



Australia is playing a significant part in the development of the Square Kilometre Array (SKA), the international radio telescope for the 21st Century.

Australia has been at the forefront of radio astronomy since the 1940s when scientists at the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Radiophysics Laboratory used an antenna perched high on a cliff at Dover Heights in Sydney to make a number of important discoveries.

Since those early days, Australia has become a leader in radio astronomy, building up a suite of world-class facilities including the Australia Telescope Compact Array and the CSIRO Parkes radio telescope and a large and productive astronomy community. On average, each scientific paper produced by the Parkes telescope is more often cited (referred to) than the papers from any other radio telescope in the world.

The Australian Government has now provided \$117 million (US\$103 million) to help meet some of the key technology and engineering development requirements of the SKA. Australia is also working to offer the best possible location for the SKA. In collaboration with the Western Australian State Government, the Commonwealth Government is establishing a world-leading radio-astronomy observing site in the Mid West Region of Western Australia, as a potential SKA core site.

The significant technological and scientific challenges of the SKA provide an outstanding opportunity to build international science partnerships and high-level skills globally. The SKA will attract some of the world's best scientists and engineers, and provide major industry opportunities in high technology and other sectors. Destined to become a global icon for science collaboration and endeavour, the SKA will also have a valuable role in promoting the excitement and wonder of science.



Visualisation of the SKA. Image: Xilostudios/ISPO

What is the SKA?

The SKA will be a revolutionary, next-generation radio telescope capable of transformational science addressing some of the most fundamental unanswered questions in physics and cosmology.

The scale of the telescope is massive and unprecedented. The SKA will digitally combine signals from antennas with a combined collecting area of around one million square metres.

The combination of huge collecting area, versatility and sensitivity will make the SKA the world's premier imaging and survey telescope over a wide range of radio frequencies, producing the sharpest pictures of the sky of any telescope. It will have up to 50 times the sensitivity and 10,000 times the survey speed of any present radio telescope.

Around half of the array will be located at an extremely radio-quiet core site, with the remaining antennas arranged in clusters which become more sparsely located as they move further from the core site. The SKA will effectively simulate a telescope with a diameter equivalent to the widest separation of antennas, which could be up to 5,000 km in a possible Australasian configuration.



Australia Telescope Compact Array, CSIRO



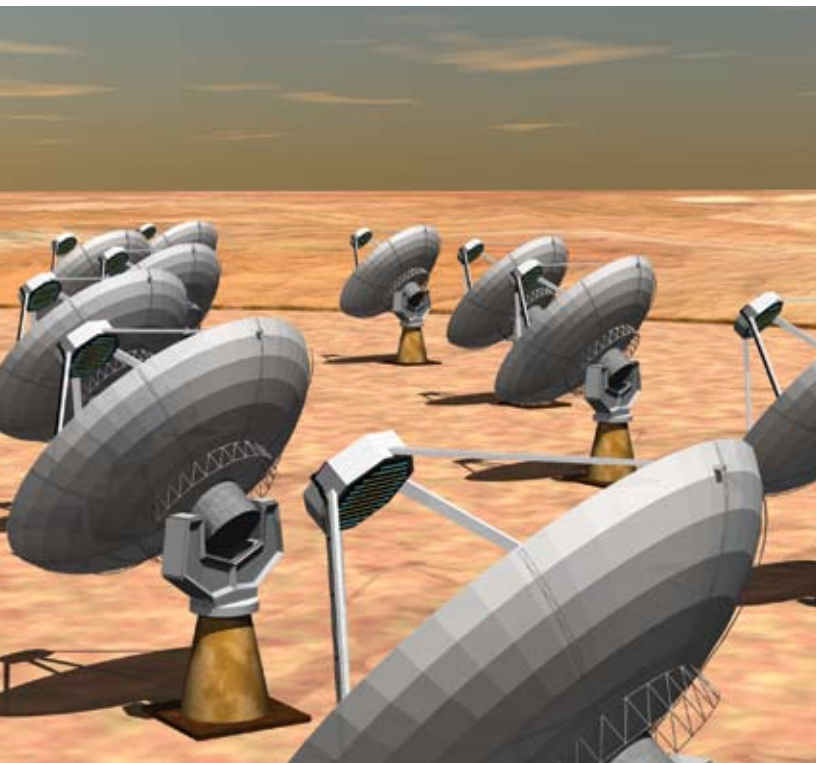
Australian Government



CSIRO



“ASKAP will gather more information in its first six hours of operation than has been saved by the world’s radio telescopes in the last 50 years.”



An artist's visualisation of the ASKAP telescope. Credit: Chris Fluke, Swinburne University of Technology

The International SKA program

International collaboration to build a very large radio telescope began around 1994 when the International Astronomical Union established a working group for this purpose. The SKA program is now a major collaboration between institutions in 19 countries. The collaboration is led by the SKA Science and Engineering Committee and a jointly-funded SKA Program Development Office.

Many of the SKA program institutions and agencies are also participating in a study, primarily funded by the European Union Framework Programme 7, to design both the technologies and systems required by the SKA as well as governance and funding options to prepare its construction and operation.

