

The Australia Telescope Millimetre-Wave Upgrade

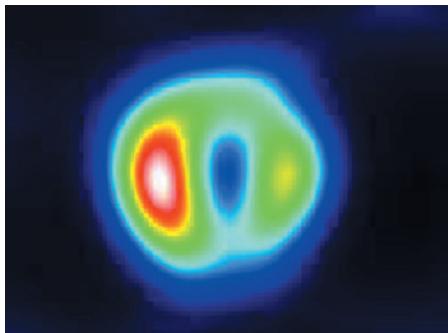


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CSIRO Australia Telescope National Facility

The Australia Telescope Compact Array (ATCA) is being upgraded so that it will be able to produce radio images of the sky at wavelengths as short as three millimetres, making it the first millimetre-wave synthesis telescope in the Southern Hemisphere.



Radio image of the supernova 1987A made using the ATCA at a wavelength of three centimetres; significantly more detail should be visible within the ring structure when using the Telescope at shorter wavelengths.



Prototype ATCA millimetre-wave receiver being assembled at ATNF Headquarters, Sydney.

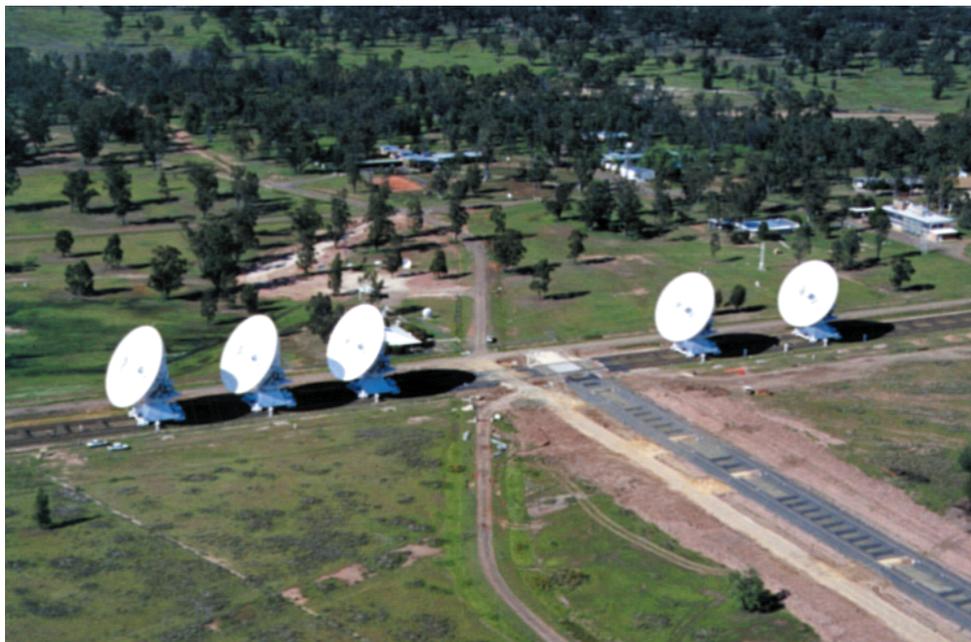
Background

The ATCA was opened in 1988, with scheduled astronomical observations commencing in 1990. Situated at Narrabri, in north-western New South Wales, it consists of six 22-m dish antennas. Five antennas are moveable on an east-west rail track three kilometres in length, while the sixth dish is fixed at a position a further three kilometres to the west.

Using advanced digital signal processing and computing techniques, and exploiting the changing view of the sky as the earth rotates, data from the six antennas are combined to "synthesise" a radio picture having the detail associated with a single enormous antenna six kilometres in diameter. At present, ATCA observations are made in the electromagnetic wavelength range 3-20 centimetres.

The Upgrade

Two new observing bands are now being added to the ATCA: 12 mm (covering the frequency range 16-25 GHz) and 3 mm (85-110 GHz).



Aerial view of the five moveable ATCA antennas on the main east-west rail track; the north spur track, still under construction when the photograph was taken, is clearly visible.

These new bands will improve the angular resolution of the Telescope by nearly a factor of 10 and will allow it to observe (and image) the radiation from many cosmically abundant molecules, including those associated with highly-evolved stars, molecular clouds, and distant galaxies. The ATCA has more collecting area than any of the few millimetre-wave arrays operating in the Northern Hemisphere, together with an unrivalled view of the centre of our own Milky Way Galaxy. It will be a true stepping-stone, both scientifically and technologically, to the very large, next-generation, millimetre-wave arrays likely to be built by international consortia in the first decade of the 21st century.

Technology Highlights

The major elements of the upgrade project are:

- More accurate reflecting surfaces for five of the six antennas, allowing efficient operation at three millimetres
- A 230-m north spur rail-track, converting the ATCA to a two-dimensional array for better imaging at short wavelengths
- Cryogenically cooled millimetre-wave receivers, incorporating low-noise radio-frequency amplifiers operating at frequencies up to at least 110 GHz

- A fibre-optic distribution network for the highly-stable ATCA master reference signals
- A remote-sensing system to correct the image distortion caused by blobs of atmospheric water vapour moving above the Telescope

The original ATCA construction project in the 1980s resulted in a significant technology transfer to Australian industry; the upgrade will have similar benefits.

Timescale

The ATCA millimetre-wave upgrade is scheduled for completion in January 2002. However, engineers and astronomers plan to begin test observations as early as mid-1999.



Experimental remote sensing radiometer installed on top of the central support structure of an ATCA antenna.

Project Costing and Management

The capital cost of the ATCA upgrade is \$6.85M, \$5.55M of which is provided under the Australian Government's Major National Research Fund scheme.

CSIRO contributed funding of \$1.3M directly to the project and, in a related development, has made a further \$2.2M available to the ATNF and CSIRO Telecommunications and Industrial Physics for research in the area of millimetre-wave integrated circuits; the ATCA project will serve as a test platform for many of these leading-edge devices.

The Telescope upgrade is managed by ATNF staff and companies involved in the project include Connell-Wagner, Barclay Mowlem Construction and Evans Deakin Engineering.

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