



The Australia Telescope Compact Array

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CSIRO ASTRONOMY & SPACE SCIENCE
www.csiro.au



Welcome!

- Selamat Datang!
- Namaste!
- Youkoso!
- Huan-ying ni-man!
- Hwangyong-hamnida!
- Haere mai!
- Welkom!
- Willkommen!
- Bienvenidos!
- Dobro pozalovat!
- Yaama!

Overview I

- Introduction to LOC & SOC
- Reminder
- Safety induction
- Fire alarms

Introduction to LOC & SOC

- Local Organising Committee
 - Robin Wark, Margaret McFee, Shari Breen
 - Jamie Stevens, Peter Mirtschin, Tim Wilson
 - All staff!
- Scientific Organising Committee
 - Ian Heywood
 - Shari Breen
 - Josh Marvil
 - Jamie Stevens



BEFORE PROCEEDING PLEASE TURN OFF ALL



PHONES



PDA's



LAPTOPS



TWO-WAY RADIOS



OTHER TRANSMITTERS



All transmitting and receiving equipment
should be powered off before proceeding



Help us listen to whispers from space

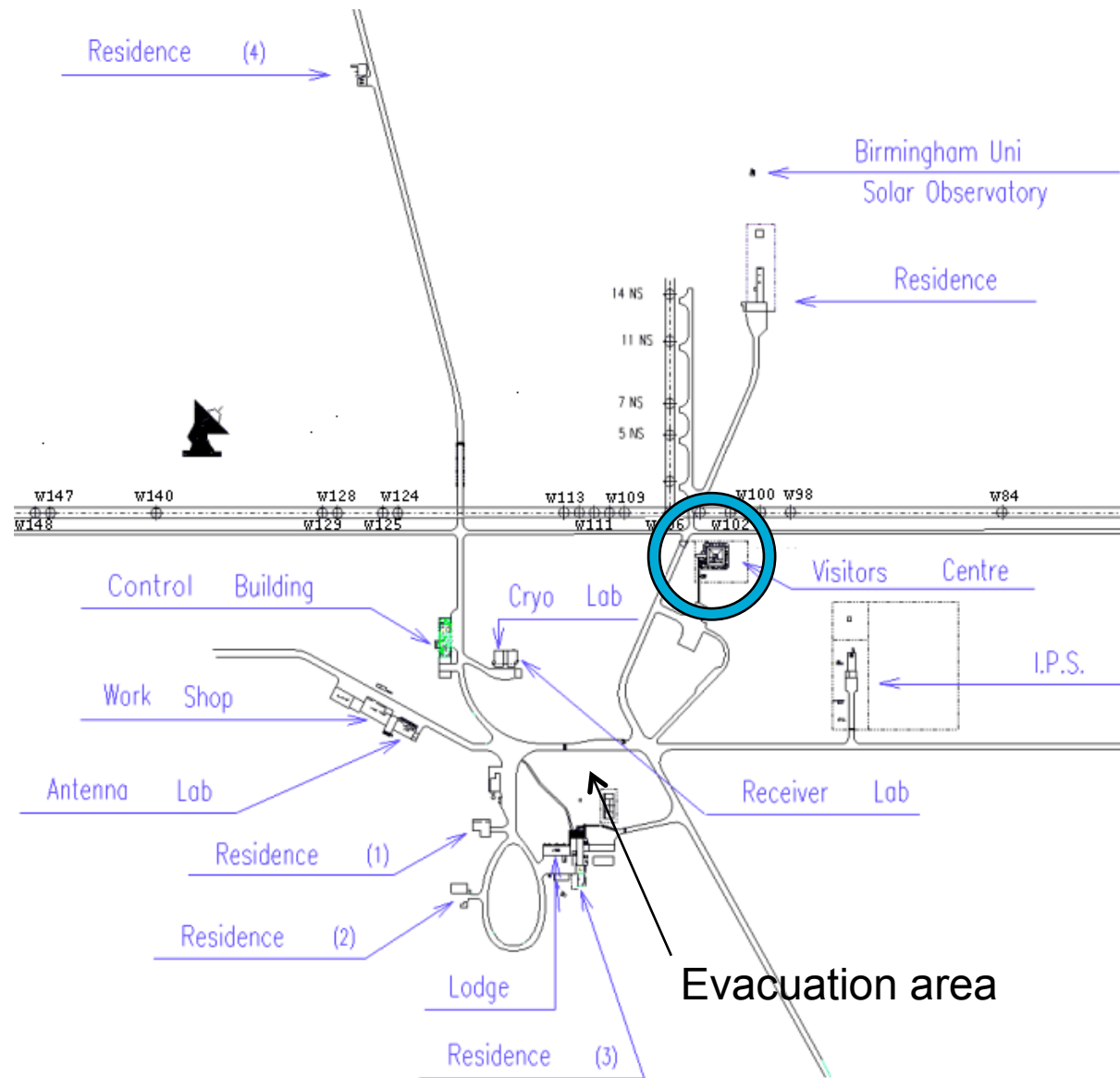
Safety

- The Observatory is a safe place
- Please be careful of
 - The sun (sun screen is available)
 - The paths (watch where you're going)
 - Heights (antenna tours are optional, but closed shoes are essential)
 - Kangaroos (don't get too close)
 - Mosquitoes (cover up; repellent is available)
 - Snakes (if you see one on-site, let us know)
- If you have any questions, ask a member of the LOC or local staff or SOC

If there's a fire alarm...

- If an alarm sounds once, do not evacuate, but stay alert
- The alarm will be stopped by Observatory staff, who will investigate
- If the alarm sounds a second time, move to the evacuation area

Site map



Outline

- What is CSIRO?
- Why are we here?
- Parkes 64m
- Mopra 22m
- ASKAP (Australian Square Kilometer Array Pathfinder)
- (Long Baseline Array, Tidbinbilla)
- Australia Telescope Compact Array (ATCA) 6x22m
- Science with the ATCA
- ATNF Performance Indicators
- Challenges
- Final words of reassurance

CSIRO

- The Council for Scientific and Industrial Research (CSIR) was founded in 1926
- In 1926, CSIR had a staff of 41
- CSIR became the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 1949
- In 2015, CSIRO has a staff of ~5500 in 9 Business Units and other Lines of Business, and an annual budget of a little over \$1000 million, roughly half from government and half external revenue

CSIRO

- Agriculture
 - Data61 (Digital Productivity)
 - Energy
 - Food and Nutrition
 - Health and Biosecurity
 - Land and Water
 - Manufacturing
 - Mineral Resources
 - Oceans and Atmosphere
-
- National Facilities and Collections
 - ATNF, CDSCC, Marine National Facility, Animal Health Laboratory, National Collections, ...



CSIRO's top ten inventions

- Wi-Fi
- Plastic banknotes
- Hendra virus vaccine
- Extended wear contact lenses
- Aerogard
- Total wellbeing diet
- RAFT polymerisation
- BARLEYmax
- Self-twisting yarn
- Softly washing liquid

<http://www.csiro.au/en/About/History-achievements/Top-10-inventions>





Why are we here?

The Culgoora Radio Heliograph

- First planned to be located at Parkes
- Culgoora selected as large flat area with
 - suitable soil
 - free from flooding
 - relatively free from RFI
 - easy access from Sydney
- CSIRO DAP elected to base solar optical observatory at the same site.
- Funding (US\$550,000) granted by Ford Foundation in April 1962
- Construction from mid-1962 to mid-1967

