Radio facilities in Australia

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30 September 2013

CSIRO ASTRONOMY & SPACE SCIENCE
www.csiro.au

Outline

CSIRO

CASS

ATNF Facilities:

- Parkes
- Mopra
- ATCA
- Tidbinbilla
- LBA
- ASKAP

CSIRO

CSIRO was founded as CSIR in 1926

The Council for Scientific and Industrial Research (CSIR) became the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 1949

In 2012, CSIRO had a staff of 5800 in 15 Divisions, and an annual budget of about $1200 million, roughly half from government and half external revenue

The Australia Telescope National Facility (ATNF) was formed in 1989 from the Division of Radiophysics

CASS Structure

CSIRO Astronomy and Space Science was formed in 2009.

CSIRO Astronomy and Space Science (CASS) has about 300 staff and is made up of

- Australia Telescope National Facility (ATNF) Operations
  - operate Parkes, ATCA, Mopra, LBA
- Three other themes
  - astrophysics
  - technologies for radio astronomy
  - ASKAP (the Australian SKA Pathfinder)
- The Canberra Deep Space Communications Complex
  - operate the Tidbinbilla antennas

The Chief of CASS is Lewis Ball

CASS Divisional Sites

WESTERN AUSTRALIA

BOOLARDY STATION

GERALDTON

PERTH

NEW SOUTH WALES

NARRABRI

MOPRA

PARKES

SYDNEY

Radiophysics Laboratory

Pawsey HPC Centre

Impact

Rank	No. of papers		No. of citations		Citations/paper	
1	VLA	(582.2)	VLA	(8478)	Ryle	(19.9)
2	ATCA	(139.4)	ATCA	(1704)	Parkes	(16.9)
3	VLBA	(105.2)	Parkes	(1669)	VLA	(14.6)
4	Parkes	(98.6)	VLBA	(1161)	Green Bank	(13.1)
5	Arecibo	(84.7)	Arecibo	(969)	ATCA	(12.2)

Results for cm-band radio telescopes from Trimble & Ceja (2008), examining impact for papers published in 2001, 2002, and 2003, based on citations in the following three years

Annual Performance Goals

Table 1: Telescope usage in 2010.

	Compact Array	Parkes	Mopra*
Successful astronomy observations	75.5%	75.8%	66%
Maintenance/test time	17.0%	12.1%	5%
Time lost due to equipment failure	4.1%	2.2%	3%
Time lost due to weather	0.6%	2.7%	10%
Idle time	2.8%	7.2%	16%

* Mopra statistics are for dates between 1 May to 24 October, corresponding to the 'millimetre season'.

The Parkes 64m telescope

Parkes

http://www.smh.com.au/technology/sci-tech/date-with-the-milky-way-led-to-stars-20110622-1gfij.html

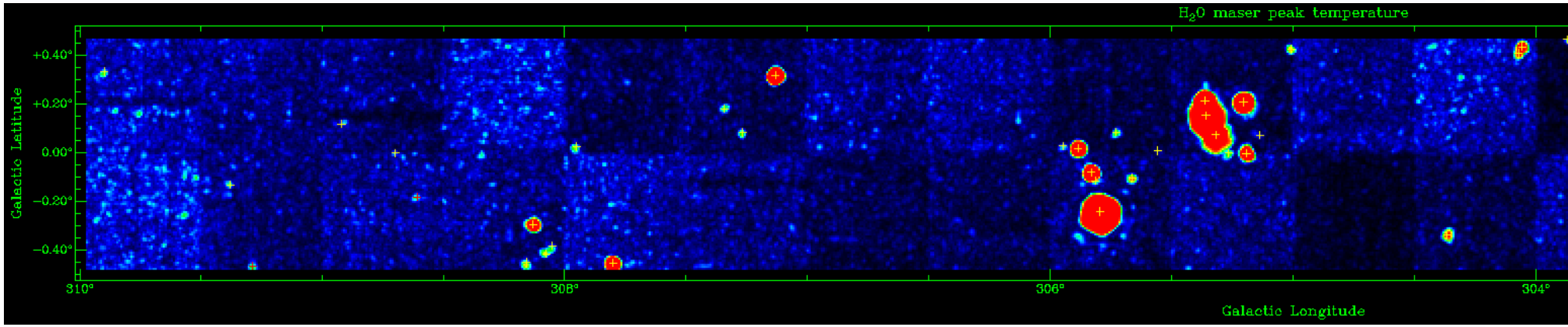
Parkes 64m (300 MHz to 25 GHz)

- Observing started in 1961
- New 13mm receiver (2008), upgraded H-OH (2011)
- DFB backends, APSR, BPSR
- RF switching matrix (2010), MCP upgrade (2011), translator refurb (2011), power overhaul (2011)
- Limited number of receiver changes per semester (currently 6)
- New Telescope Protection System (TPS) installed this year
- Remote observing started last year
- Beamsize ranges from 14 arcmin to 1 arcmin (55m dish at 15mm)

