SOUTH AFRICA'S PROPOSAL TO BRING THE SKA TO AFRICA

Ready to HOST THE SKA

SKA SOUTH AFRICA
SQUARE KILOMETRE ARRAY

AFRICA IS READY TO HOST THE WORLD'S MOST POWERFUL RADIO TELESCOPE, THE SQUARE KILOMETRE ARRAY (SKA). FOLLOWING AN INITIAL IDENTIFICATION OF SITES SUITABLE FOR THE SKA BY THE INTERNATIONAL SKA STEERING COMMITTEE IN 2006, AFRICA AND AUSTRALIA ARE THE FINALISTS. A CONSORTIUM OF THE MAJOR INTERNATIONAL SCIENCE FUNDING AGENCIES, IN CONSULTATION WITH THE SKA SCIENCE AND ENGINEERING COMMITTEE (SSEC), WILL ANNOUNCE THE SELECTED SITE FOR THE SKA IN 2012.

At about 50 – 100 times more sensitive than any other radio telescope on Earth, the SKA will be able to probe the edges of our Universe. It will help us to answer fundamental questions in astronomy, physics and cosmology, including the nature of dark energy and dark matter. It will be a powerful time machine that scientists will use to go back in time to explore the origins of the first galaxies, stars and planets. If there is life somewhere else in the Universe, the SKA will help us find it.

The construction of the SKA is expected to cost about 1.5 billion Euro. The operations and maintenance of a large telescope normally cost about 10% of the capital costs per year. That means the international SKA consortium would be spending approximately 100 to 150 million Euro per year on the telescope. It is expected that a significant portion of the capital, operations and maintenance costs would be spent in the host country. Africa offers a competitive and affordable solution for constructing, operating and maintaining the SKA.

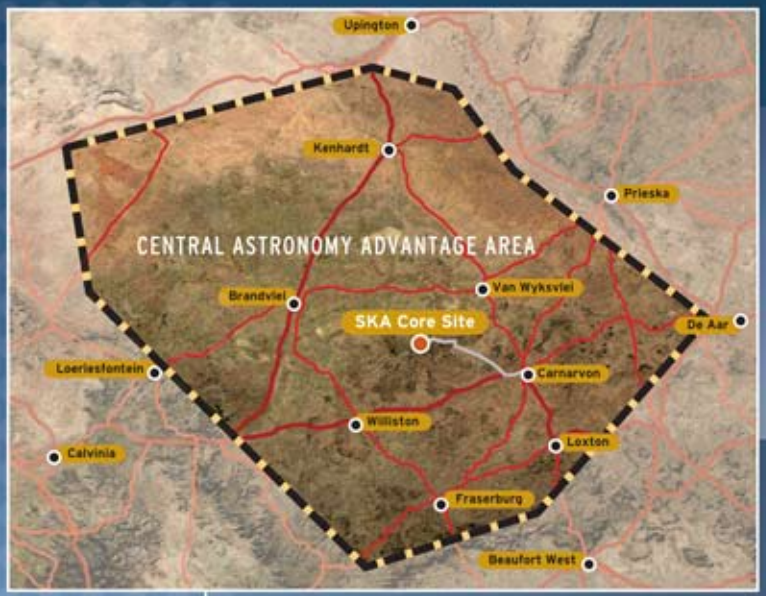
THE SKA IN AFRICA

A major component of the SKA telescope will be an extensive array of approximately 3 000 antennas. Half of these will be concentrated in a 5 km diameter central region, and the rest will be distributed out to 3 000 km from this central concentration. Africa's bid proposes that the core of the telescope be located in an arid area of the Northern Cape Province of the Republic of South Africa, with about three antenna stations in Namibia, four in Botswana and one each in Mozambique, Mauritius, Madagascar, Kenya, Ghana and Zambia. Each antenna station will consist of about 30 individual antennas.

These antennas will all be connected via a data communications network to a very large and powerful data processing facility on the core SKA site in the Northern Cape Province. The combined collecting area of all these antennas will add up to one square kilometre. The telescope will be operated and monitored remotely from Cape Town, where the operations and science centre will be located.

The SKA will be one of the largest scientific research facilities in the world and will consolidate Africa as a major hub for astronomy in the world. It will attract the best scientists and engineers to work in Africa and will provide unrivalled opportunities for scientists and engineers from African countries to engage with trans-formational science and cutting edge instrumentation and to collaborate in joint projects with the most renowned universities and research institutions in the world.