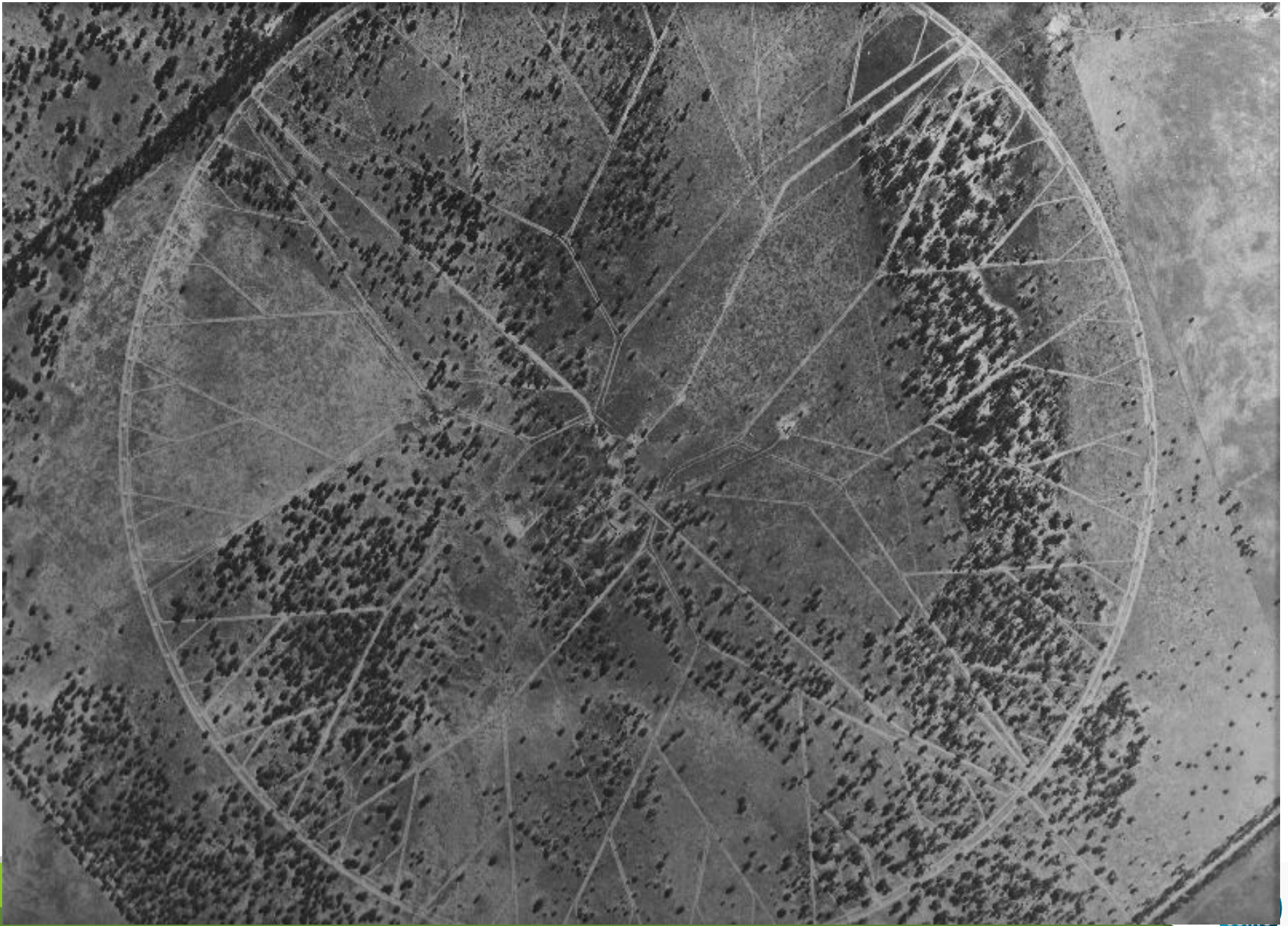
Radio Heliograph

- A ring of 96 antennas in a circle with a 3km diameter
- Each wire-mesh antenna 13.7m in diameter
- Antennas covered an Hour Angle range of +/- 2.5 hr
- Operated
 - at 80MHz initially (with 3.8' beam),
 - also at 160 MHz later and
 - at 43 MHz (with a concentric array of 48 corner-reflector antennas)
- Signals transmitted from antenna to control building along open transmission lines (320km of copper wire used!)
- 48 pencil beams (N-S) scanned (E-W) across sun every second, as a phased array
- Also used at night ...

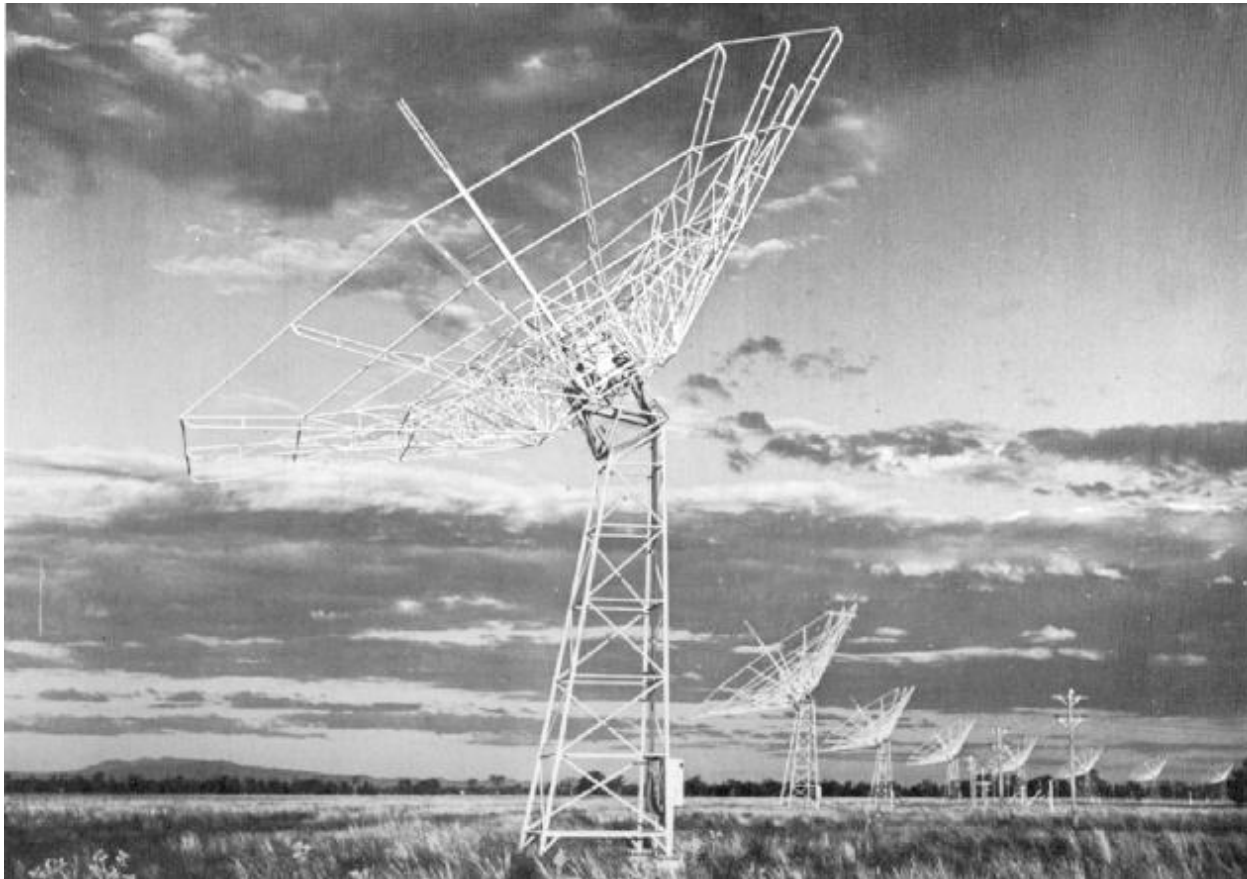
Paul Wild

- b. 17 May 1923, Sheffield, UK
- Joined CSIR in 1947
- Led the team that built and operated the Culgoora radioheliograph
- Chief of Division of Radiophysics 1971 to 1978
- Chairman of CSIRO 1978 to 1985
- d. 10 May 2008