- Large projects: PMN, HIPASS, PPTA, HITRUN, S-PASS, SPLASH…

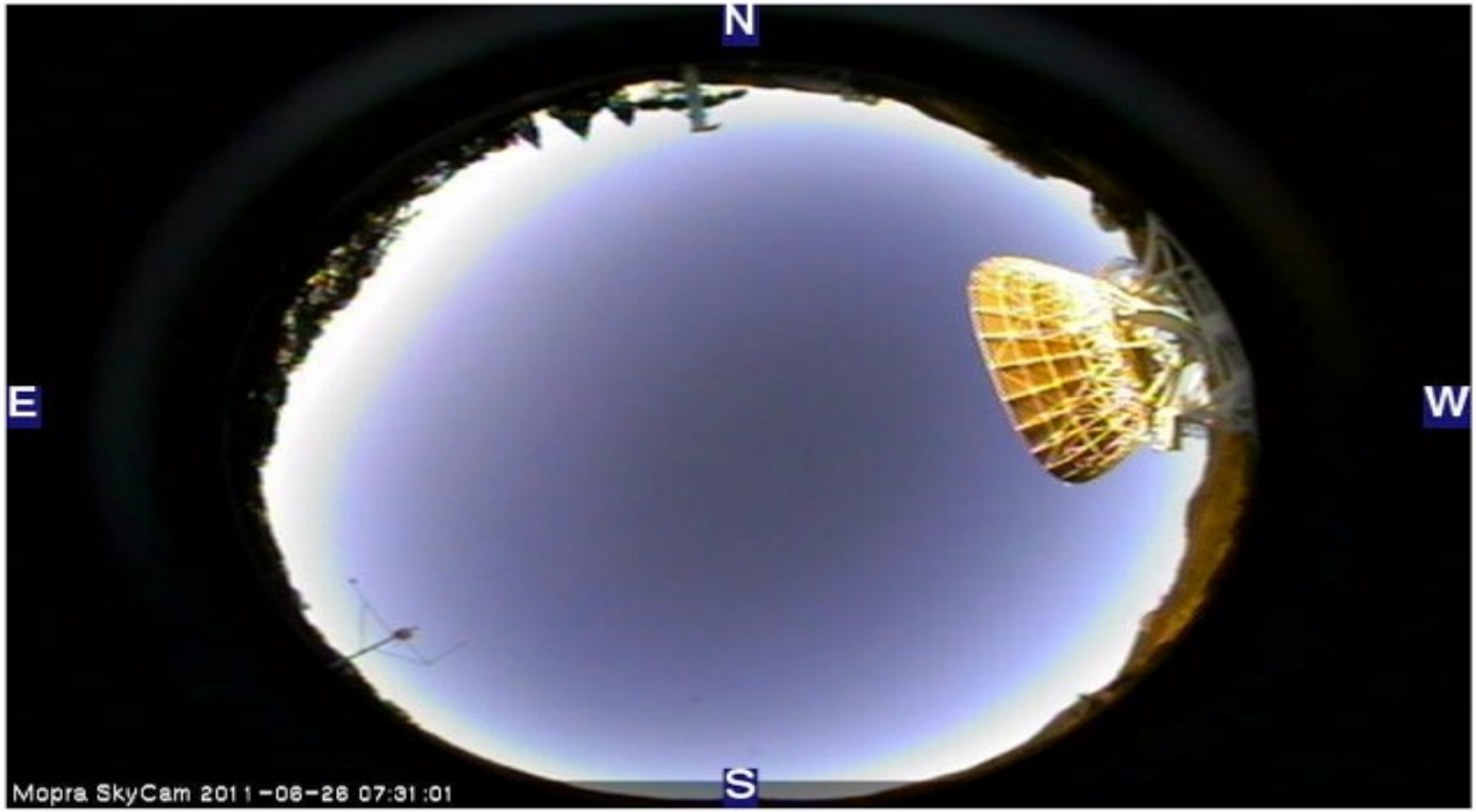
The Mopra 22m telescope

The 22m Mopra telescope is located between Coonabarabran and Siding Springs



Portion of the map of the inner galactic plane from the HOPS 12mm survey

Mopra



Mopra 22m (12mm, 7mm, 3mm)

- New 3mm system in 2005
- New 12mm system in 2006
- MOPS 4x2.2 GHz backend in 2006
  - Up to 16 “zoom” bands simultaneously!
- Remote observing from Narrabri 2006
- Remote observing from further afield 2007
- New 7mm system in 2008
- Mopra observing from Marsfield from 2011
- Beamsize ~ 2’ at 15mm, 30” at 3mm

- Large surveys: HOPS, CMZ, MALT-90 …

Mopra

- Funding has been secured to operate the Mopra Telescope for three years, commencing in October 2012. Mopra operations will initially be supported by NAOJ and UNSW/Adelaide consortium.
- Next call for Mopra proposals for ATNF time, 2014APR.
- “Characterization of the MALT90 Survey and the Mopra Telescope at 90 GHz” PASA, in press (arXiv:1306.0560)
- UNSW team have recently released data from galactic CO survey through ATOA

SkyCam

http://www.youtube.com/watch?v=WlHP9J1UPrs

Mopra

The H_2O Southern Galactic Plane Survey (HOPS)