Hosting the SKA would be a major accomplishment for the Astronomy Geographic Advantage Programme (AGAP), an initiative by the South African government to establish a hub of world-class astronomy facilities in Southern Africa. Other major astronomy facilities in the region include the Southern African Large Telescope (SALT) in the Karoo, and the HESS gamma ray telescope in Namibia.



WHY THE NORTHERN CAPE?

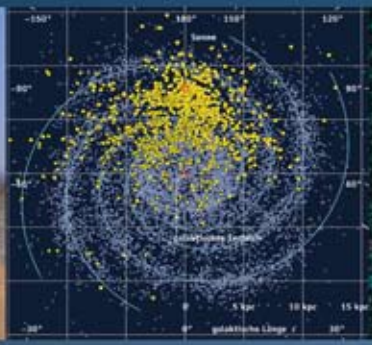
The Karoo region of the Northern Cape Province is ideal for radio astronomy, because it is remote and sparsely populated, with a very dry climate. There is minimal radio frequency interference from man-made sources such as cellular phones and broadcast transmitters, and the lack of commercial activity in the area will ensure that this radio quietness will continue into the future.

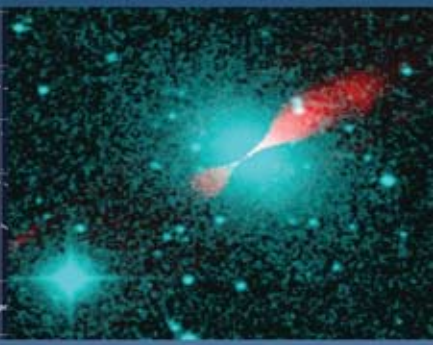
South Africa's Parliament passed the Astronomy Geographic Advantage Act of 2007, which declares the Northern Cape Province as an astronomy advantage area. An area of 12.5 million hectares around the proposed core of the SKA will be protected as a radio astronomy reserve, with strict regulations controlling the generation and transmission of interfering radio signals in the reserve and the area around it.

MEERKAT – A WORLD CLASS TELESCOPE

South Africa is building the Karoo Array Telescope (MeerKAT) which is a precursor instrument for the SKA, but will in its own right be amongst the largest and most powerful telescopes in the world. MeerKAT is being constructed adjacent to the site proposed for the SKA near the small town of Carnarvon in the Northern Cape Province. MeerKAT will develop technologies appropriate to the SKA, including the use of composite, one-piece reflectors, single-pixel wideband receivers, low-cost, high-reliability cryogenic systems, and reconfigurable digital processing systems.

Following the successful building and testing of a prototype dish at the Hartebeesthoek Radio Astronomy Observatory near Johannesburg, the MeerKAT team is now working on KAT-7, a seven-dish prototype interferometer array in the Karoo. The construction and commissioning of the full MeerKAT array (consisting of 80 dishes) will follow at the same site. A high speed data network will link the telescope site in the Karoo to the control centre in Cape Town. The telescope will be commissioned in 2013.





MeerKAT final system properties	
Number of dishes[a]	80 (central array) + 7 (spur)
Dish diameter	12 m
Aperture efficiency	0.7
System temperature	30 K
Low frequency range[a]	0.58 – 2.5 GHz
High frequency range[a]	8 – 14.5 GHz
Field of view	1 deg^2 at 1.4 GHz 6 deg^2 at 580 MHz 0.5 deg^2 at 2 GHz
A_e/T_{sys}	200 m^2/K
Continuum imaging dynamic range[b]	1:10^5
Spectral dynamic range[b]	1:10^5
Instrumental linear polarisation purity	–25 dB across field
Minimum and maximum bandwidth per polarization[a]	8 MHz – 4 GHz
Number of channels	16384
Minimum sample time	0.1 ms
Minimum baseline	20 m
Maximum baseline	8 km (without spur) 60 km (with spur)

a: Final values. See Table 2 for roll-out schedule
b: Dynamic range defined as rms/maximum

MEERKAT SPECIFICATIONS

MeerKAT will provide an array in the southern hemisphere that complements the eVLA from L-band to X-band. The array will be optimized for deep and high fidelity imaging of extended low-brightness emissions, the detection of nano-jansky radio sources, the measurement of polarization, and the monitoring of radio transient sources. The MeerKAT reference design is an array of 80 12-metre dishes fitted with wideband single-pixel cryogenic receivers.

MEERKAT SCIENCE

MeerKAT will be the most sensitive centimetre-wavelength radio telescope in the southern hemisphere, and will make significant contributions to both galactic and extragalactic astronomical research. MeerKAT will explore phenomena such as cosmic magnetism, the evolution of individual galaxies and clusters of galaxies, the influence of dark matter on galaxies and clusters, and the nature of transient radio sources. The scientific programme will be a mixture of blind and directed surveys conducted by large project teams, and smaller experiments designed by individual principal investigators or small teams.