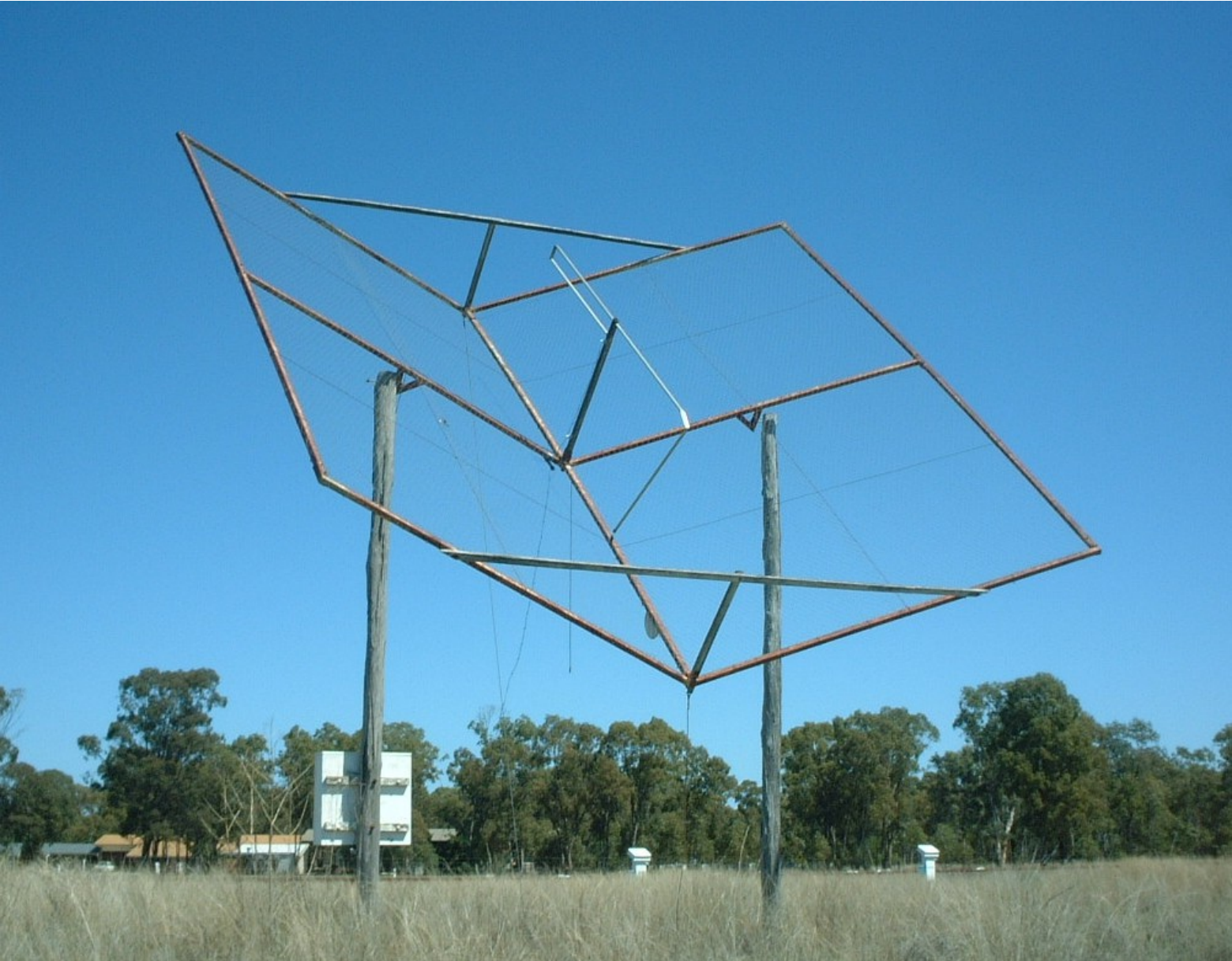


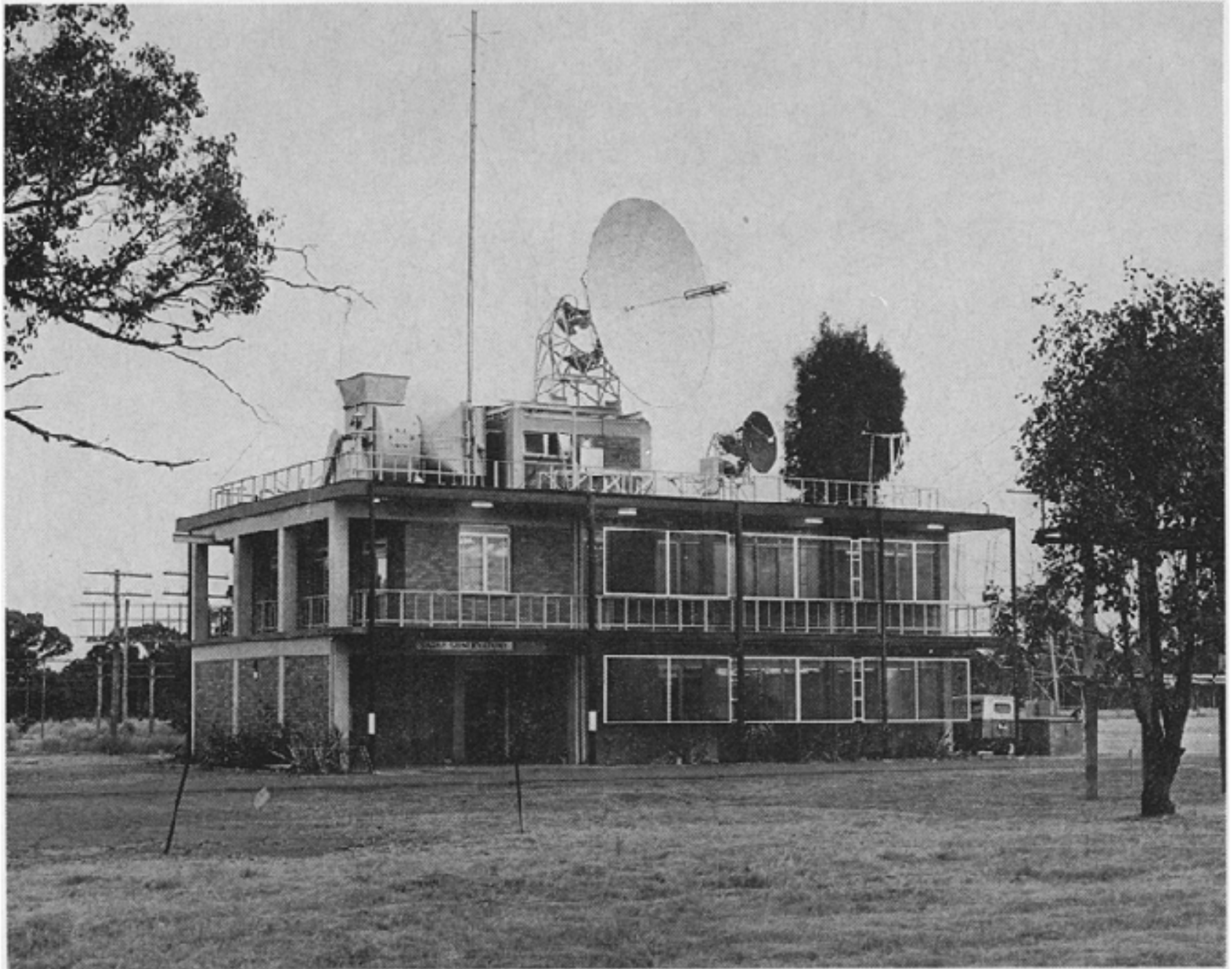


The Culgoora Radioheliograph



1967 to 1984

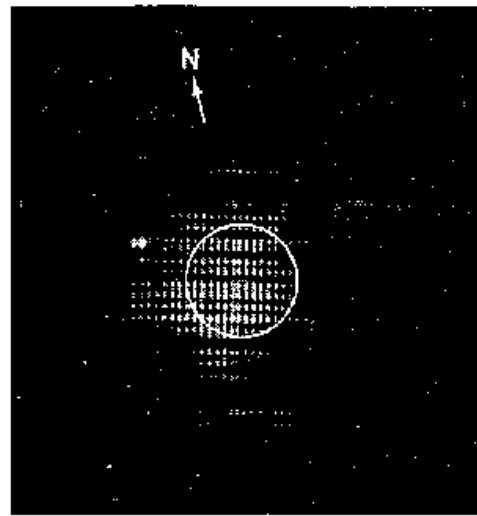




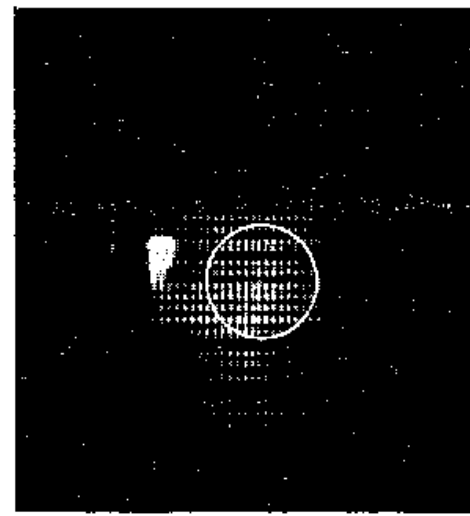
Radioheliograph results



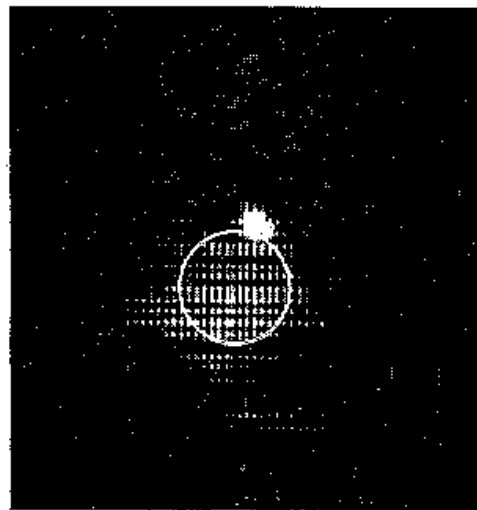
Figure 1.—Radiometer record of the total solar flux at 80 MHz during an event of September 2, 1967.



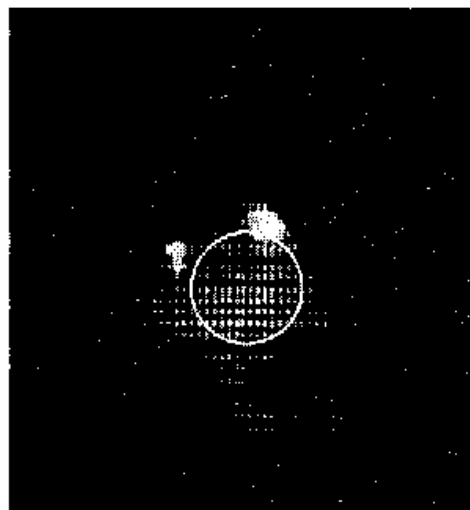
(a)



(b)



(c)