Survey the southern Galaxy with Mopra at 12mm

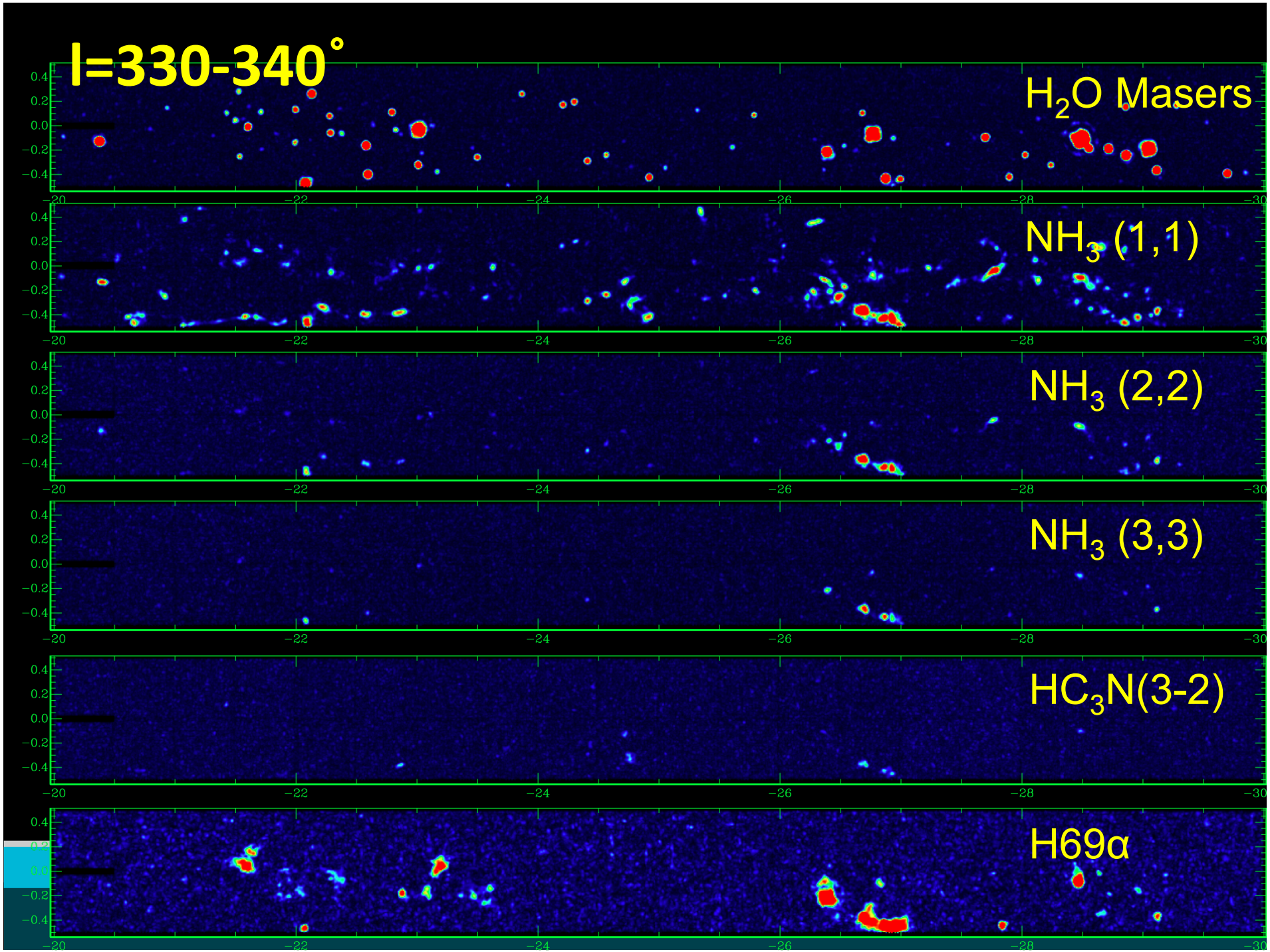
100 square degrees at 2’ resolution

l=290° - 30°; $|b| < 0.5°$

Use MOPS zoom mode to survey multiple lines

- H_2O maser
- NH_3 (1,1), (2,2), (3,3), (6,6), (9,9)
- HC_3N (3-2)
- H69α radio recombination line
- Many CH_3OH lines

Many others including H62α, H64α, H65α, NH_3 (non-metastable), CCS, HC_5N


l=330-340°
H2O Masers
NH3 (1,1)
NH3 (2,2)
NH3 (3,3)
HC3N(3-2)
H69α

ATCA

Australia
Telescope
Compact
Array

1—105 GHz

apod/ap110413.html


http://apod.nasa.gov/apod/ap080310.htm


AUSTRALIA
TELESCOPE
NATIONAL
FACILITY

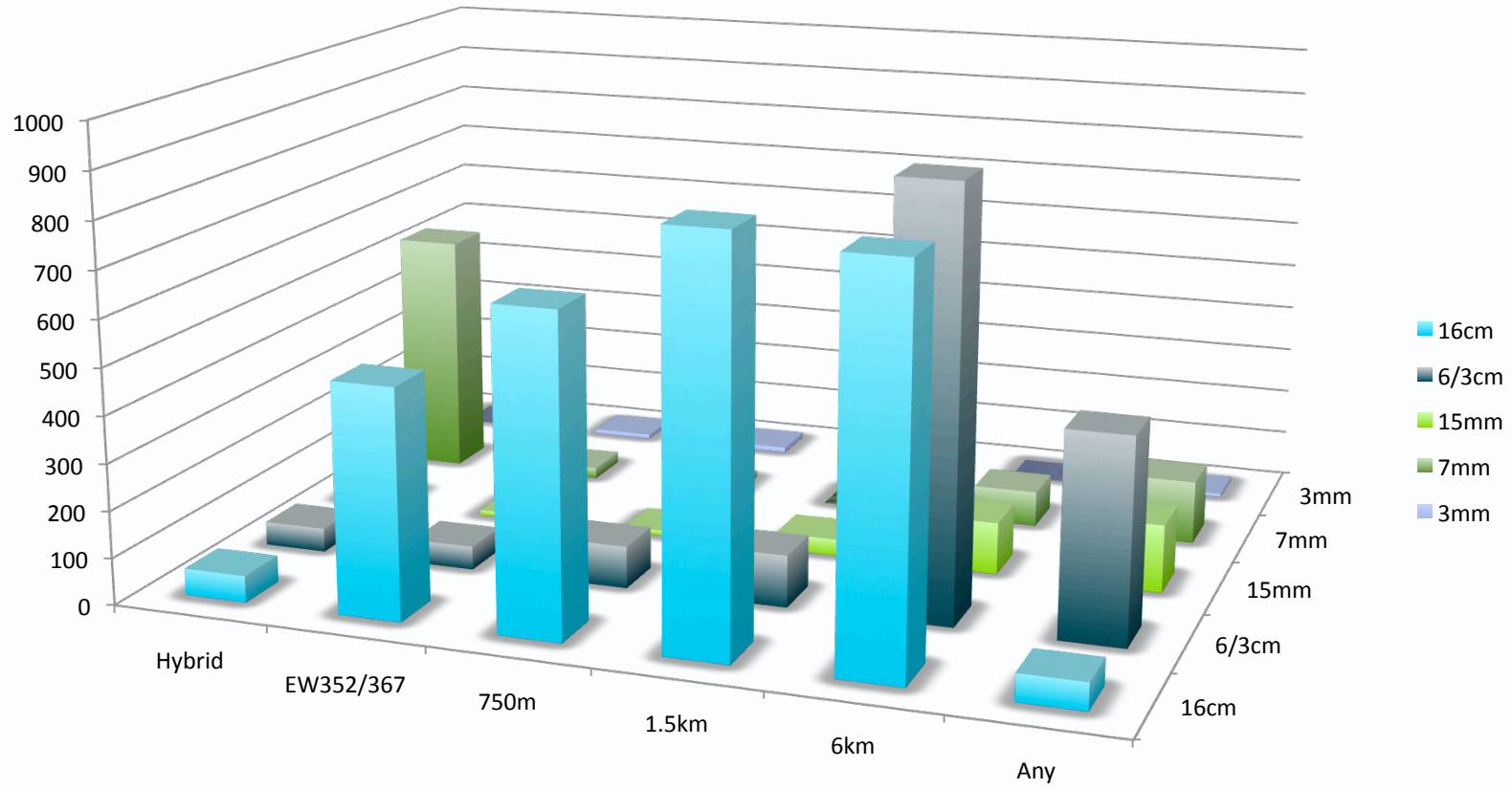
http://www.youtube.com/watch?v=TCVmacSNfQM

