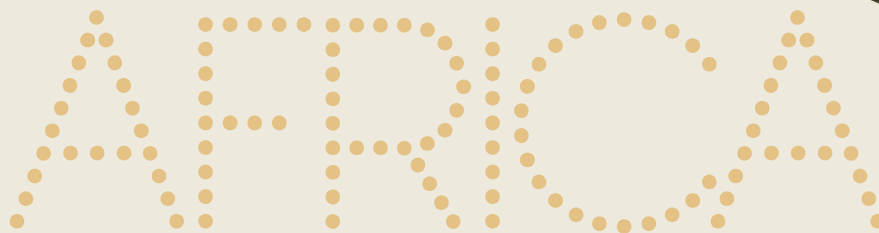


# AN OUTSTANDING AND AFFORDABLE SITE FOR THE SKA



*"We have an outstanding site for the SKA, as well as the people and the expertise to build and operate this mega-instrument"*

— Dr Bernie Fanaroff, Director:  
SKA South Africa



**The location of the candidate core site in the Karoo (which is also the site for the MeerKAT) was chosen because of the following attributes:**

- The radio frequency interference (RFI) environment is intrinsically quiet because of the remoteness of the site and the shielding effect of the flat-topped hills surrounding the area.
- The area is far from centres of economic activity and has a very low and decreasing rural population.
- The climate is benign with no extreme weather conditions (e.g. high winds or extreme diurnal temperature variations).
- The site is at a 1 000 metre elevation with a flat topography.
- The water vapour content in the troposphere is low.
- Despite being remote, the area is well-served with essential infrastructure, including all-weather roads and national grid electrical power, and is easily accessible from major cities.

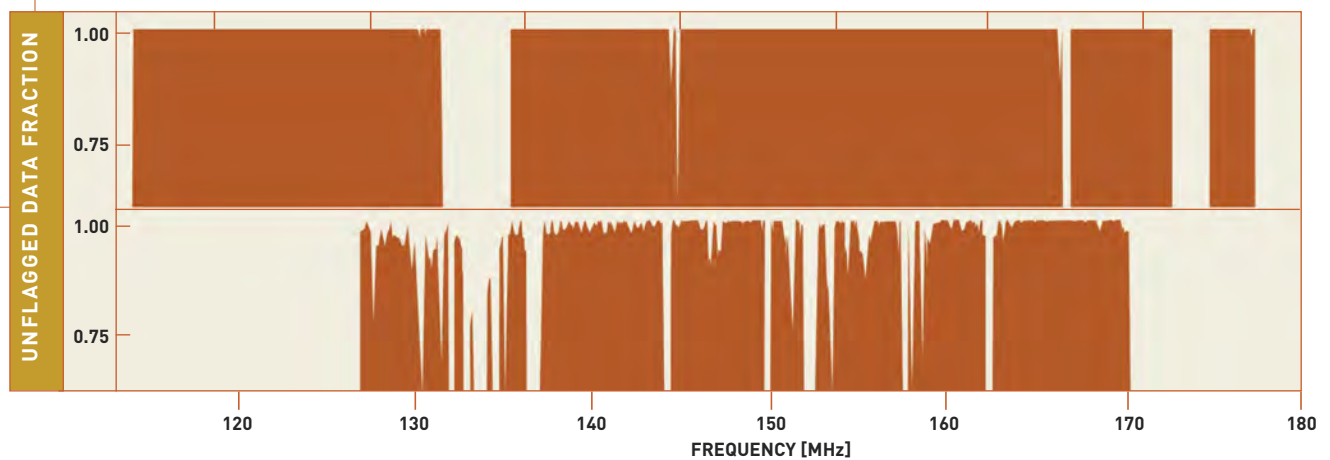
**THE SCIENTIFIC RETURN** from a radio telescope depends both on the capability of the instrument itself and on the physical characteristics of the site on which it is located. The African SKA proposal, with the core site located on a 1 000 m-altitude plateau in the arid and sparsely populated Karoo region, provides a site that has excellent physical characteristics that will ensure that the SKA is able to achieve its full scientific potential, both planned and serendipitous. In addition, the favourable infrastructure and operational costs associated with the site will have a positive effect on the capability of the instrument, given that the SKA budget will have to cover these significant costs in competition with actual telescope capital expenditure.

