kramer, Sarkissian, Lyne, Burgay, Corongiu, Camilo, Bailes, van Straten	Timing of millisecond pulsars in globular clusters	P427
Burgay, Possenti, Manchester, Kramer, Lyne, Lyne, mcLaughlin, D'Amico, Camilo, Stairs, Lorimer, Yuen, Ferdman	Timing and geodetic precession in the double pulsar	P455
Hobbs, Manchester, Sarkissian, Bailes, Bhat, Keith, Burke-Spolaor, Coles, van Straten, Ravi, Oslowski, Kerr, Khoo, Shannon, Wang, Levin, Wen, Zhu, Dai	A millisecond-pulsar timing array	P456
Kerr, Possenti, Manchester, johnston, Hobbs, Romani, Thompson, Weltevrede, Shannon, Petroff, Brook	Pulsar timing and the Fermi mission	P574
Hobbs, Hollow, Bannister, Ravi, Kerr, Shannon, Petroff	PULSE@Parkes (Pulsar student exploration online at Parkes)	P595
Camilo, Johnston, Sarkissian, Reynolds, Ransom, Halpern	The remarkably active radio magnetar 1E 1547.0–5408	P602
Burgay, Possenti, Sarkissian, Israel, Rea, Esposito	Searching for radio pulsations triggered by the X-ray outburst of magnetars	P626
Reynolds, Edwards	64 m/PTF 12 m tests	P628
Champion, Possenti, Johnston, Kramer, Burgay, D’Amico, Bailes, Bhat, Keith, van Straten, Stappers, Bates, Levin, Milia, Ng, Thornton, Coster, Barsdell, Tiburzi, Petroff, Barr, Flynn	The high-time-resolution Universe	P630
Li, Staveley-Smith, Pen, Chang, Peterson, Bandura, Chen, Wang, Price, Anderson, Voytek, Masui, Switzer, Wu, Timbie, Liao, Li, Oppermann, Kuo, Yadav	Clustering of neutral hydrogen with intensity mapping – 2dFGRS cross-correlation	P641
Bauer, Staveley-Smith, Kesteven, Bailes, Hopkins, Meyer, Boyle, Delhaize, Lopez-Sanchez, Dunne, Driver, Robotham, Wright, Maddox, De Vis	Galaxy evolution — a pathfinder study	P669