Australia Telescope Compact Array (ATCA)

- Celebrated its 25th anniversary earlier this month!
- 6 x 22m antennas, maximum E-W separation = 6km
- 7mm (30—50GHz) receivers added 2007
- CABB upgrade (2x2GHz bandwidths) 2009
- 20/13cm ("L/S") receiver upgrade completed 2011 – now "16cm band"
- 6/3cm ("C/X") receiver upgrade completed 2013 – now "4cm band"
- Water Vapour Radiometers installed
- Primary beam ranges from 42 arcmin to 30 arcsec
- Synthesized beam ranges from 9 arcsec to 0.2 arcsec

- Large Projects: AT20G, ATLAS, LMC, Cen A, SN1987A…

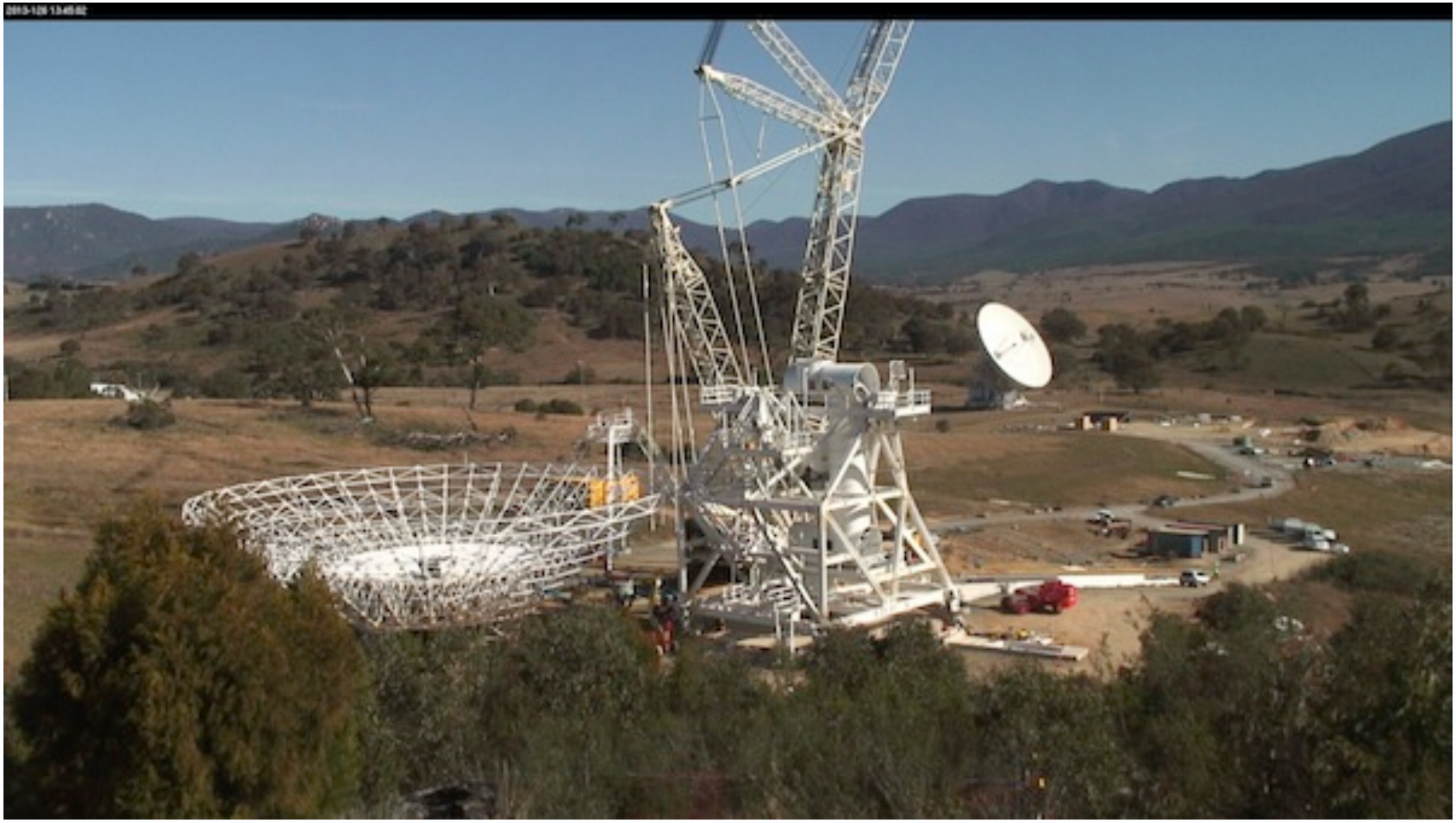
ATCA proposal demand 2012OCT



Tidbinbilla (1—25GHz)