The 19 countries with institutions currently engaged in the SKA program are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, the Netherlands, New Zealand, Poland, Portugal, Russia, South Africa, Spain, Sweden, the United Kingdom and the United States.

An annual International SKA Forum is held to bring together scientists, engineers, public officials, business people and people from the sphere of science education and awareness to promote widespread understanding of the state of the SKA program and the opportunities it provides.



The Australian SKA Pathfinder telescope

A number of SKA 'pathfinder' projects around the world are important in the effort to develop technology and engineering solutions to fulfil the ambitions of the SKA. At the leading edge of this effort is the Australian SKA Pathfinder (ASKAP) telescope currently being built by CSIRO with funding from the Australian Government. The enabling technologies for the project are being developed in partnership with institutions in Canada, the Netherlands and South Africa.

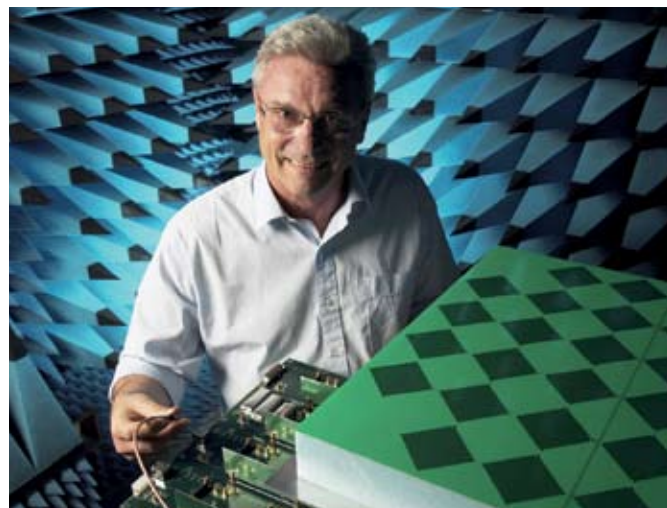
ASKAP will comprise up to 45 parabolic dishes. Most of the instrument will be located at the Murchison Radio-astronomy Observatory (MRO) in Western Australia, with a remote station some 3,000 km away in New South Wales, linked via fibre optic cable, which will provide for very-long-baseline observing.

A number of potential SKA technologies will be developed and tested on ASKAP, including phased array receivers and feeds and a 'green' power solution for remote site operations. Importantly, ASKAP is being designed and built to be consistent with the SKA Phase 1 reference design as it evolves, ensuring that progress is being made along the critical SKA technology path.

ASKAP will be a significantly more powerful survey instrument than anything built to date. It will be capable of ground-breaking scientific programs in applications such as pulsar astronomy, the study of transient radio sources, cosmology, and the structure and magnetic field of our Galaxy. It is estimated that ASKAP will gather more information in its first six hours of operation than has been saved by the world's radio telescopes in the last 50 years.

ASKAP is to be operated as part of the CSIRO's national facilities network and will therefore be available to the international community on a merit basis.

A test antenna for ASKAP is being built at the CSIRO's observatory at Parkes, New South Wales. Construction of ASKAP itself will start in 2009, with the first science results expected in 2010 and full operation beginning in 2013.



CSIRO Digital Systems Engineer, Dr John O'Sullivan, with a revolutionary detector-receiver being developed for the ASKAP telescope. Photo: Chris Walsh

Australia and the Square Kilometre Array



Murchison Radio-astronomy Observatory site in the Mid West Region of Western Australia

“The region where the MRO is located is characterised by an exceptionally high degree of radio-quietness, low population density and favourable observing conditions.”

The Australian SKA site

In September 2006 the International SKA Steering Committee announced a shortlist of potential sites for the SKA: Australia and Southern Africa.

The Australian site proposal is for a core site to be established in the remote Murchison Shire in the Mid-West Region of Western Australia, 315km north east of Geraldton. That site is now being developed by the Western Australian Government and the Australian Government, in collaboration with the local community, as a unique radio-quiet observatory to be known as the Murchison Radio-astronomy Observatory (MRO).

The region where the MRO is located is characterised by an exceptionally high degree of radio-quietness, low population density and favourable observing conditions. The pristine condition of the site is being preserved by the exclusion of mining activities and the creation of a 260km radius Mid-West Radio Quiet Zone to limit incompatible radio frequency emissions.

In addition to the MRO site, Australia offers a number of suitable radio-quiet locations for the placement of SKA remote stations. It also offers quality existing infrastructure and a high degree of economic and political stability. Australia generally, and Western Australia particularly, has a long history of successfully undertaking large-scale infrastructure projects, especially in the minerals sector where vast distances and remote locations are common.

Scientific work at the MRO recently began with the establishment of the Early Research Area operated by CSIRO, with infrastructure and equipment to support ongoing site testing and early SKA related experiments. The site is already hosting the Murchison Wide-Field Array experiment (led by the MIT Haystack Observatory), the PAPER experiment (led by the University of California, Berkeley) and the Cosmological Reionization Experiment, or CoRE (led by CSIRO, ATNF).