OBSERVERS	PROGRAM	NO.
Andersson, Carretti. Bhat, Robishaw, Crutcher, Vaillancourt	The magnetic field in Tapia's globule 2	P736
Hobbs, Manchester, Carretti, Johnston, Sarkissian, Reynolds, Bailes, Keith, van Straten, Jameson, Shannon	Instrumental calibration for pulsar observing at Parkes	P737
Crawford, Lorimer, Ridley, StJohn	Timing of new Magellanic Cloud pulsars	P743
Possenti, Manchester, Johnston, Kramer, Sarkissian, Lyne, Burgay, Corongiu, D'Amico, Camilo, Bailes, van Straten	A new deep search for millisecond pulsars in globular clusters	P778
Petroff, Johnston, Kramer, McLaughlin, Bailes, Burke-Spolaor, Stappers, Keane, Miller	Transient radio neutron stars	P786
Barr, Possenti, Manchester, Johnston, Kramer, Hobbs, Burgay, Camilo, Stairs, Bailes, Ransom, Keith, Burke-Spolaor, Ferdman, Eatough, Lorimer, van Straten, Stappers, Ray, Keane, Levin, Kerr, Champion, Ng	Timing of binary and millisecond pulsars discovered at Parkes	P789
Camilo	Monitoring known X-ray magnetars for intermittent radio emission	P791
Keane, Kramer, Burgay, Eatough	New pulsars from Einstein@Home	P813
Dawson, Caswell, Gomez, McClure-Griffiths, Lo, Jones, Dickey, Cunningham, Green, Carretti, Ellingsen, Walsh, Purcell, Breen, Hennebelle, Imai, Lowe, Gibson, Brown, Krishnan	SPLASH: a southern Parkes large-area survey in hydroxyl	P817
Staveley-Smith, Carretti, Wyithe, Bernardi, Blake	Mapping the cosmic web	P819
Jones, Ott, Staveley-Smith, Carretti, Haverkorn, Morris, Lang, Crocker, Aharonian	The GC spur: relic jet from Sgr A*, or star-formation-driven wind ouflow?	P823
Kraan-Korteweg, Staveley-Smith, Jarrett, Schroeder, Henning, van Driel, Said	Filling in the 2MASX redshift Zone of Avoidance	P831
Staveley-Smith, Manchester, Zanardo	Searching for the pulsar in SN1987A	P834
Johnson, Koribalski, Ford, McQuinn, Bailin	Determining the starburst trigger in dwarf irregular galaxies	P844
Keane	A slow neutron star or a heavyweight white dwarf?	P848
Bannister, McConnell, Reynolds, Chippendale, Landecker, Dunning	Pilot observations at 74 MHz for global 21-cm cosmology with the Parkes 64-m	P849
Hobbs, Hollow, Ravi, Shannon	Studying intermittency in PSR J1717–4054	P850
Ekers, Phillips, Reynolds, James, Roberts, Bray, Shannon	Detecting high-energy gamma-ray emission from a newly discovered magnetar	P852
Shannon, Hobbs, Ravi	A Parkes transit survey for pulsed radio emission during windstows and maintenance	P855
Robishaw, Heiles, Landecker	Tracing the magnetic field in Galactic WNM filaments	P856
Keane, Possenti, Johnston, Kramer, Burgay, Bailes, Bhat, Keith, Burke-Spolaor, Eatough, van Straten, Stappers, Bates, Levin, Champion, Jameson, Ng, Tiburzi, Petroff, Barr, Flynn, Jankowski, Caleb, Lyon, Morello	SUPERB – A SUrvey for Pulsars and Extragalactic Radio Bursts	P858
Ng, Possenti, Johnston, Kramer, Burgay, Bailes, Bhat, Keith, Burke-Spolaor, van Straten, Stappers, Bates, Keane, Levin, Champion, Jameson, Tiburzi, Petroff, Barr, Flynn	Initial follow-up of pulsar discoveries from the HTRU Galactic Plane survey	P860
Hobbs, Johnston, Hollow, Ravi, Kerr, Shannon	Analysis of state-switching pulsars	P863
Caleb, Bailes, van Straten, Keane, Petroff, Barr, Flynn	A search for the intergalactic magnetic field	P864
Shannon, Hobbs, Ravi	Commensal searches for microhertz gravitational waves and fast radio bursts: a pilot study	P865
Barr, Possenti, Johnston, Kramer, Burgay, Freire, Eatough, van Straten, Keane, Kerr, Champion, Jameson, Ng, Tiburzi, Flynn, Caleb, Morello	Candy from the 47 Tuc shop	P866
Ferrara, Camilo, Ransom, Ray, Kerr, Shannon, Johnson	Searching for radio millisecond pulsars in a new set of Fermi sources	P867

OBSERVERS	PROGRAM	NO.
Possenti, Ord, Turolla, Bhat, Ransom, Mereghetti, Tiengo, Esposito	Simultaneous X-ray/radio observations of the mode-switching pulsar PSR B0943+10	P868
Eatough, Johnston, Kramer, Keane, Shannon	Ultra-Deep searches for pulsars around Sgr A*	P869
Petroff, Possenti, Johnston, Kramer, Bailes, Burke-Spolaor, van Straten, Keane, Champion, Jameson, Ng, Barr, Flynn, Caleb	A follow-up campaign for fast radio bursts	P871
Walsh, Reynoso, Lazendic	A high-resolution H I and OH study of the SNR Puppis A	P872
Brook, Johnston, Karastergiou, Kerr, Shannon	Correlated torque changes and emission variability in pulsars	P873
Ferdman, Kaspi, Gotthelf	Detecting and timing a pulsed radio counterpart to the recently discovered high-magnetic-field X-ray pulsar PSR J1640–4631	P874
Jankowski, Bailes, van Straten, Keane, Barr	A snapshot survey of 500 pulsar spectral indices	P875
Ravi, Shannon, Lasky	High-time-resolution immediate radio follow-up of gamma-ray bursts	P876