- Prime duty is (still) NASA DSN tracking
- Observing time available on the 70m and 34m antennas under host country agreement
- Improved 22 GHz system and new spectrometer and filters currently being tested
- Two new 34m antennas funded
- Mostly 22 GHz single-dish observing carried out in service mode
- Some blocks of time usually able to be found during LBA sessions

Tidbinbilla DSS-35



Tidbinbilla DSS-35 “photobombing”

Tidbinbilla DSS-35

Tidbinbilla DSS-35


MRO
Ceduna
Hobart
Parkes
ATCA
Tidbinbilla
Warkworth
The Expanding LBA
5,500 Km Baseline

The Long Baseline Array (LBA)

Operated as a National Facility by ATNF (which is part of CSIRO Astronomy & Space Science), in close cooperation with University of Tasmania, Curtin University, and Auckland University of Technology

Core elements: ATCA (5x22m), Mopra (22m), Parkes (64m), Ceduna (30m), Hobart (26m)

+ Tidbinbilla (70m & 34m), Warkworth (12m), Hartebeesthoek (26m), TIGO (6m), O'Higgins (9m), Shanghai (25m), ASKAP (12m), AuScope (3x12m)…

Typically 4 x ~1 week sessions per year

The Long Baseline Array (1—25 GHz)

- Reliability greatly enhanced by Gbps network links and software correlators over last ~5 years
- First fringes to an ASKAP antenna and Warkworth (2010)
- Warkworth 12m (AUT) formally part of LBA (2011)
- eVLBI to Warkworth, Hobart, Hartebeesthoek (2011)
- Hydrogen maser installed at ASKAP (2011)
- 8.4GHz receiver demonstrated at ASKAP (2011)
- eVLBI demonstrated between ASKAP & Ww (2011)
- DFBs able to output VLBI format data (2011)

The Long Baseline Array (LBA)

Observations in 20, 13, 6, 3, 1cm bands

- (Not all telescopes support all bands)

Disk-based recorders (with most data later streamed to correlator) or/and eVLBI on a subset of the array

LBA DR, Mk5, COTS (Xcube) systems

Max. bit-rate 1Gbps (ATNF), 512Mbps (elsewhere)

LBA reliability greatly enhanced by real-time fringe checks

Data correlated by Curtin Uni on DiFX software correlator

- Deller et al. 2007, PASP, 119, 318 (DiFX)
- Deller et al. 2011, PASP, 123, 275 (DiFX-2)

Observing time (in hrs) by year and band

	2004	2005	2006	2007	2008	2009	2010	2011	2012
20cm	36	37	107	142	58	65	44	20	84
13cm	64	44	54	91	51	11	37	70	75
6cm	22	60	42	14	65	95	88	72	31
3cm	98	192	127	99	226	168	290	247	148
15mm	24	0	12	21	105	57	60	54	113
9mm	0	0	0	0	0	0	0	0	4
total	244	333	341	366	505	396	519	463	385

1 June 2012 Last updated at 15:50 GMT

'No signal' from targeted ET hunt

Very long baseline interferometry results in an effective antenna of many kilometres in size

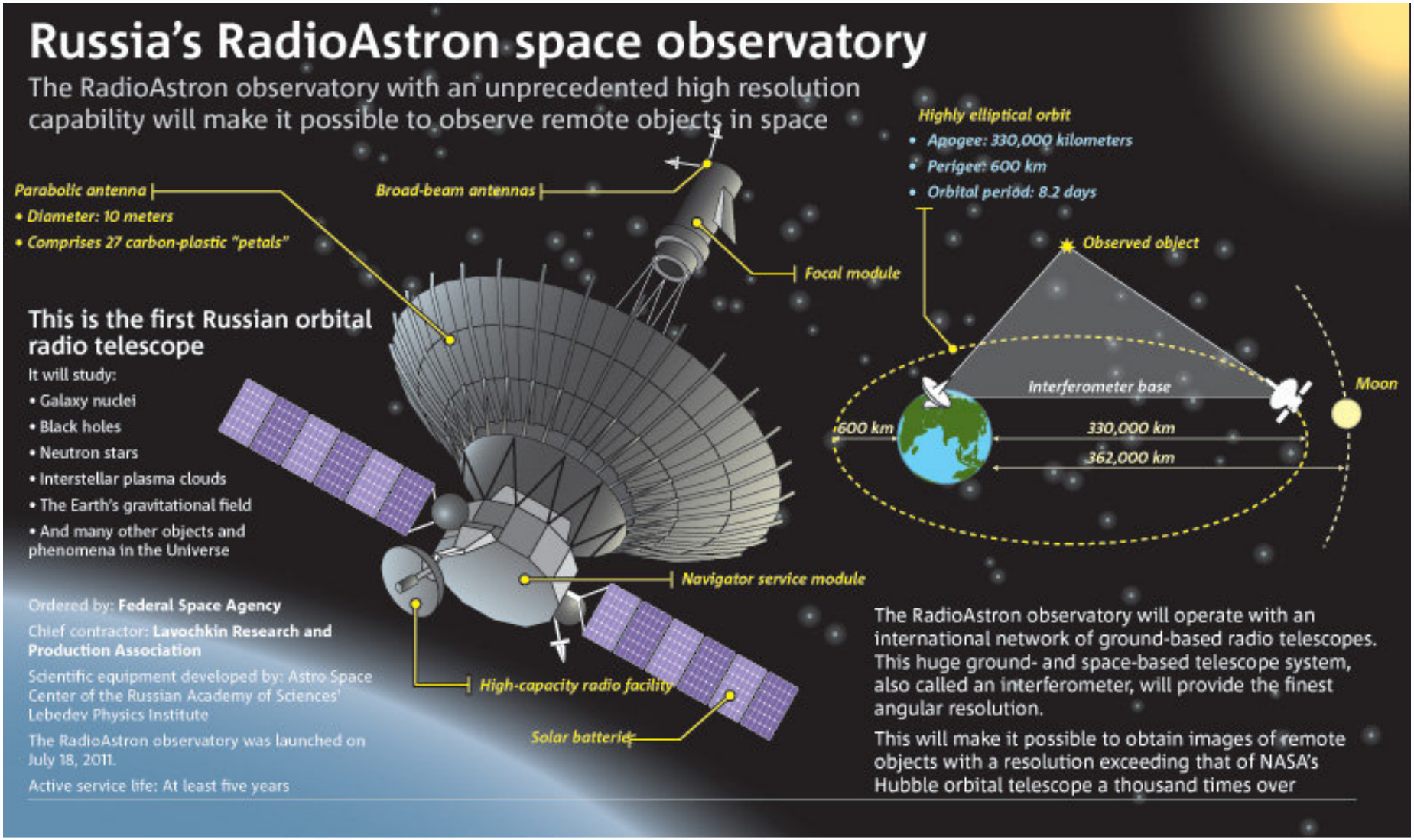
The hunt for other intelligent civilisations has a new technique in its arsenal, but its first use has turned up no signs of alien broadcasts.