## SILENCE IS GOLDEN

On-site measurements carried out with the SKA Project Office, and scientific observations made with the KAT-7 and PAPER (Precision Array to Probe the Epoch of Re-ionization) instruments, have confirmed that the South African candidate site is one of the quietest radio frequency environments for radio astronomy on Earth, and residual RFI levels are being driven even lower. This improvement of an already radio-quiet environment is being achieved by the use of wide-ranging legislation and coordination with the regulatory authorities and commercial operators.

**RFI measurements, carried out in collaboration with the SKA Project Office, confirm that South Africa's proposed site is ideal for the SKA.**

A comparison of the RFI environment at the Karoo site in South Africa (top) relative to the Greenbank Observatory that is located in a radio-quiet reserve in the USA (bottom). These plots were derived from observations of PAPER – operating between 100 MHz and 200 MHz at both sites. Most of the RFI detected at the Karoo site originates from satellites visible from all countries. The outstanding RFI environment in the Karoo is immediately evident in this comparison.



## SITE INTEGRITY IS GUARANTEED

The Karoo Radio Astronomy Reserve is protected by South Africa's Astronomy Geographic Advantage (AGA) Act, Act No 21 of 2007. This is a world-leading piece of South African legislation designed to preserve the scientific integrity of the reserve. The Act ensures the preservation and protection of areas within the Republic of South Africa that are uniquely suited to ground-based astronomy. The Act also provides for inter-governmental co-operation and public consultation on matters concerning nationally significant astronomy advantage areas. The Act specifies limits on radio signal levels in an "Astronomy Advantage Area" that are generally lower across the entire SKA radio spectrum than the International Telecommunications Union Recommendation ITU-R RA.769-2.

This is significantly more stringent than similar legislation in all other countries. The Act provides the Minister of Science and Technology with powers to ensure that these low RFI levels are achieved and maintained.



The KAT-7 prototype array is validating the excellent characteristics of South Africa's Karoo site.



A large part of South Africa's Northern Cape Province is legally protected as a radio astronomy reserve.

An Independent Regulations Advisory Committee, comprised of operators and regulators, provides a forum for support from stakeholders. The comprehensive Act also controls all activities in the area, such as mining, that could compromise astronomy facilities and observations.

## ONGOING IMPROVEMENTS IN THE RFI ENVIRONMENT

Digital migration of terrestrial television broadcasting in South Africa will lead to a substantial increase in the available spectrum for radio astronomy observations in the VHF and UHF broadcasting bands. Existing analogue services broadcasting from high-power transmitters that cover wide areas will be closed down, and replaced with digital systems that protect the integrity of the radio astronomy reserve. Transmitters outside of the reserve will have directional antennas facing away from the reserve, and towns on the periphery of the reserve will be serviced by lower-power transmitters sharing just two 8 MHz bands. Remote, low-density communities will make use of Ku-band satellite downlinks that have no detrimental effect on the RFI environment.

The South African mobile networks Vodacom and MTN have also done their part to minimise radio frequency interference. Cell phone towers surrounding the reserve area will be equipped with phased array antennas that null out signals towards the MeerKAT and SKA sites, further improving the already excellent radio quiet environment.

*"A radio-quiet environment does not necessarily imply a very remote location that is expensive to provide infrastructure to, and difficult to access and operate. The Karoo site was chosen because it has excellent RFI and other key physical characteristics despite being conveniently close to existing infrastructure and urban areas."*

— Prof Justin Jonas, Associate Director: Science & Engineering, SKA South Africa

## MAXIMIZING RETURN ON INVESTMENT

*"A significant fraction of the cost of ownership of the SKA will be the capital expenditure associated with the establishment of the telescope infrastructure, and the operational expenditure of the entire facility. Locating the SKA central hub in the Karoo astronomy reserve provides a cost-effective solution in an outstanding environment, maximizing science return on financial investment."*

— Dr Adrian Tiplady, SKA Site Characterisation Manager, SKA South Africa

South Africa has world-class construction, engineering, technology, and maintenance industries, with an international track record. A study of major construction projects around the world has shown that those undertaken in South Africa are extremely competitive in terms of cost, delivery schedule, fiscal discipline and build quality. An SKA built in South Africa would benefit from these advantages.