OBSERVATIONS MADE WITH THE MOPRA RADIO TELESCOPE

October 2013 to September 2014

OBSERVERS	PROGRAM	NO.
Indermuehle, Edwards	Maser- and flux-monitoring at 3 mm, 7 mm and 12 mm	M426
Barnes, Lo, Jones, Muller, Cunningham, Fuller, Longmore, Whitney, Mizuno, Schuller, Brogan, Benjamin, Indermuehle, Caselli, Molinari, Hernandez, Lowe, Nguyen-Luong, Crutcher, Wakker, Goodman, Chibueze, Umemoto, Nakanishi, O'Dougherty, Sharpe, Pitts	The Three-mm Ultimate Mopra Milky way Survey (MALT110): completion of Phase II	M566
Zhang, Kwok, Strom	A spectral-line survey of a 3-mm wavelength window toward southern proto-planetary nebulae and planetary nebulae	M664
Bot, Hughes, Bernard	Molecular gas in the diffuse cirrus cloud Paley 3	M666
Olmi, Jones, Cunningham, Molinari, Elia, Lowe, Morales	The segregation of starless and proto-stellar clumps in the Hi-GAL l=224° region	M667
Indermuehle, McIntosh	Monitoring SiO maser emissions in high time resolution	M668
Foster, Burton, Miller-Jones, Indermuehle, Jackson	Monitoring G301 and characterising Mopra	M669
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VLBI OBSERVATIONS

October 2013 to September 2014

OBSERVERS	PROGRAM	NO.
Ojha, Lovell, Edwards, Kadler	Physics of gamma-ray-emitting AGN	V252
Ellingsen, Caswell, Voronkov, Dodson, Phillips, Green, Dawson, Menten, Shen, Reid, Hachisuka, Goedhart, Walsh, Brunthaler, Chen, Fujisawa, Rioja, Zhang, Xu, Zheng, Honma, Krishnan	Astrometric observation of methanol masers: determining Galactic structure and investigating high-mass star formation	V255
Bhat, Verbiest, Deller, Bailes, Tingay	Measuring the proper motion of the relativistic binary PSR J1141-6545	V256
Beasley, Ellingsen	Methanol-maser proper-motion measurement of the LMC	V316
Zanardo, Staveley-Smith, Tzioumis, Ng, Tingay, Potter	High-resolution observations of SNR 1987A	V389
Green, Caswell, Dodson, Kramer	Magnetic field properties at the highest resolution	V452
Horiuchi, Phillips, Stevens, Jacobs, Sotuela, Garcia Miro	32-GHz celestial reference frame survey for Dec <-45°	V463
Tsai, Phillips, Norris, Jarrett, Bietenholz, Emonts, Cluver, Oozeer, de Witt, Stern, Assef	High-resolution observations of a binary black hole candidate	V470