Top

Aid wor
US wars
Putin st
Queen s

Related Stories

arXiv:1205.6466


Russia's RadioAstron space observatory
The RadioAstron observatory with an unprecedented high resolution capability will make it possible to observe remote objects in space
Parabolic antenna
• Diameter: 10 meters
• Comprises 27 carbon-plastic "petals"
Broad-beam antennas
Focal module
Navigator service module
High-capacity radio facility
Solar batteries
Highly elliptical orbit
• Apogee: 330,000 kilometers
• Perigee: 600 km
• Orbital period: 8.2 days
Observed object
Interferometer base
Moon
600 km
330,000 km
362,000 km
This is the first Russian orbital radio telescope
It will study:
• Galaxy nuclei
• Black holes
• Neutron stars
• Interstellar plasma clouds
• The Earth's gravitational field
• And many other objects and phenomena in the Universe
Ordered by: Federal Space Agency
Chief contractor: Lavochkin Research and Production Association
Scientific equipment developed by: Astro Space Center of the Russian Academy of Sciences' Lebedev Physics Institute
The RadioAstron observatory was launched on July 18, 2011.
Active service life: At least five years
The RadioAstron observatory will operate with an international network of ground-based radio telescopes. This huge ground- and space-based telescope system, also called an interferometer, will provide the finest angular resolution.
This will make it possible to obtain images of remote objects with a resolution exceeding that of NASA's Hubble orbital telescope a thousand times over

ASKAP

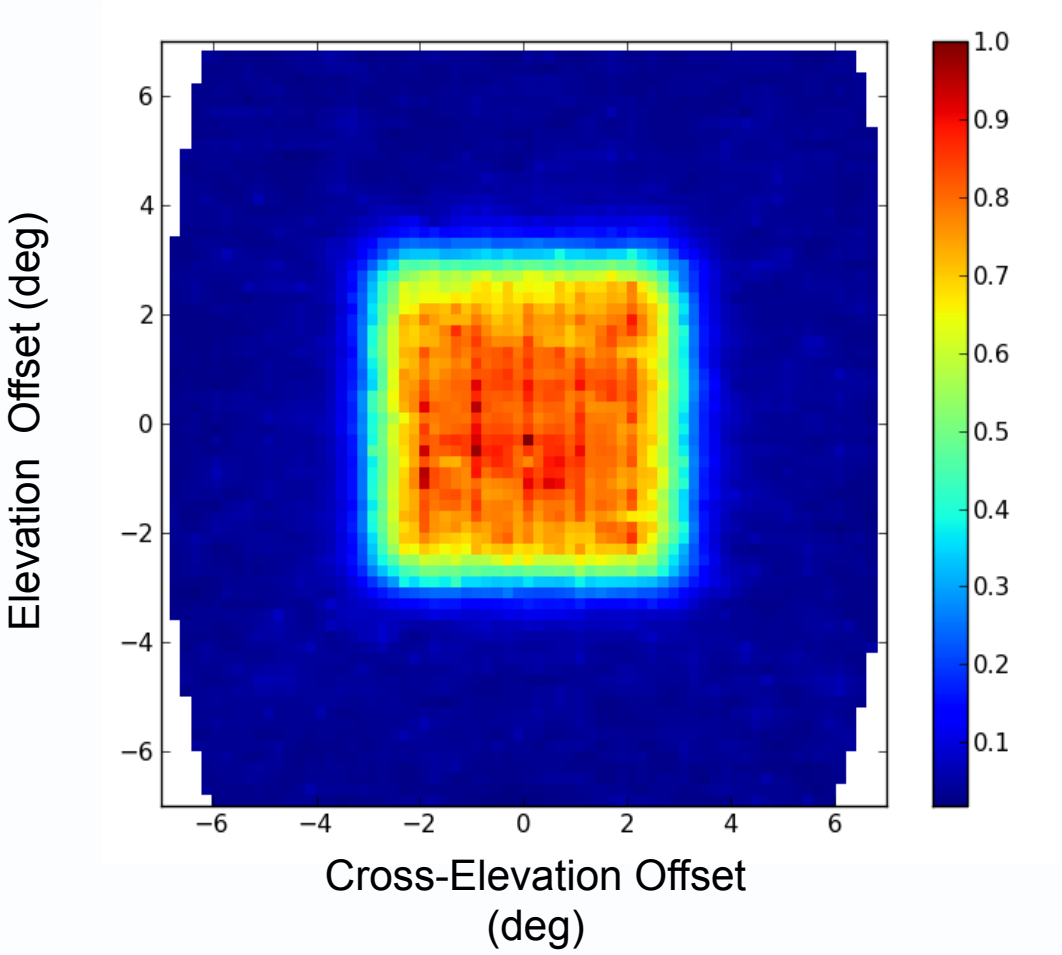
High-dynamic range, wide field-of-view imaging

