

Australia Telescope Compact Array

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CSIRO ASTRONOMY AND SPACE SCIENCE www.csiro.au



Australian Synthesis Telescope (AST)

- Proposed 1975, 1978
 - Parkes 64m
 - 4-6 x 25m dishes, 1.2km baselines
 - \$6m
- Not funded
 - not sufficiently ambitious!

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Heliograph at Narrabri (closed 1984)









The AT Compact Array

- 6 antennas
- 22 m diameter
- 6km E-W track
- 200m N-S track
- frequency range
 - 1.3 10 GHz
 - 16 26 GHz (2002)
 - 30 50 GHz (2007)
 - 80 100 GHz (2002)
- Correlator
 - 4 x 2GHz (2005)
 - Polyphase FX





ATCA proposed science case 1982

- Galactic Centre
 - Continuum and interstellar molecules
- Dense Molecular Clouds and HII regions
 - Can access those not accessible from the NH
- Supernovae Remnants only visible from the SH
- Large and Small Magellanic Clouds
 - This was a major success for ATCA
- HI in nearby southern galaxies
- Centaurus A and the other nearby AGN
- AGN and Quasars
- Other topics mentioned
 - Extragalactic astrometry & violent galactic stars



AT wavelength coverage



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Australia Telescope Visibility



A new era in Australian scientific research. Bob Hawke, Prime Minister

- Opened by the Prime Minister
 - Sep 1988 at a cost of \$50m
- Prestige
- High impact showpiece for Australian science and technology
 - 85% local content
 - Impressive facility
- International credibility



ATCA time allocation



CSIRC

International linkages





ATNF publications by telescope





MNRF ca. 2000 High Frequency Upgrade



- New 12/3mm receivers
- Antenna surface upgrade
- MMIC developments within CSIRO
- North-South spur
- 12 mm Prototype
 - First fringes Dec 1999
- 3 mm Prototype
 - First fringes Nov 30 2000

Panel replacement





Ca. 2010 receiver & correlator replacements





ATCA success factors

People

- Bob Frater appointed Chief of CSIRO Division of Radiophysics
- CSIRO DRP already had world class antenna expertise
- Bob head hunted expert (mostly expat) Australian engineers and astronomers to cover other areas
 - Warwick Wilson (MPIfRA, Germany)
 - John O'Sullivan (ASTRON, Netherlands)
 - Alan Young (Caltech)
 - Mike Kesteven (Queens, Canada)
 - Ray Norris (Manchester, UK)
 - Ron Ekers (VLA)
- Expert external advisory committee





National Facility under ASTEC guidelines (1990 - 2012)





ATCA success factors Location

- Southern Hemisphere Sky
 - Galaxy overhead
 - Closest AGN (Centaurus A)
 - Less competition (good and bad)
 - Use SH location to leverage opportunities for Australian involvement in International programs
- Used an extremely high fraction of Australian content



- 85%
- Had to train some companies to use new technologies
- Necessary to be self sufficient in Australia
 - Few high tech companies to solve problems

S. Kim, 1998, LMC in HI, 1344 pointings



ATCA success factors

Innovative technology

- Wideband feeds and antenna optics
 - Two simultaneous frequencies, octave separation
 - Shaped reflector for high efficiency
- Wide bandwidth backend
 - 2 x 256MHz dual polarization (VLA was 2 x 50MHz)
- Polarization quality
 - Wideband performance (feed and OMT design)
 - On axis rotating turret design
 - Injected calibration signal
- Fibre Optic data transmission
- Correlator well beyond existing correlator design
 - Parallel VLSI processing (frequency channelization) 16 x 16 MHz
 - 128 8192 frequency channels for 128 2 MHz bandwidth (recirculation)
 - Special purpose chip designed in house and fabricated in Australia





SMC (388 pointings)

Stanimirovic et al (2002)



dirty image

linear mosaic of deconvolved images

joint deconvolution

CSIRO

SGPS+Parkes (McClure-Griffiths et al.)





ATCA success factors

Science

- Radio/X-ray variability (5 papers in top 25)
 - Established the low/hard state correlation
 - 5 top cited papers, 1264 citations
- Gamma Ray Burst follow-up (3 in top 25)
 - *Nature* 1998 is top cited: GRB supernovae association
- HI aperture synthesis of the Magellanic Clouds (3 in top 25)
 - Also the first large scale mosaic observations
 - Included Parkes for short spacings
- Pulsars and magnetars (2 in top 25)
 - PKS1259-63 pulsar with Be star companion
- Radio galaxy surveys (2 in top 25)
 - 2Jy sample
- Fermi detected AGN
- AT20G survey

Black = included in the Science case (1983) Based on the 25 most highly cited ATCA papers (PGE)