OBSERVERS	PROGRAM	NO.
Alakov, Henkel, McCallum, Sobolev, Menten, Ellingsen, Baan, Voronkov, Imai, Kostenko, Colomer, Rizzo, Parfenov, Avdeev	Space-VLBI observations of southern water and hydroxyl masers	V477
Miller-Jones, Dodson, Johnston, Deller, Dubus, Moldon, Ribo, Parades, Shannon, Tomsick	Mapping the orbit of PSR B1259–63 with LBA astrometry	V486
Ellingsen, Macquart, Bignall, Dawson, Beasley, Breen, Reynolds, Imai, Keller, Bekki, Krishnan, Cioni	Measuring the proper motions of the Large and Small Magellanic Clouds	V490
Petrov, Murphy, McConnell, Edwards, Sadler, Taylor, Mahony, Kovalev, Schinzel	High-angular-resolution study of gamma-ray sources associated with radio-faint AGN	V493
Gwinn, Bignall, Tzioumis, Kramer, Reynolds, Kovalev, Buchner, Johnson, Soglasnov, Kardashev, Popov, Safutdinov, Rudnitskiy	The visibility of heavily scattered pulsars on the longest baselines	V494
Melis, Maddison, Deller	An LBA probe of PZ Tel's planetary system	V495
Gonidakis, Chapman, Tzioumis, Phillips, Harvey-Smith, Imai, Diamond	The importance of magnetic fields in the formation of water fountains	V498
Cimo, Lovell, Gurvits, Tudose, Pogrebenko, Brisken, Vermeersen, Rosenblatt, Dehant, Rivoldini, Marty, Bocanegra Bohamon, Duev, Molera Calves, Lainey, Thuillot, Huang	Toward understanding the origin of Phobos	V502
de Witt, Phillips, Bietenholz, Basu	Southern calibrator sources at L-band	V504
Collier, Filipovic, Norris, Chow, Crawford, Huynh, Banfield, Tothill, Sirothia, Wong, Shabala	Measuring jet sizes of the youngest radio sources	V506
Deller, Johnston, Burke-Spolaor, Romani, Kerr	LBA parallaxes to probe gamma-ray-pulsar physics	V507
Norris, Lenc, Chow, Mao, Spoon, Collier, Seymour	LBA observations of the baby quasar F00183–7112	V508
Moin, Deller, Ng, Wang	VLBI astrometry of PSR J1549–4848: test of its association with an infrared bow shock	V509
Reynolds, Lobanov, Giovannini, Orienti, Tingay, Kovalev, Krichbaum, Savolainen, Anderson	The nuclear structures of Cen A, M87 and 3C273 at very high resolution with RadioAstron and the LBA	V510
Reynolds, Macquart, Bignall, Lovell, McCallum, Edwards, Tzioumis, Cimo, Jauncey, Deller, Reynolds, Bietenholz, Gurvits, Garrett, Tingay, Horiuchi, Kellermann, O'Sullivan, Kovalev, Shabala, Sokolovsky, Kardashev	RadioAstron–LBA space VLBI survey of AGN at the highest angular resolution	V511
Anderson, Lobanov, Perez Torres, Ros, Alberdi, Taylor, Zensus, Cawthorne, Kovalev, Krichbaum, Savolainen, Gomez, Bach, Bernhart, Clausen-Brown, Eilek, Fromm	Probing the innermost regions of AGN jets and their magnetic fields: LBA	V513
Bannister, Johnston, Walker, Stevens	VLBI follow-up of ATCA extreme scattering events	V516
Bietenholz, Macquart, Phillips, Johnston, Deller, Ekers, Bartel, Pen, Reynolds, Horiuchi, Shannon	Is the Galactic Centre magnetar SGR J1745–2900 bound to Sgr A*?	V517
Maini, Norris, Parker, Prandoni, Giovannini	Assessing the origin of the radio emission in radio-quiet AGNs	V519
de Witt, Lovell, McCallum, Phillips, Quick, Ojha, Bertarini, Horiuchi, Jacobs, Jung, Sohn	Completing the K-band CRF in the southern hemisphere: high-resolution imaging and astrometry	V521
Zaw, Greenhill, Briggs, Moin, Horiuchi, Kuiper, Soni	Geometry of an AGN accretion disk on parsec scales: ESO 269–G012	V527
Bannister	VLBI observations of Nova Centauri 2013	VX021

CDSCC OBSERVATIONS

October 2013 to September 2014

OBSERVERS	PROGRAM	NO.
Wong, Green, Horiuchi, Tothill	The physical conditions of the Lupus I south-west cloud	T206
Heise, Green, Horiuchi, Engels	A search for water masers in silicate carbon star candidates	T208
Horiuchi, Hagiwara	Submillimetre and millimetre H_2O maser in the Circinus galaxy	T209
Engels, green, Horiuchi, Etoka	A search for OH masers in silicate-carbon star candidates	T210
Wong, Green, Horiuchi, Tothill	The physical conditions of the Chameleon clouds	T211
Camarata, Miller-Jones, Jackson	The connection between anomalous NH_3 spectra and high-mass star formation	P870