These teams and principal investigators will be international in their composition, and will include participants from Africa. The scientific productivity of MeerKAT will be enhanced by combining its results with those obtained by instruments operating at other wavelengths, for instance infrared and X-ray satellite data.

The longer baselines of the MeerKAT will allow it to make full use of its superior sensitivity, providing detailed images of objects discovered by other instruments at different wavelengths, or indeed of objects discovered by the MeerKAT itself. The longer baselines will also allow accurate astrometry of objects discovered by the MeerKAT, which will aid the cross-identification of these objects in surveys at other wavelengths, for instance surveys conducted by infrared and X-ray satellites.

MeerKAT Phasing Schedule	KAT-7 2010	Phase 1 2013	Phase 2 2014	Phase 3 2015	Phase 4 2016
Number of dishes	7	80	80	87	87
Low frequency range (GHz)	1.2 – 1.95	0.9 – 1.75	0.9 – 1.75	0.9 – 1.75	0.58 – 2.5
High frequency range (GHz)	–	–	8 – 14.5	8 – 14.5	8 – 14.5
Maximum processed bandwidth (GHz)	0.256	0.850	2	2	4
Minimum baseline (m)	20	20	20	20	20
Maximum baseline (km)	0.2	8	8	60	60

SITE PREPARATION

The SKA South Africa Project has purchased 14 000 hectares around Losberg farm for the SKA and MeerKAT. The access roads, workshops and accommodation at the MeerKAT site are ready and the power lines and optic fibre will follow in 2010. Inside the huge dish assembly shed the 12 m dish mould has been prepared. An adjacent building will house six RFI-shielded containers. A hybrid power transmission line to the site and the underground optical fibre cables will connect this facility to a control centre in Cape Town. Following the renovation of an existing building, the SKA South Africa Support Base at Klerefontein, about 80 km from the site, now has offices, workstations, a mechanical laboratory, a boardroom and an entertainment area.

The preparation of the astronomy site at Losberg, the support base at Klerefontein and the infrastructure has created extensive business and job opportunities in the area for local people, and there is huge enthusiasm for the project in these communities.

SKA COLLABORATION

The MeerKAT scientists and engineers are fully embedded in the international SKA project, participating in technical committees and working groups set up by the SKA Project Development Office (SPDO) and supported by the PrepSKA (European FP7) and TDP (USA/NSF) programmes. Bilateral agreements have been established with key institutions involved with the SKA to improve collaboration efficiency, including the Universities of Oxford, Cambridge and Manchester, the University of California at Berkeley and Caltech, as well as with the National Radio Astronomy Observatory (NRAO) of the USA. In South Africa, the Hartebeesthoek Radio Astronomy Observatory and the South African Astronomical Observatory participate in the MeerKAT Project, while researchers and students at many universities in Africa also actively participate. The SKA Project's head office is in Rosebank, Johannesburg, while the MeerKAT engineering office is in Pinelands, Cape Town. The Department of Science and Technology funds the SKA Project via the National Research Foundation.




PEOPLE SKILLS TO POWER SKA AND MEERKAT

The SKA South Africa Project, including the MeerKAT telescope, is one of the biggest science and engineering projects in South Africa. The SKA therefore represents an unrivalled opportunity for the development of very high level skills and expertise in Africa. This will allow Africa to be a significant contributor to the global knowledge economy.

SKA technologies include, amongst others, the construction of large precision structures using modern composite materials, novel designs for wideband antennas and receivers, high-speed digital signal processing and transport, reconfigurable and parallel computing platforms, and low-cost, high reliability control and monitoring systems for large scientific infrastructures.

In 2005 the South African SKA Project initiated a targeted "Youth into Science and Engineering Programme" to develop highly skilled young scientists and engineers. The young people supported by this programme will serve South Africa, and our African partner countries, in the future in key areas of economic development in addition to their participation in "blue skies" scientific research.

The programme offers comprehensive bursaries to students in engineering, mathematics, physics and astronomy at undergraduate and postgraduate level. Bursary holders benefit from regular workshops and student conferences, where they interact with the world's leading astronomers. To date more than 80 postgraduate students (from South Africa and the rest of the African continent) and about 40 undergraduate students are studying or have studied with SKA bursaries and are on their way to being a part of Africa's exciting future in radio astronomy.

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