In combination with other telescopes

- HIPASS HI galaxy survey follow-up observations
 - With Parkes
- mm properties of sources in the SPT survey
 - With South Pole Telescope
- HI rotation curves for nearby galaxies the Dark Matter distribution
 - With optical and VLA
 - Gentile + 4, MNRAS, 351, 903 (2004)
- Relativistic motion in bright X-ray sources
 - With LBA
- Southern galactic plane HI survey
 - With Parkes for short spacings

Black = included in the Science case (1983) Based on the 25 most highly cited ATCA papers (PGE)



Thank you

CSIRO Astronomy and Space Science Douglas Bock Director

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Appendix 25 most cited papers (2017)

Publications analysis by PG Edwards



The 25 most cited papers in 2017

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Radio emission from the un 25 April 1998	<i>usual superno</i> Kulkarni + 8,	ova 1998bw and its association with the gamma Nature, 395, 663 (1998)	<i>-ray burst of</i> 469 citations	
Studies of ultracompact HII	<i>regions - II. H</i> Walsh + 3, M	igh-resolution radio continuum and methanol m NRAS, 301, 640 (1998)	<i>aser survey</i> 379 citations	
The cored distribution of da	<i>rk matter in s</i> Gentile + 4, N	piral galaxies /INRAS, 351, 903 (2004)	376 citations	
The large-scale HI structure	of the Small I Stanimirovic	Magellanic Cloud + 4, MNRAS, 302, 417 (1999)	362 citations	
An HI Aperture Synthesis M	<i>osaic of the Lo</i> Kim + 6, ApJ,	arge Magellanic Cloud 503, 674 (1998)	315 citations	
Relativistic motion in a nea	rby bright X-ra Tingay + 19,	<i>ay source</i> Nature, 374, 141 (1995)	314 citations	
Correlated X-Ray Spectral and Timing Behavior of the Black Hole Candidate XTE J1550-564: A New				
	Homan + 8, A	pJS, 132, 377 (2001)	304 citations	
Radio/X-ray correlation in t	<i>he low/hard s</i> Corbel + 4, A	tate of GX 339-4 &A, 400, 1007 (2003)	287 citations	

The 25 most cited papers in 2017

The 1000 Brightest HIPASS (Galaxies: H I Properties Koribalski + 39, AJ, 128, 16 (2004)	274 citations
PSR 1259-63 - A binary radio	o pulsar with a Be star companion Johnston + 7, ApJ, 387, L37 (1992)	269 citations
Optical and Radio Observati	ions of the Afterglow from GRB 990510: Evidence for a Jet Harrison + 19, ApJ, 523, L121 (1999)	268 citations
Coupling of the X-ray and ra	idio emission in the black hole candidate and compact jet sou Corbel + 6, A&A, 359, 251 (2000)	<i>urce GX 339-4</i> 253 citations
A common origin for cosmic	explosions inferred from calorimetry of GRB030329 Berger + 10, Nature, 426, 154 (2003)	247 citations
The Southern Galactic Plane	e Survey: H I Observations and Analysis McClure-Griffiths + 5, ApJS, 158, 178 (2005)	238 citations
Quenching of the Radio Jet o	<i>during the X-Ray High State of GX 339-4</i> Fender + 10, ApJ, 519, L165 (1999)	233 citations
H I Shells in the Large Mage	<i>llanic Cloud</i> Kim + 3, AJ, 118, 2797 (1999)	210 citations
A Survey for OH (1720 MHz)) Maser Emission Toward Supernova Remnants Frail + 5, AJ, 111, 1651 (1996)	210 citations

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The 25 most cited papers in 2017

1E 1547.0-5408: A Radio-emitting Magnetar with a Rotation Period of 2 Seconds Camilo + 3, ApJ, 666, L93 (2007)	199 citations		
The Radio Structures of Southern 2 Jy Radio Sources Morganti + 2, MNRAS, 263, 1023 (1993)	191 citations		
The Australia Telescope 20 GHz Survey: the source catalogue Murphy + 23, MNRAS, 402, 2403 (2010)	189 citations		
A Long, Hard Look at the Low/Hard State in Accreting Black Holes Miller + 7, ApJ, 653, 525 (2006)	187 citations		
The Deep X-Ray Radio Blazar Survey. I. Methods and First Results Perlman + 6, AJ, 115, 1253 (1998)	184 citations		
The extended radio emission in the luminous X-ray cluster A3667 Rottgering + 3, MNRAS, 290, 577 (1997)	181 citations		
Extragalactic Millimeter-wave Sources in South Pole Telescope Survey Data: Source Counts, Catalog,			
Vieira + 54, ApJ, 719, 763 (2010)	175 citations		

The Australia Telescope Compact Array Broad-band Backend: description and first resultsWilson + 32, MNRAS, 416, 832 (Sep 2011)176 citations