E: PhD students

PHD STUDENTS CO-SUPERVISED BY CASS STAFF IN 2014 (AS AT DECEMBER 2014)

NAME	UNIVERSITY	PROJECT TITLE
Shaila Akhter	University of New South Wales	Turbulence in the interstellar medium and its relationship to massive star formation
Tui Britton	Macquarie University	Methanol masers in star forming regions
Paul Brook	Oxford University	Variability in pulsars
Joseph Callingham	University of Sydney	An MWA source catalogue: CSS and GPS sources at low radio frequencies
Francesco Cavallaro	University of Catania	Stellar radio emission in the SKA era: surveys of the galactic plane
Jordan Collier	University of Western Sydney	The history of supermassive black holes in the universe
Shi Dai	Peking University	High precision pulsar timing
Phoebe de Wilt	Adelaide University	Investigating the connection between star forming regions and unidentified TeV gamma-ray sources
Kosuke Fujii	University of Tokyo	The effects of large-scale stellar feedbacks on the molecular cloud formation in the Large Magellanic Cloud
Timothy Galvin	University of Western Sydney	Radio emission from star forming galaxies at high and low-z
Marcin Glowacki	University of Sydney	Study of HI absorption against distant radio sources through ASKAP
Claire-Elise Green	University of New South Wales	Milky Way dynamics and structure
Raheel Hashmi	Macquarie University	Application of electronic band gap devices to phased array feeds
Andreas Herzog	Ruhr University Bochum	The broad-band spectra of infrared faint radio sources
Courtney Jones	University of Tasmania	The Southern Milky Way
Christopher Jordan	University of Tasmania	CS(1–0) observations with MALT-45: A 7mm Survey of the Southern Galaxy
Jane Kaczmarek	University of Sydney	Investigating the role of magnetic fields in galaxy and structure evolution
Dane Kleiner	Monash University	The large scale structure's effect on the HI content of galaxies
Vasaant Krishnan	University of Tasmania	Astrometric observation of methanol masers
Katharina Lutz	Swinburne University of Technology	How do galaxies accrete gas and form stars?
Alessandro Maini	University of Bologna/ Macquarie University	Modelling the faint radio sky: the pathway to SKA
Aina Musaeva	University of Sydney	Intermediate mass black holes in dwarf galaxies
Andrew O'Brien	University of Western Sydney	ATCA–SPT: A survey of 100 square degrees of the southern sky
Emily Petroff	Swinburne University of Technology	Our dynamic galaxy
Daniel Reardon	Monash University	Bayesian analysis of pulsar timing array data to study noise properties of pulsars
Glen Rees	Macquarie University	Cosmology using next-generation radio telescopes
Sarah Reeves	University of Sydney	HI and OH absorption line studies of nearby galaxies
Elise Servajean	University of Chile	The physical and kinematical structure of massive and dense cold cores
Anita Titmarsh	University of Tasmania	Investigating the earliest stages of massive star formation
Stuart Weston	AUT University	Data-mining for statistical analysis of the faint radio sky: the pathway to EMU
Marion Wienen	University of Bonn	Galactic high-mass star formation at submillimeter wavelengths
Graeme Wong	University of Western Sydney	Physics and chemistry molecular gas in the Milky Way Galaxy
Mustafa Yildiz	University of Groningen	Star formation in the outer regions of early-type galaxies
Tye Young	Australian National University	Multi-wavelength properties of dwarf galaxies in the local volume
Xingjiang Zhu	University of Western Australia	Searching for continuous gravitational waves in the Parkes pulsar-timing-array datasets

F: PhD theses

THESES AWARDED IN 2014 TO STUDENTS CO-SUPERVISED BY CASS STAFF

Dénes, Helga (Swinburne University of Technology, July 2014). “A wide-field investigation into the H I content of galaxies”.