Pouring concrete for the foundation of the 12m ASKAP test antenna at the Parkes Observatory. Photo Barry Turner



Murchison Radio-astronomy Observatory site in the Mid West Region of Western Australia

Transformational science with the SKA

The SKA will give the international science community the capacity to study a broad range of fundamental questions in physics and cosmology. The SKA Project Development Office has identified six areas of science where key questions remain unanswered that the SKA will help to address. Of course with an instrument like the SKA, it may turn out that the so far unimagined discoveries are the most important.

SKA Key Science Areas

- Evolution of galaxies, cosmology, dark matter and energy
- The Cradle of Life – searching for life and planets
- Extreme tests of general relativity with pulsars and black holes
- Probing the Dark Ages – the first black holes and stars
- The origin and evolution of cosmic magnetism
- Exploration of the unknown

(Source: SPDO booklet – *The SKA – the International Radio Telescope for the 21st Century*, 2007).

SKA technology and engineering

Building the SKA will require the development of a range of new technologies and new approaches to designing and building telescope elements and integrating systems. Collaboration with industrial partners at the forefront of information and communications technology and high-technology manufacturing will be essential.

Although the physical reality of the SKA is imposing, in many ways it will be a 'software telescope' requiring immense data transport and signal processing capacity. The telescope is being designed in a way to take advantage of Moore's Law for digital hardware: that processing power doubles every 18 months. It is anticipated that by 2020, the processing capacity able to handle the SKA will be available.

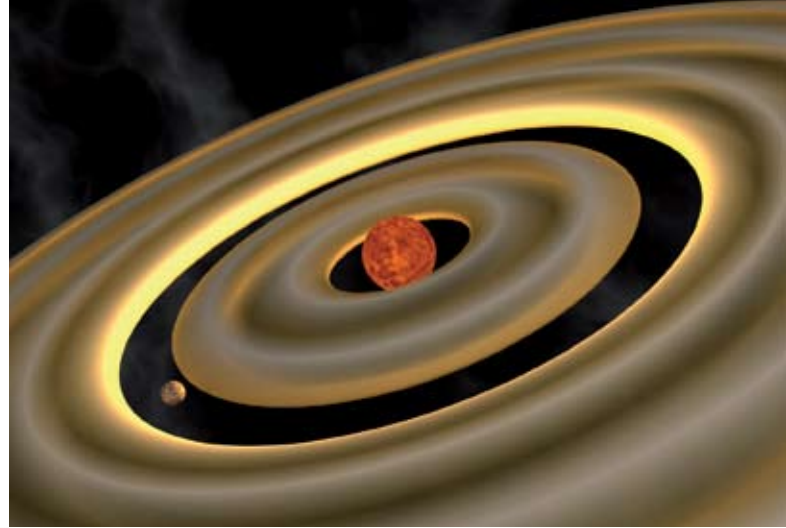
(Source: SPDO booklet – *The SKA – the International Radio Telescope for the 21st Century*, 2007).



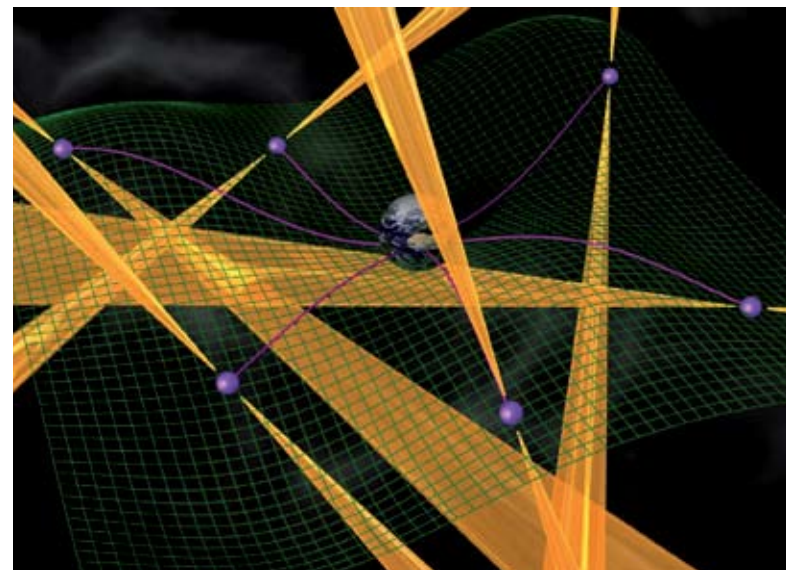
Geraldton, Western Australia.
Photo: WATC



Perth, Western Australia.
Photo: WATC



An artist's impression of a planetary disk forming around a star. Observations with the SKA will contribute to a wide range of goals in the search for life on other planets, from understanding how planets form to searching for more planets. (Credit: M. Kramer/JBO)



Pulsars discovered and monitored with the SKA will allow us to detect and study gravitational waves - ripples in the fabric of space-time. (Credit: D.Champion, M.Kramer/JBO)

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