The infrastructure already in place to service the Karoo site has been scoped to support MeerKAT, but has been designed to allow it to be scaled up to provide for SKA Phase-1 requirements. The bulk infrastructure already has the capacity to support SKA Phase-1, and it is only on-site equipment and reticulation that will need expansion at marginal additional cost. A comprehensive and highly competitive plan to provide for SKA Phase-2 infrastructure requirements has been developed.



The Karoo site is already fully operational with an on-site facilities complex (above) and PAPER experiment (above right).

A dominant component of the SKA operational expenditure will be the provision of continuous and reliable power. Through a strategic partnership with South Africa's electricity utility, Eskom, the SKA South Africa Project has developed a cost-effective power solution based on the national grid. Eskom is committed to ensuring that a substantial fraction of the grid generating capacity will be provided by renewable energy sources, primarily solar power plants in the Northern Cape.

In summary, the SKA in South Africa will be a cost-effective instrument that maximizes scientific "bang per buck".

## AN ESTABLISHED AND OPERATING FACILITY

The Karoo site is already an operating observatory, supporting three new-generation radio telescopes: KAT-7, C-BASS and PAPER. PAPER is already producing publication-ready data, despite the short time since the initial deployment. The RFI-quiet environment and favourable physical characteristics of the site have attracted C-BASS and PAPER to the Karoo in preference to other competing sites. The SKA South Africa project office has pledged financial and in-kind support for these experiments, with the full backing of the Department of Science and Technology. The rapid deployment of these instruments was facilitated by a number of factors, including:

- Ready access to electrical power and data connectivity.
- The convenience of short travel times and supply lines from Cape Town and other centres.
- On-site facilities, such as cranes, workshops and comfortable accommodation.
- Technical support, ranging from on-site technicians to high-level engineers with appropriate skills and experience.

The successful deployment, commissioning and operation of these radio telescopes attest to the outstanding opportunities provided by the physical site, installed infrastructure, excellent technical support, and South Africa's commitment to establishing an exceptional destination for radio telescopes.

***The Karoo radio astronomy reserve is an ideal location for the SKA.***



The South African SKA Project worked closely with the country's electricity supply utility – Eskom – to provide a cost-effective power solution for the SKA.

### *South Africa – a record of delivering major projects successfully.*



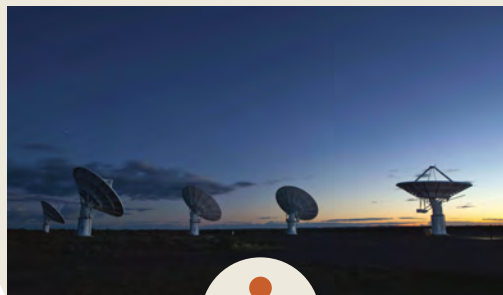
Southern African Large Telescope



FIFA World Cup Stadium

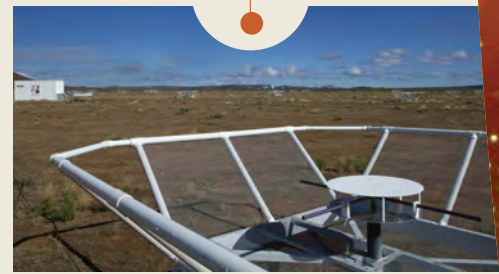


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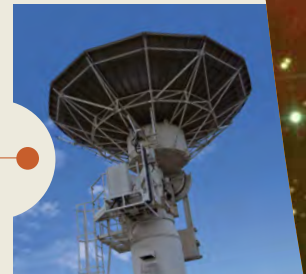


South Africa's KAT-7 will be commissioned by end 2011, but has already delivered test images of Centaurus A, a galaxy 14 million light years away.

The very successful operation of the PAPER low frequency array has verified that the Karoo site has very low levels of RFI in the important frequency band corresponding to the expected redshift of the epoch of reionization signal, and that the ionosphere is stable and does not distort low-frequency radio waves. The rapid deployment of the array resulted from the availability of local expertise and assistance.



The C-BASS telescope capitalizes on the convenience of operation on the site, the ready access to infrastructure and skilled personnel, and the dry atmosphere and troposphere above the 1 000-m plateau. South African scientists have played an important role in developing the instrumentation for this precision experiment.



[www.ska.ac.za](http://www.ska.ac.za)