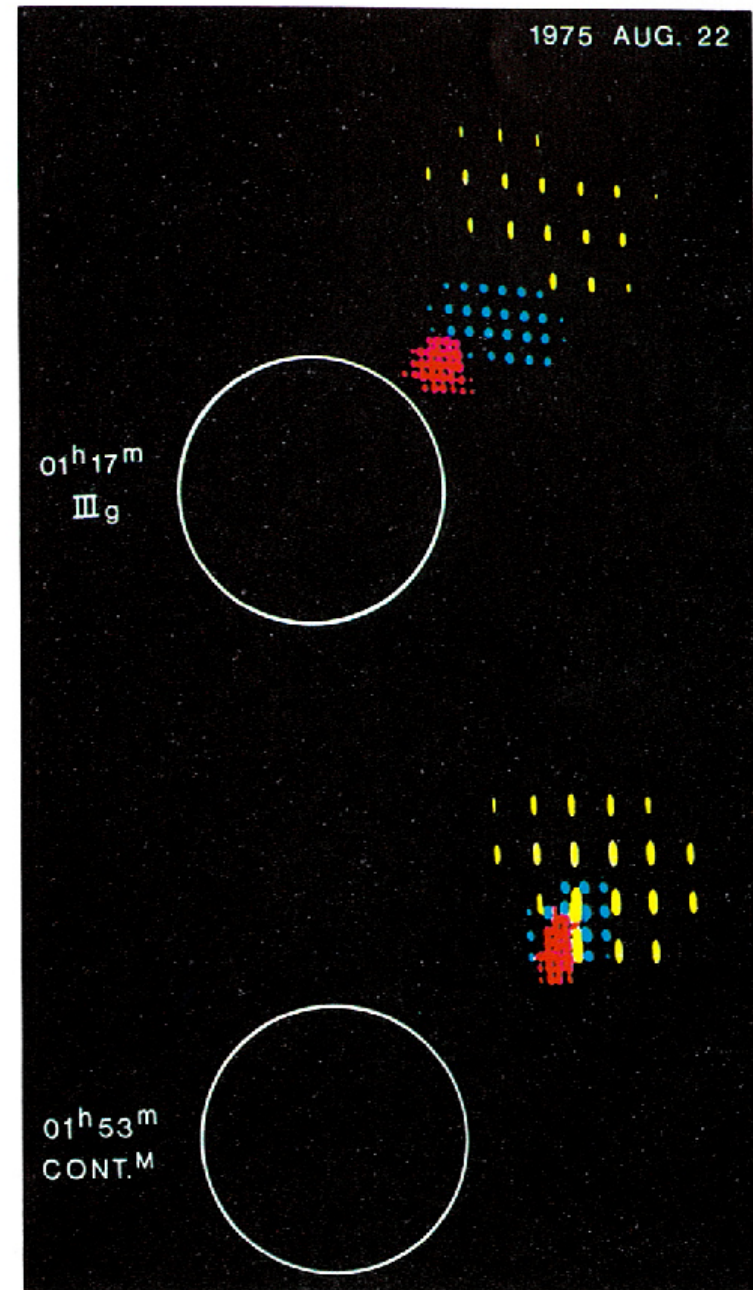


(d)

Figure 2.—Rautiokulmograph (80 Mm) pictures taken for the event shown in fig. 1. Superimposed on the quiet Sun are :
 (a) burst A of fig. 1 ; (b) burst B ; (c) bursts C and D ; and (d) bursts E, F, G, and H.
 Burst E occurs in the eastern (left-hand) region and bursts F, G and H in the northern. The circles indicate the optical limb of the Sun.

Bursts

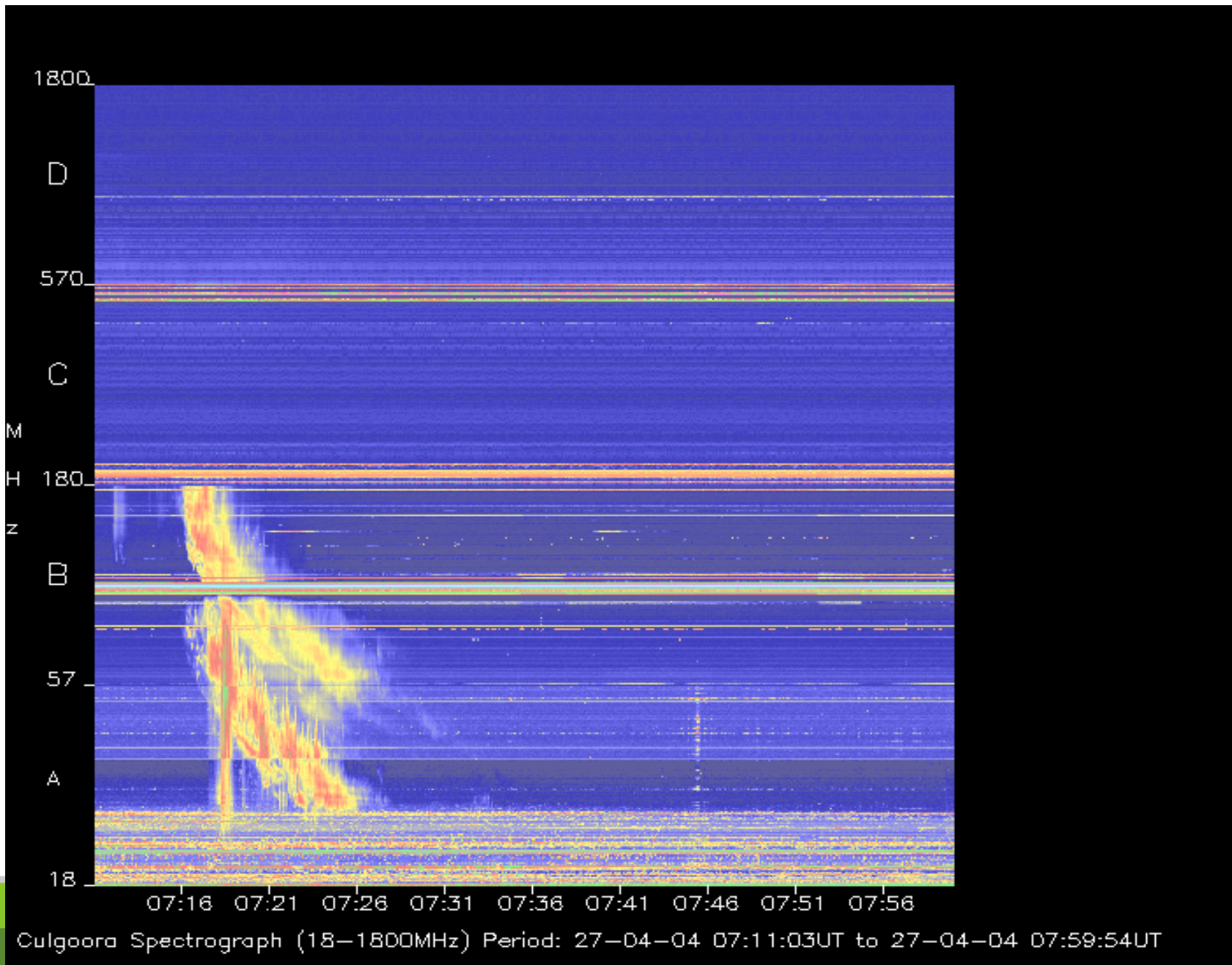
- Superimposed radioheliograms at 160 MHz (red) 80 MHz (blue) and 43MHz (yellow) of a type III burst (top) and a type IV moving source (bottom)
- The different frequencies are separated by 1 sec in time



IPS today



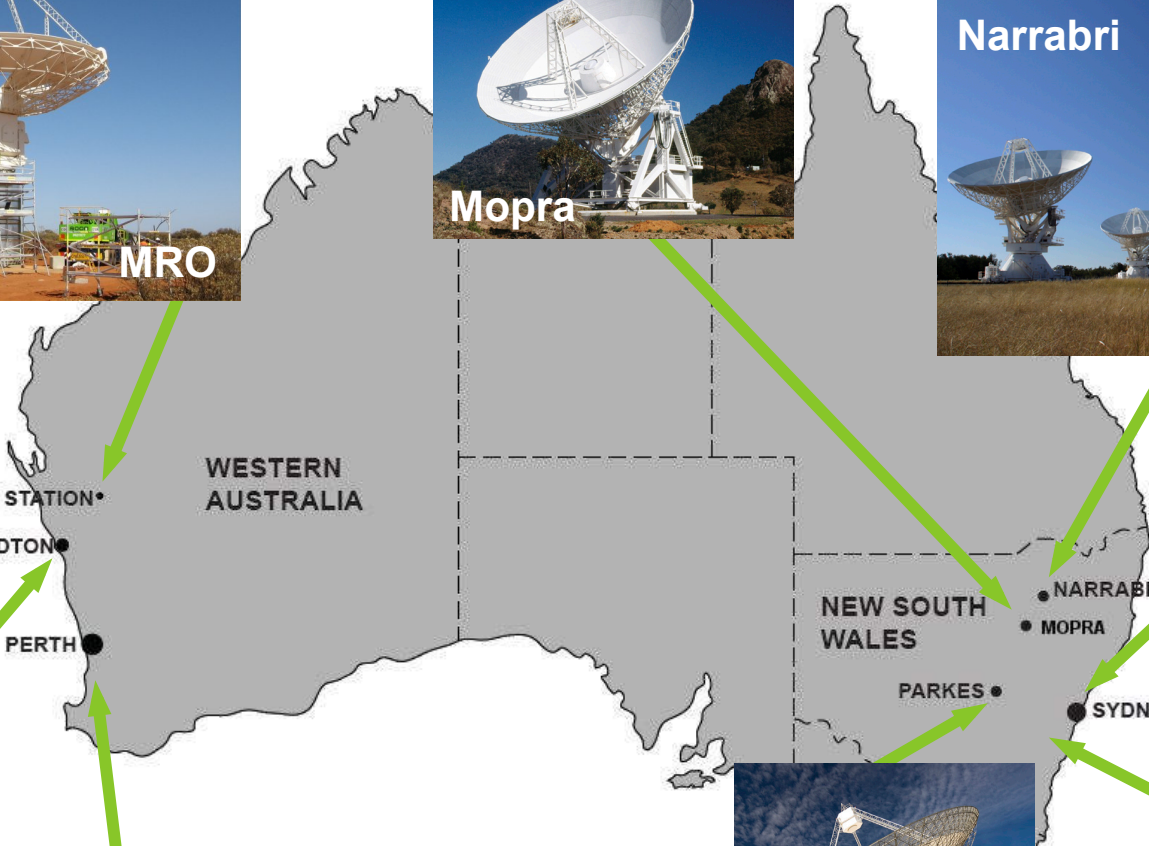
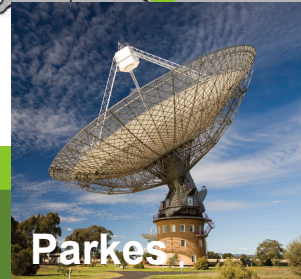
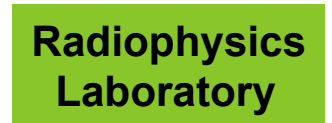
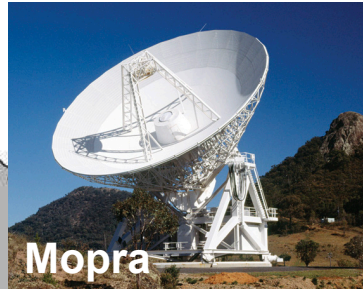
The Ionospheric Prediction Service, a unit of the Bureau of Meteorology, is the Australian Space Weather Agency. The Culgoora site monitors the sun daily at radio and optical wavelengths.