Lowe, Vicki (University of New South Wales, December 2014). “The environment of high-mass star formation: a study of the molecular environment within two giant molecular clouds”.

Moss, Vanessa (University of Sydney, June 2014). “The Galactic ecosystem: outflow and infall in the halo of the Milky Way”.

Patra, Nipanjana (Raman Research Institute, November 2014). “Precision measurements of the radio background at long wavelengths”.

Rampadarath, Hayden (Curtin University, August 2014). “Applications of high-frequency resolution, wide-field VLBI: observations of nearby star-forming galaxies and habitable exoplanetary candidates”.

Wolfinger, Kathrin (Swinburne University of Technology, August 2014). “The effect of environment on the evolution of nearby gas-rich spiral galaxies”.

Yuen, Rai (University of Sydney, January 2014). “Pulsar magnetosphere revisted: emission geometry and the synthesis of the vacuum-dipole and the rotating-magnetosphere models”.

AWARDED IN 2013

Zinn, Peter-Christian (Ruhr University Bochum, October 2013). “Lighting the Universe: Active Galactic Nuclei, star formation and their interplay”.

G: Publications

REFEREED PAPERS WITH DATA FROM, OR RELATED TO, ATNF FACILITIES AND OTHER STAFF PAPERS

* Indicates publication with CASS staff (not including CASS staff based at CDSCC)

C = Compact Array, M = Mopra, P = Parkes, V = VLBI, A = ASKAP, O = other staff paper

*Aasi, J.; Abadie, J.; Abbott, B.P.; Abbott, R.; Abbott, T.; Abernathy, M.R.; Accadia, T.; Acernese, F.; Adams, C.; Adams, T. and 888 coauthors. "Gravitational waves from known pulsars: results from the initial detector era". ApJ, 785, A119 (2014). (P)

Abergel, A.; Ade, P.A.R.; Aghanim, N.; Alves, M.I.R.; Aniano, G.; Arnaud, M.; Ashdown, M.; Aumont, J.; Baccigalupi, C. and 188 coauthors. "Planck intermediate results. XVII. Emission of dust in the diffuse interstellar medium from the far-infrared to microwave frequencies". A&A, 566, A55 (2014). (P)

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Allison, J.R.; Sadler, E.M.; Meekin, A.M. "A search for H I absorption in nearby radio galaxies using HIPASS". MNRAS, 440, 696–718 (2014). (P, C)

Anderson, C.N.; Meier, D.S.; Ott, J.; Hughes, A.; Wong, T.; Henkel, C.; Chen, R.; Indebetouw, R.; Looney, L.; Muller, E. and two coauthors. "From gas to stars in energetic environments: dense gas clumps in the 30 Doradus Region within the Large Magellanic Cloud". ApJ, 793, A37 (2014). (C)

Anderson, G.E.; Gaensler, B.M.; Kaplan, D.L.; Slane, P.O.; Muno, M.P.; Posselt, B.; Hong, J.; Murray, S.S.; Steeghs, D.T.H.; Brogan, C.L. and 11 coauthors. "Chasing the identification of ASCA Galactic Objects (ChIcAGO): An X-ray survey of unidentified sources in the Galactic Plane. I. Source sample and initial results". ApJS, 212, A13 (2014). (C)

*Ashley, T.; Elmegreen, B.G.; Johnson, M.; Nidever, D.L.; Simpson, C.E.; Pokhrel, N. R. "The H I chronicles of LITTLE THINGS BCDs II: The origin of IC 10's H I structure". AJ, 148, A130 (2014). (O)

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*Banfield, J.K.; Schnitzeler, D.H.F.M.; George, S.J.; Norris, R.P.; Jarrett, T.H.; Taylor, A.R.; Stil, J.M. "Radio galaxies and their magnetic fields out to z ~ 3". MNRAS, 444, 700–710 (2014). (O)

*Bannister, K.W.; Madsen, G.J. "A galactic origin for the fast radio burst FRB010621". MNRAS, 440, 353–358 (2014). (P)