Number of dishes	36 -- three-axis design
Dish diameter	12 m
Max baseline	6 km (30 dishes inside 2 km)
Resolution	10″
Sensitivity	65 m^2/K
Speed	1.3×10^5 $m^4/K^2 \cdot deg^2$
Observing frequency	700 – 1800 MHz
Field of View	30 deg^2
Processed Bandwidth	300 MHz
Channels	16384
Integration time	5 seconds
Focal Plane Phased Array	192 elements

+ Infrastructure for new SKA-ready observatory at the MRO

Phased Array Feed tests at Marsfield

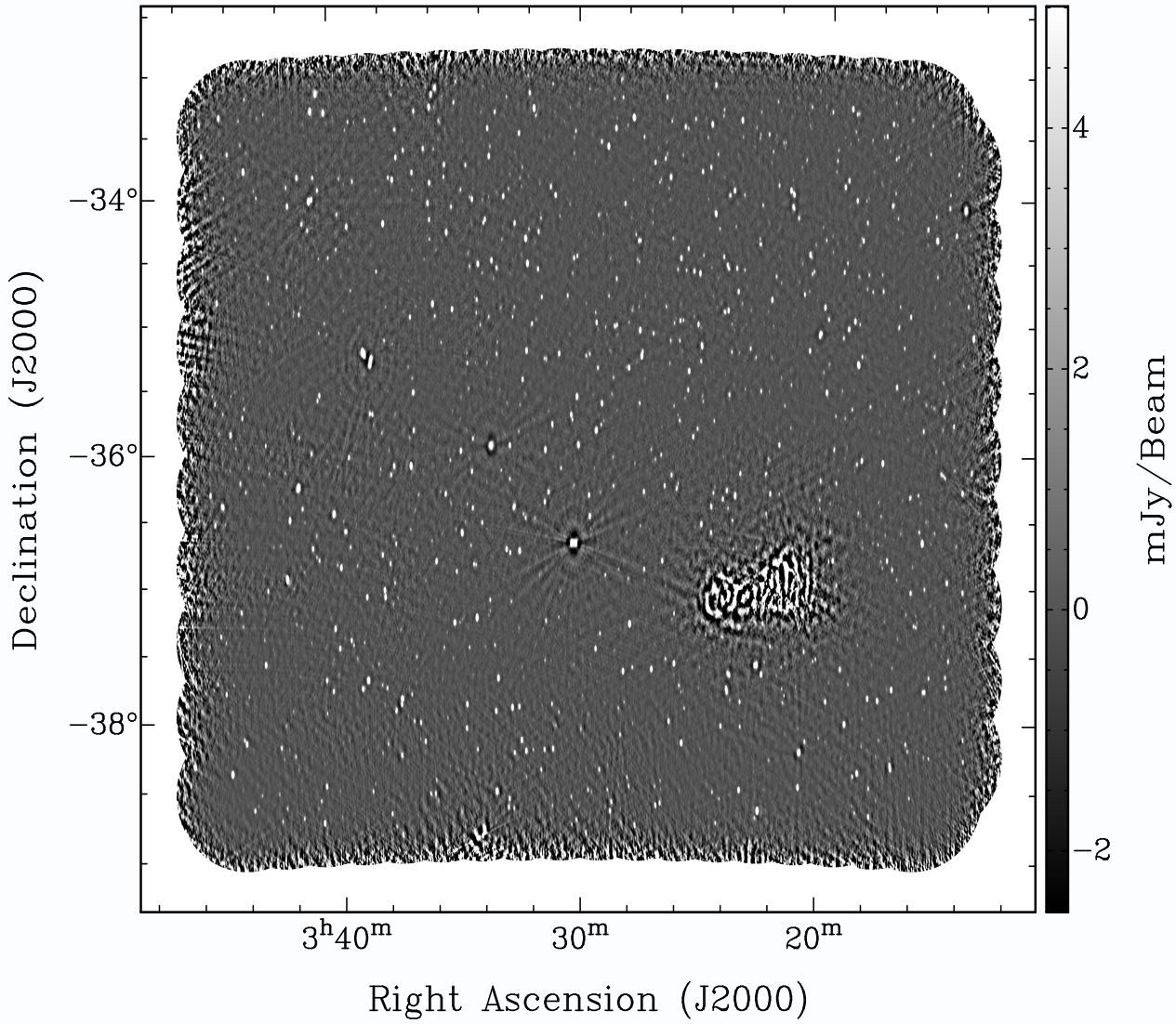
Sensitivity over a 30 square degree field



ASKAP Mk I PAF on 12m dish at Parkes

(courtesy Aaron Chippendale and Aidan Hotan)

ATCA image of Fornax test field (Thomas Franzen).
342 pointings. ASKAP will match in one pointing.



Science Highlights

The scientific priorities for ASKAP are:

1. Understanding galaxy formation and gas evolution in the nearby Universe through extragalactic HI surveys
2. Determining the evolution, formation and population of galaxies across cosmic time through radio continuum surveys
3. Characterise the radio transient sky through detection and monitoring of transient and variable sources
4. Exploring the evolution of magnetic fields in galaxies over cosmic time through polarization surveys

ASKAP Science Survey Teams

Early 2009, ASKAP called for proposals for large (>1500hrs) amounts of time.