Australia Telescope National Facility

- The CSIRO Division of Radiophysics was established in 1939
- ATNF became a separate division in 1989
- CSIRO Astronomy and Space Science (CASS) formed in 2009, combining ATNF, CDSCC (Tidbinbilla Deep Space Network station), and other space activities
- ATNF effort is grouped into 4 areas
 - Astrophysics
 - Operations
 - Technologies for Radio Astronomy
 - SKA (the Square Kilometre Array)

CASS Divisional Sites



Pawsey HPC Centre



The Science Operations Centre

- The Science Operations Centre (SOC) was established at ATNF Headquarters in Sydney in 2012, with a view to centralising the observing support and expertise for the existing telescopes and ASKAP.
- It also enables visiting astronomers to more easily interact with the ATNF Astrophysics group, which is located in Sydney.
- The SOC is now the default location for Parkes observing and ATCA.
- Video-links in place between the SOC and the observatories.
- On-site accommodation is available

Parkes 64m (0.7 – 27 GHz)



Mopra 22m (1.1 – 116 GHz)



Mopra 22m



Mopra bushfire, January 2013



<http://www.youtube.com/watch?v=WIHP9J1UPrs>

Mopra

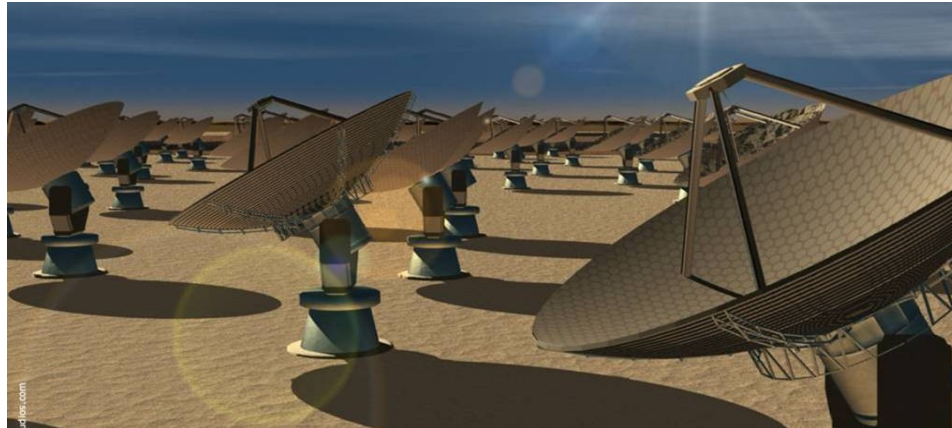
- Significant bushfire damage January 2013, observing restarted in May 2013.
- A new operations model began in October 2012, with the provision of funding from NAOJ and UNSW/Adelaide allowing for the the continued operation of the telescope, with these groups being provided with guaranteed observing time in return.
- Some National Facility time retained.
- In May 2014, CSIRO announced that it will cease funding Mopra at the end of Oct 2015.
- Discussions are underway with a consortium interested in taking over Mopra from CSIRO.

ASKAP 36 x 12m (0.7 – 1.8 GHz)



<http://www.atnf.csiro.au/projects/askap>

ASKAP at the Murchison Radio Observatory



Antennas	36 x 12m diam., 3-axis rotation
Field of view	30 deg²
Max baseline	6 km
Frequency	700–1800 MHz
Bandwidth	300 MHz (with 16384 channels)
Phased Array Feed	188 elements
System temperature	~70 K

Commissioning underway with 6 element test array (BETA)

Australia Telescope Compact Array



APOD 080310 White & Cozens

ATCA 6x22m (1.1 - 106 GHz)



The ATCA

- Operates 24 hours a day
- ~75% astronomical observing
- ~20% maintenance, testing, array reconfigs
- ~ 5% downtime or idle time
- The proposers are the observers
- Observers visiting from around the world
- Opened 2nd September 1988



“Today we are inaugurating a new era in Australian scientific research - the major Bicentennial science project - which will ensure Australia remains at the forefront of radio astronomy “

2nd September 1988

Australia Telescope Compact Array

- Six 22 metre diameter antennas
- Five antennas on a 3km east-west track
- One antenna 3km to the west
- A 214 m north-south spur added, 12mm & 3mm receivers added, outer panels replaced (1998-2002)
- 7mm receivers added in 2007
- Change array configuration every ~3 weeks
- The ATCA can observe in 5 bands:
 - wavelengths between 27cm and 3mm,
 - frequencies of 1 GHz to 105 GHz
- CABB upgrade in 2009 increased bandwidth from 2x128MHz to 2x2GHz

Australia Telescope Compact Array

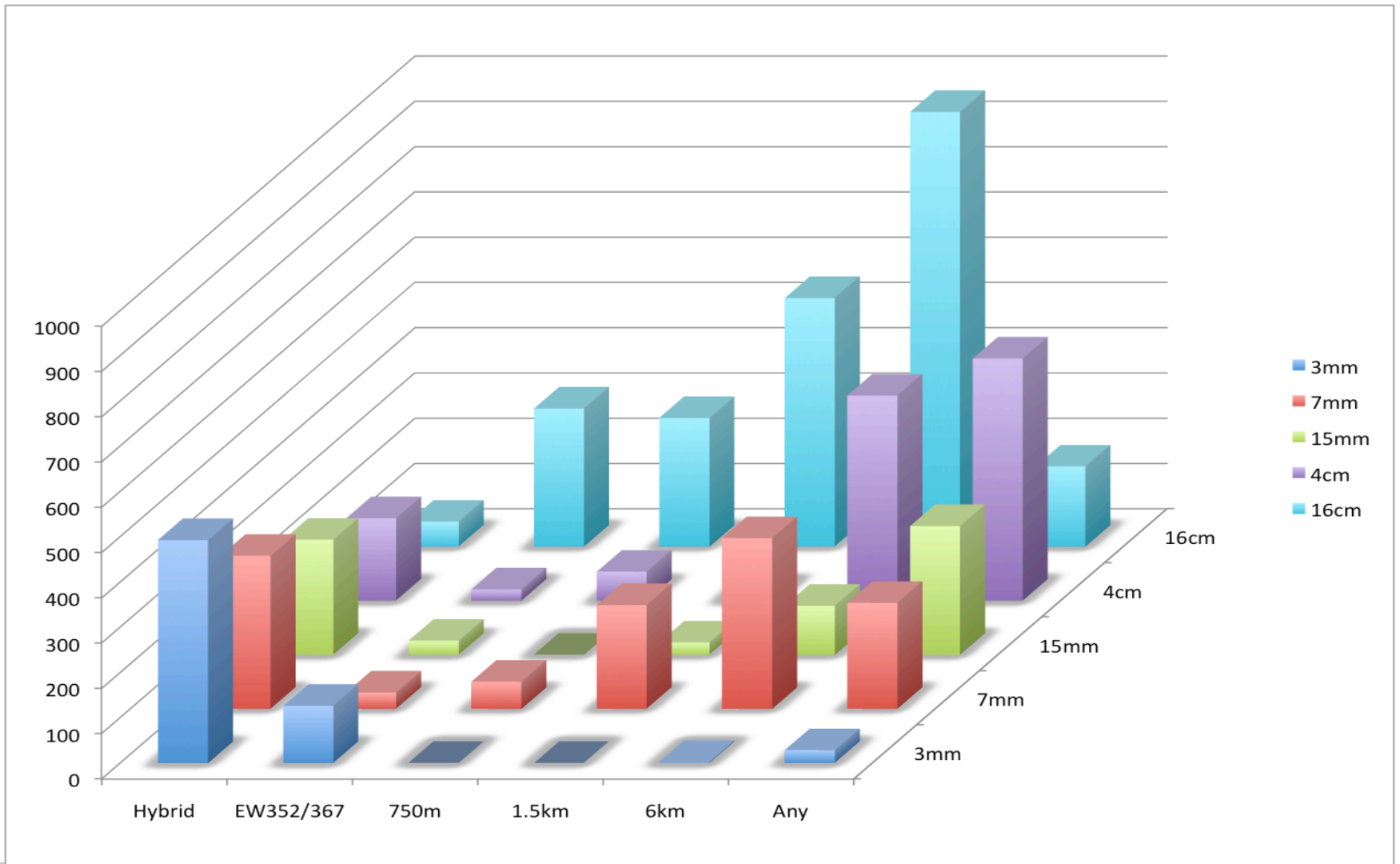
- The ATCA is a synthesis telescope
- 6 telescopes → 15 baselines (except at 3mm)
- Each baseline samples a Fourier component of the source structure (recall $\theta \approx \lambda/D$)
- The Earth's rotation sweeps all baselines around the (u,v) plane
- A 12 hour synthesis covers all baseline orientations
- Standard imaging assumes the source is unchanging on this timescale