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*Collier, J.D.; Banfield, J.K.; Norris, R.P.; Schnitzeler, D.H.F.M.; Kimball, A.E.; Filipovic, M.D.; Jarrett, T.H.; Lonsdale, C.J.; Tothill, N.F.H. "Infrared-faint radio sources: a new population of high-redshift radio galaxies". MNRAS, 439, 545–565 (2014). (O)

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Crawford, E.J.; Filipovic, M.D.; McEntaffer, R.L.; Brantseg, T.; Heitritter, K.; Roper, Q.; Haberl, F.; Uroševic, D. "HFPK 334: An unusual supernova remnant in the Small Magellanic Cloud". AJ, 148, A99 (2014). (C)

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H: Abbreviations

AAL	Astronomy Australia Limited
ACMA	Australian Communications and Media Authority
AGN	Active Galactic Nuclei
ALMA	Atacama Large Millimeter/sub-millimeter Array
ANZSCC	Australia – New Zealand SKA Coordination Committee
ARC	Australian Research Council
ARCADE	Absolute Radiometer for Cosmology, Astrophysics and Diffuse Emission
ASKAIC	Australasian SKA Industry Consortium
ASKAP	Australian Square Kilometre Array Pathfinder
ATCA	Australia Telescope Compact Array
ATLAS	Australia Telescope Large Area Survey
ATNF	Australia Telescope National Facility
ATSC	Australia Telescope Steering Committee
ATUC	Australia Telescope User Committee
AUT	Auckland University of Technology
BETA	Boolardy Engineering Test Array
CABB	Compact Array Broadband Backend
CASS	CSIRO Astronomy and Space Science
CDSCC	Canberra Deep Space Communication Complex
COSPAR	Committee on Space Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DLA	Damped Lyman-Alpha
EIF	Education Investment Fund
ELAIS	European Large Area ISO Survey
EMU	Evolutionary Map of the Universe
ESO	European Southern Observatory
FIR	Far Infrared
GRB	Gamma-Ray Burst
HI	Neutral Hydrogen
HIPASS	HI Parkes All Sky Survey
HIZOA	HI Zone of Avoidance
HSE	Health, Safety and Environment
IAU	International Astronomical Union
ICRAR	International Centre for Radio Astronomy Research
IEEE	Institute of Electrical and Electronics Engineers
ISM	Interstellar Medium
ITU	International Telecommunications Union
IUCAF	Scientific Committee on the Allocation of Frequencies for Radio Astronomy and Space Sciences
IVS	International VLBI Service
JPL	Jet Propulsion Laboratory
LBA	Long Baseline Array, used for Australian VLBI observations
LMC	Large Magellanic Cloud
LMXB	Low-Mass X-Ray Binary
LOFAR	Low Frequency Array
MALT	Millimetre Astronomers Large-area multi-Transition
MASIV	Micro-Arcsecond Scintillation-Induced Variability
MNRAS	Monthly Notices of the Royal Astronomical Society
MRO	Murchison Radio-astronomy Observatory
MSF	Murchison Radio-astronomy Observatory Support Facility
MWA	Murchison Widefield Array
NAPA	Non A-Priori Assignable
NASA	National Aeronautics and Space Administration
NCRIS	National Collaborative Research Infrastructure Strategy
NRAO	National Radio Astronomy Observatory
NRC-Canada	National Research Council, Canada
PAF	Phased-Array Feed
PTF	Parkes Testbed Facility
RAFCAP	Radio Astronomy Frequency Committee in the Asia Pacific
RFI	Radio Frequency Interference
SCORPIO	Spectral Camera with Optical Reducer for Photometrical and Interferometrical Observations
SINGS	Spitzer Infrared Nearby Galaxies Survey
SKA	Square Kilometre Array
SNe	Supernovae
SNR	Supernova Remnant
SPT	South Pole Telescope
TAC	Time Assignment Committee
UNSW	University of New South Wales
URSI	International Union of Radio Science
VLBI	Very Long Baseline Interferometry
WRC	World Radio Conferences
WSRT	Westerbork Synthesis Radio Telescope
YSO	Young Stellar Object

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