Extensive interest, with:

- 17 proposals
- 693 astronomers from 358 science institutions around the world
- Requesting 4,384 24-hour days of observing (12 years)

Ten teams were selected, representing over 400 astronomers

Survey Science Projects

Highest Priority

EMU: All-sky radio continuum survey (*Norris*)

WALLABY: All-sky HI emission survey (*Korbalski/Staveley-Smith*)

Also supported

CRAFT: Fast transients (*Hall*)

COAST: Pulsars (*Stairs*)

FLASH: HI absorption against continuum sources (*Sadler*)

GASKAP: Galactic HI and masers (*Dickey/McClure-Griffiths*)

DINGO: Deep HI survey (*Meyer*)

POSSUM: All-sky polarisation survey (*Gaensler/Taylor/Landecker*)

VAST: Variables and slow transients (*Murphy/Chatterjee*)

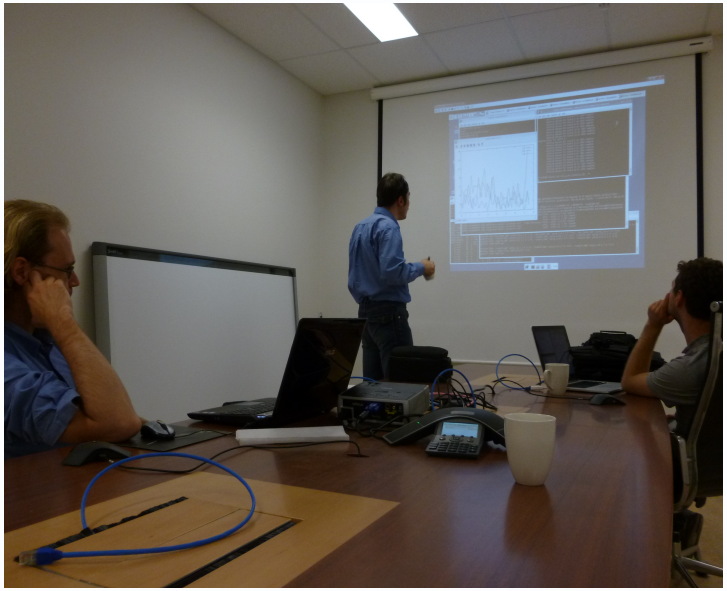
VLBI: Very Long Baseline Interferometry including ASKAP (*Tingay*)

ASKAP teams are open collaborations

Project duration and commensality

- In first five years of operation, 75% of ASKAP time will be for science surveys.
- No a priori guaranteed time will be given to particular countries, groups or institutions
- ASKAP not a user-operated telescope – scientists interact with archive
- It is expected that several projects will run commensally where possible
- Major projects have requested >1500 hours each, but may require much more to achieve goals (~2 years)

Basic Commissioning

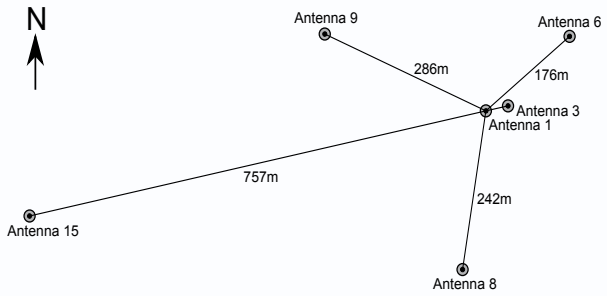


Current status: 6 antennas
with PAFs, hardware correlator

ASKAP Mk II (Design Enhancements) Program

- Re-design to meet receiver noise temp. specification across band
- Reduced mass of PAF (cheaper, improves antenna performance)
- Improve RFI suppression and shielding.
- Reduce modularity (reduces maintenance).
- Reduce number of custom-built components (spare parts)
- Move electronics from antenna pedestals to the control building.
- Replace coaxial cables with fibre optics for entire signal path.

What's Next?



BETA – Antennas 1, 3, 6, 8, 9, 15

- Six antennas equipped with phased array feeds
- Hardware correlator
- Full program of technical commissioning tests (2013-14)

In parallel: **ASKAP Design Enhancements Program**

Production and basic testing of first Mk II test phased array feed
Installation of Mk II feeds in batches of six

When will we see data?

A portion of commissioning data will be released to science teams

Early science likely ~2015 to 2016

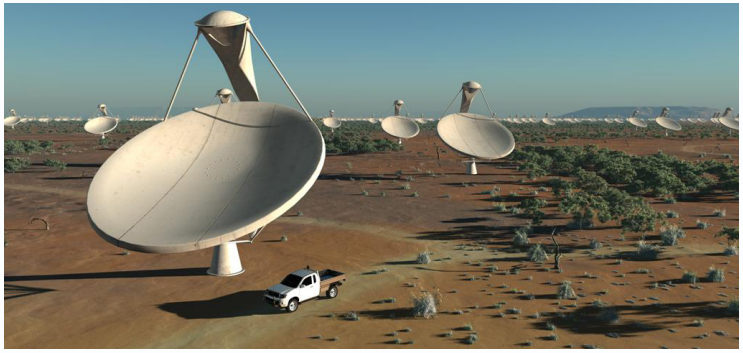
Extension to SKA

Phase 1: (2020)

- A 96-dish survey telescope (Australia)
- A compact low frequency array (Australia)
- A 250-dish array (South Africa)

Phase 2: (2030)

- An extended low-frequency array (Australia)
- An extended dish array (Africa)



Summary

ATNF facilities are in good health!

- New SOC at Marsfield
- New remote observing capability for Parkes
- New operating model for Mopra
- New antenna at Tidbinbilla

ASKAP commissioning phase underway

ASKAP early science from 2015

Next proposal deadline December 15 (for 2014 Apr to Sep)

Thank you

CASS
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