Standard array configurations

- 6A, 6B, 6C, 6D
- 1.5A, 1.5B, 1.5C, 1.5D
- 750A, 750B, 750C, 750D
- EW367, EW352
- H214
- H168
- H75

- <http://www.narrabri.atnf.csiro.au/observing/configs.html>

ATCA requested band/array for 2014APR

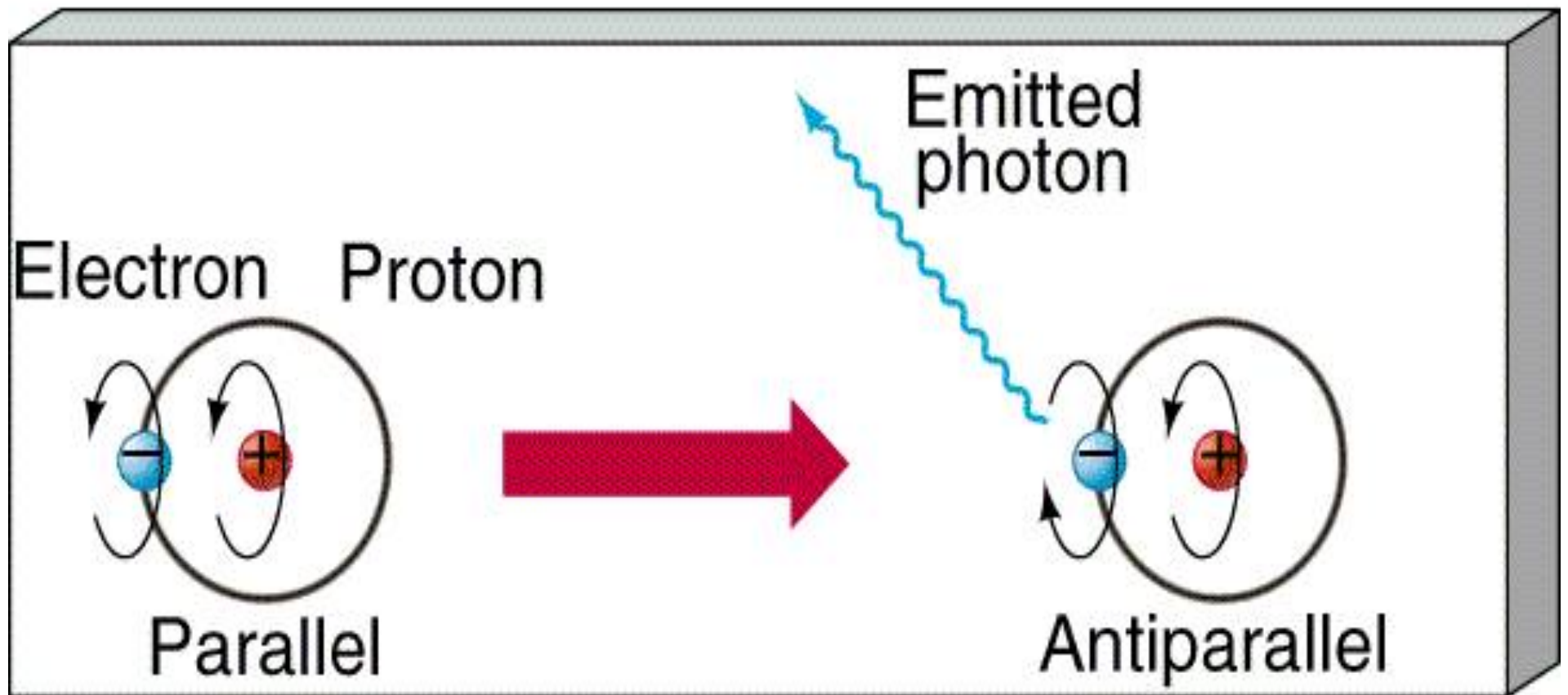


Observations by science category

• Galactic	47%
• Extragalactic	39%
• Stellar	20%
• Magellanic Clouds	6%
• Solar system	2%

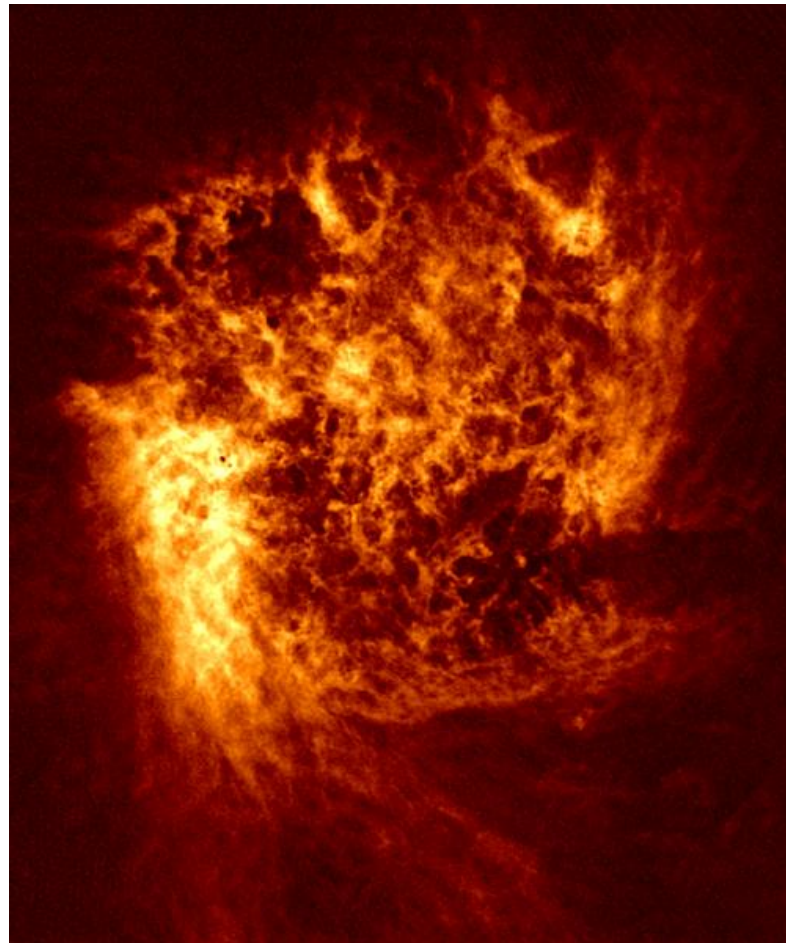
As nominated by proposers on coversheets of proposals

Hydrogen



A hydrogen atom emits (or absorbs) radiation at 21cm

Hydrogen in the LMC



1344 pointings in four 750m configurations between Oct 1994 to Feb 1996



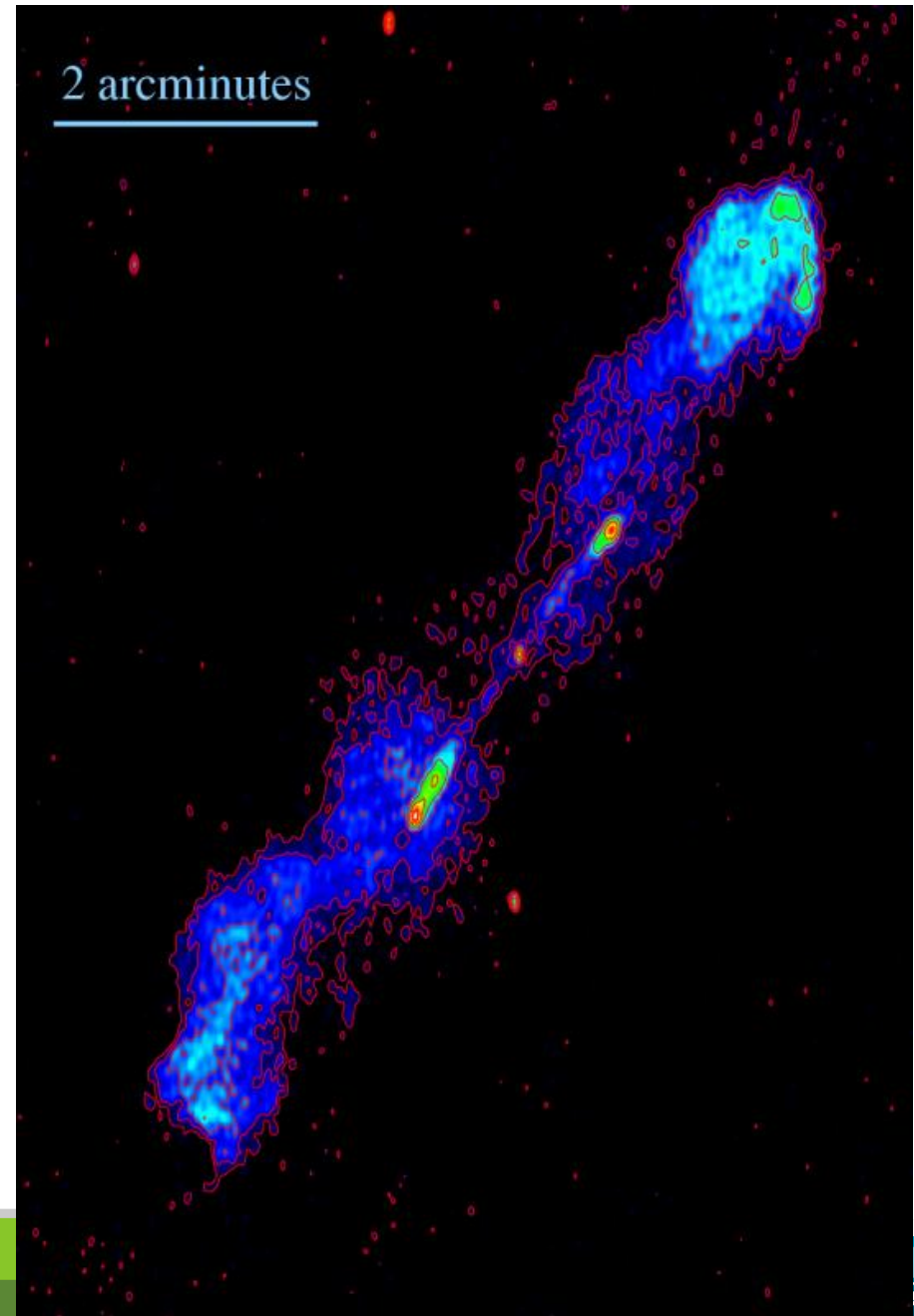
B1545-321

ATCA observation at
13cm

The galaxy is 1.4
billion light-years
away ($z=0.1$)

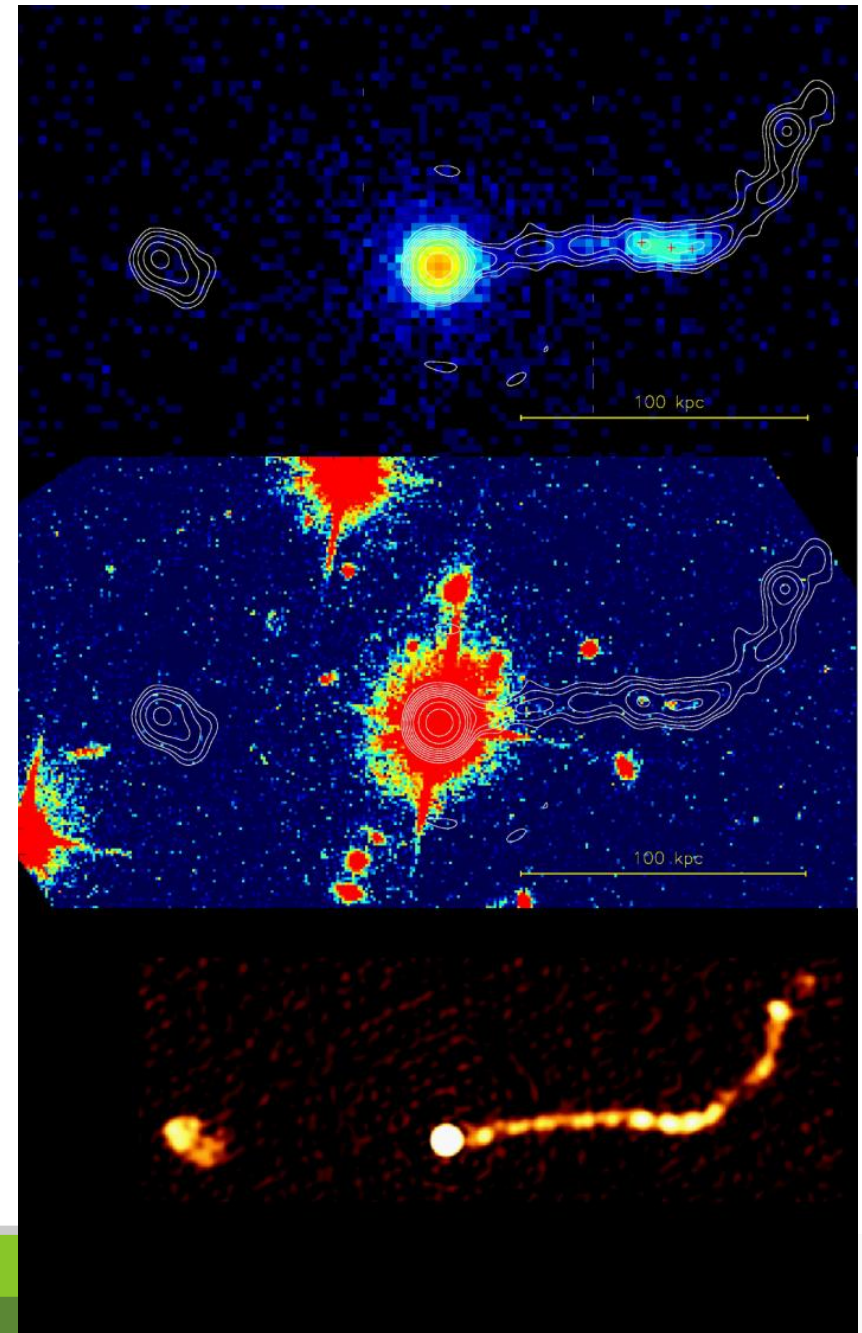
The radio lobes are
1.5 million light years
in size!

Evidence for
reactivation



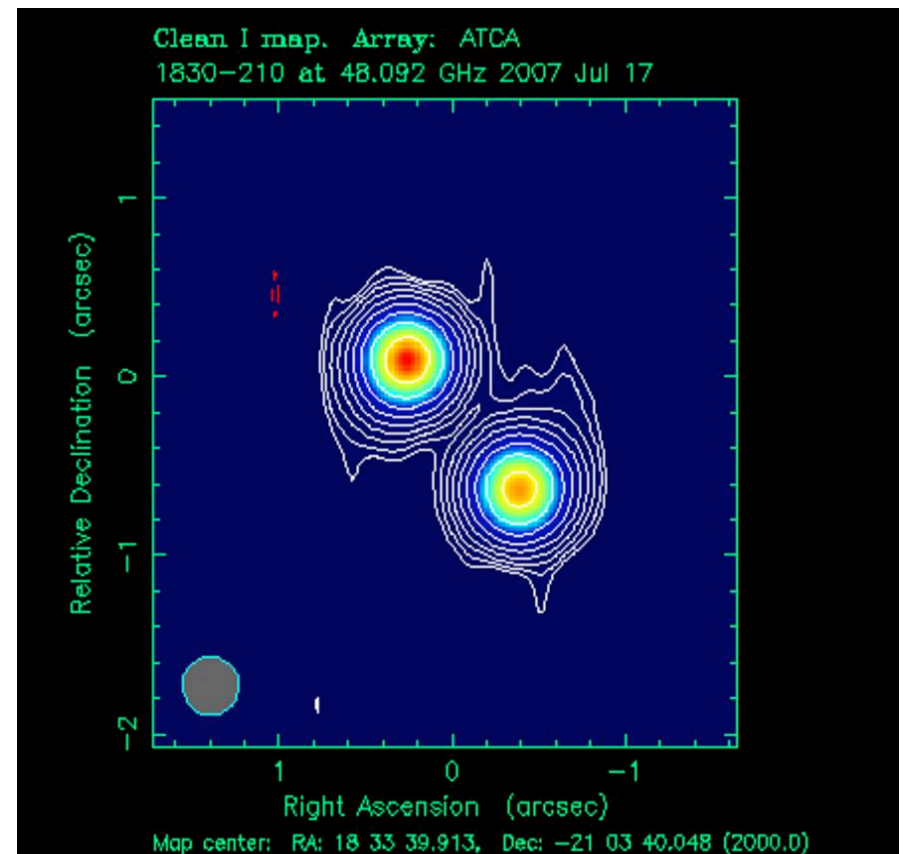
A quasar

- X-ray image (top)
- HST image (middle)
- 12mm ATCA image (bottom)
- This quasar, known as PKS 0637-752, is 8 billion light-years away ($z=0.65$)



A gravitational lens

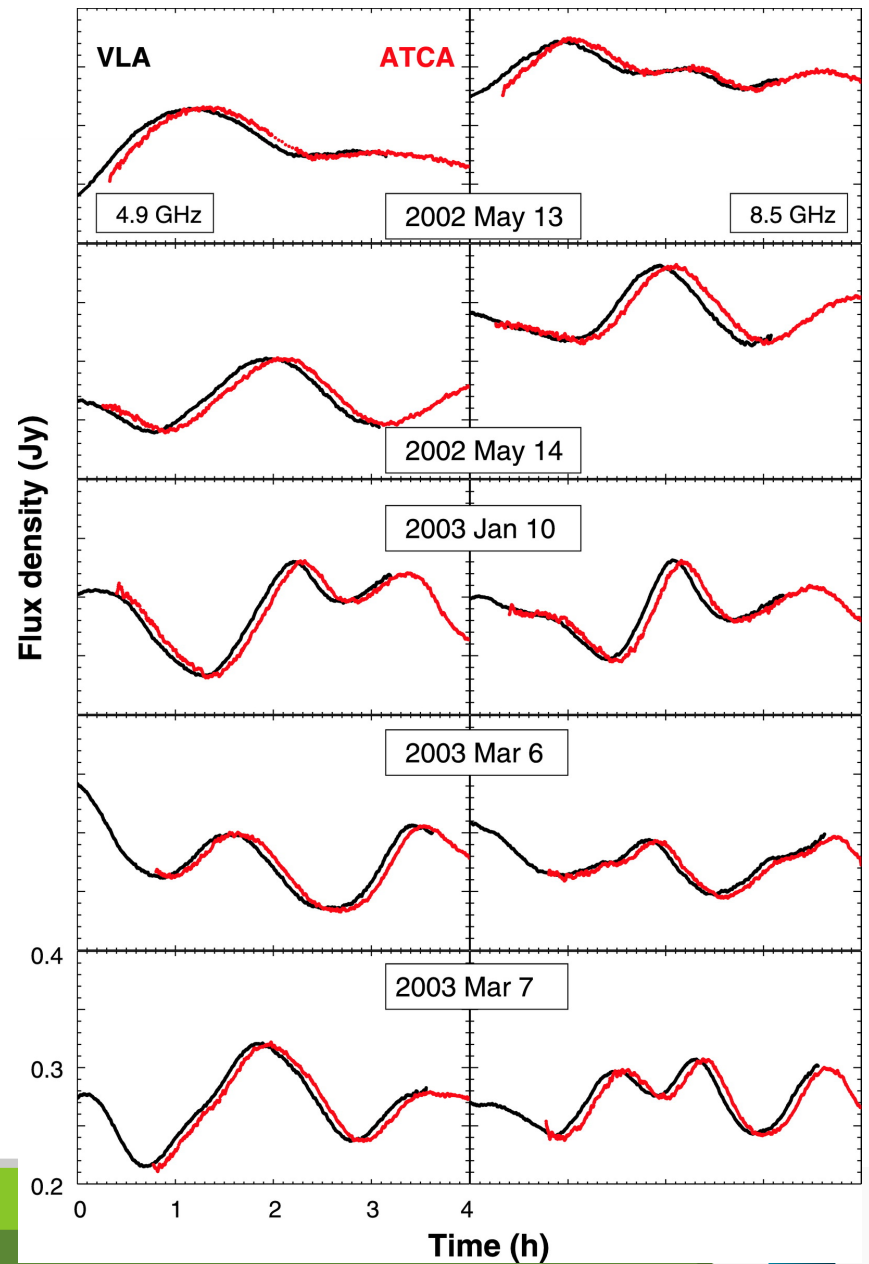
- Two images of the same quasar!
- Light from a background ($z=2.5$) quasar “lensed” by a foreground (but invisible) galaxy
- The time delay between the two images allows the Hubble constant to be measured and the age of the Universe inferred
- This image made in 2007 with the ATCA’s new 7mm receivers



Courtesy: Jim Lovell

Intra-day variability

- PKS1257-326 shows intra-day variability
- Intrinsic to the source? Or extrinsic?
- Several minute delay between VLA and ATCA indicates it is a propagation effect caused by turbulent plasma in our galaxy



ATNF Performance indicators

	ATCA	Parkes	Mopra
Astronomy	78%	78%	75%
Maintenance/test	16%	14%	5%
Equipment failure	3%	3%	3%
Time lost to weather	1%	2%	10%
Idle	2%	2%	7%

Note: Mopra figures for ~6 month austral winter mm-season only.

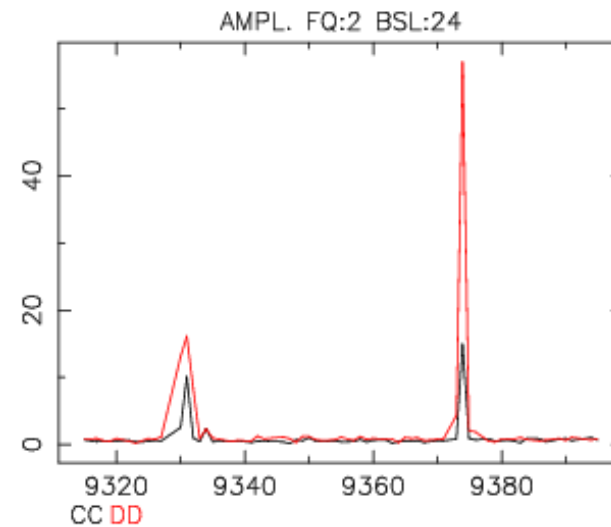
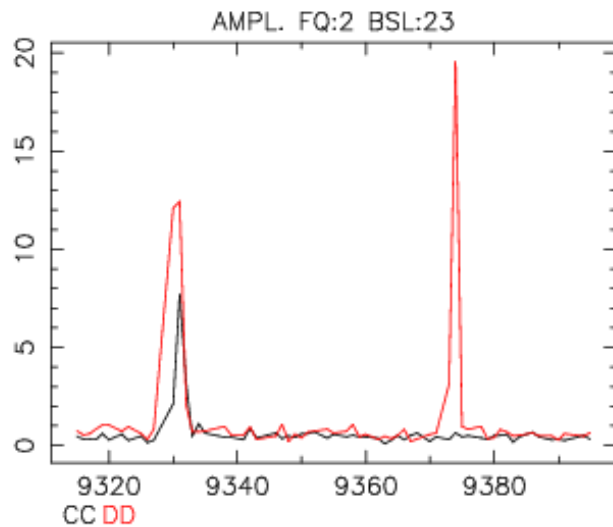
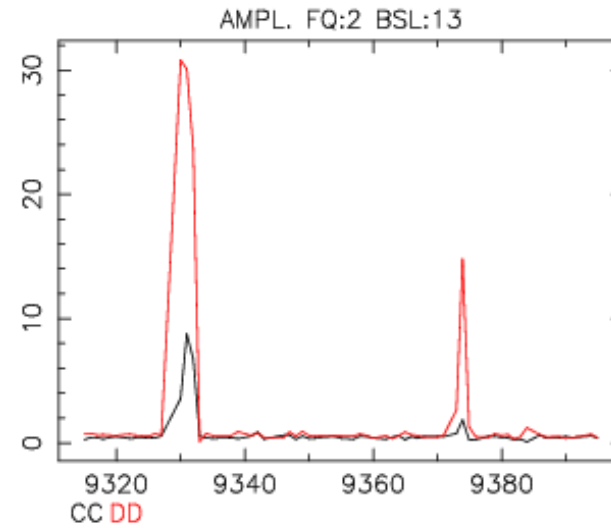
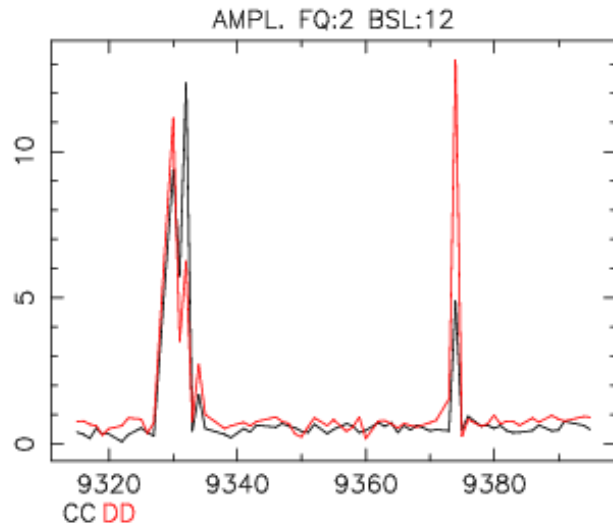
Time allocation by proposer affiliation

	ATCA	Parkes	Mopra
CASS	25%	30%	10%
Other Australian	25%	25%	20%
Overseas	50%	45%	70%

Outputs:

- ATCA ~ 70 refereed papers per year
- Parkes ~ 45 refereed papers per year
- Mopra ~ 15 refereed papers per year (~6 months)
- LBA ~ 5 refereed papers per year (~3 weeks)

Radio Frequency Interference



What are the sources of RFI?

- Natural sources: Sun, lightning
- Self-generated RFI: from synthesisers, digitisers, fast electronics...
- Locally generated: wifi, microwave ovens, mobiles phones, video cameras
- Fixed transmitters: TV, communications, radar
- Mobile transmitters: communications
- Satellites: positioning systems, communications

Cable damage



CA02 and CA05 taken off-line for several days each for repairs, recabling on CA01 and CA04 also carried out.

ATCA strengths

- Location
- Frequency coverage
- Co-axial 20/13cm and 6/3cm receivers (now 16cm and 4cm bands)
- Frequency agility
- Array configurations (factor of 80 in linear scale)
- Linear polarizations
- A tied-array mode for VLBI
- The proposers are the observers
- Ability to remote observe
- ATOA – the Australia Telescope Online Archive (atoa.atnf.csiro.au)
- CABB
- Local staff
- Engineering excellence
- National facility support: TAC, web, assistance

Making an ATCA observation

- Write a good proposal
- Check the current status and capabilities of the array
- Use the CABB scheduler to make your schedule file(s)
- Load a schedule file into CAOBS
- Monitor the observations (a,p,d) with vis
- Monitor the correlator with CACOR
- Monitor the spectra with spd
- Monitor the environment with MoniCA
- Reduce your data with miriad
- Write up the results for publication

Embracing social media

“Phasebook” !



Thoughts for the week

“You don’t need to understand everything to learn something useful”

“The next best thing to knowing something is knowing where to find it”
-- Samuel Johnson

“Experience is a wonderful thing, it enables you to recognize a mistake when you make it again”

“What we learn with pleasure with never forget”

-- Alfred Mercier



Thank you

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