White Paper on Big Radioastronomical Projects: The Brazilian participation in the Development of the Square Kilometer Array

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The Square Kilometer Array (SKA) intends to be the radio telescope of the 21st Century, a project that will achieve new levels of quality and sensitivity, developing new techniques that will revolutionize the radio sciences. SKA will have a synthesized aperture of about 1 square kilometer, 30 times bigger than the greatest current telescope. Because of this unique feature SKA will achieve unprecedented sensitivities up to 100 times better than any existing radio facility in a frequency range from 70 MHz to 10 GHz. Advanced phases of SKA consider the extension to higher frequencies, up to 30 GHz first, to 150 GHz on the long range.

The key science projects are the following (extracted from `www.skatelescope.org`):

1. The evolution of galaxies and cosmic large scale structures.
2. Probing the Dark Ages - the first black holes and stars.
3. Strong field tests of gravity using pulsars and black holes.
4. The origin and evolution of Cosmic Magnetism.

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5. The search for cradles of life.

To provide a million square meters of aperture at an acceptable cost the Square Kilometer Array must make a revolutionary break with current radio telescopes. Institutions participating in the SKA are now designing and building prototype systems, and the key technologies will be determined from these. Many different technological solutions will be selected and integrated into the final instrument. Both planar phased arrays and reflectors are being considered for the antennas. The technology must allow for multibeaming capabilities.

The SKA's collecting area of order one million square meters will be distributed over a number of stations perhaps as many as a few hundred. Each station will have a diameter of 100-200 m. The central station will have a size of around 5 km, housing thousand of antennas. The most distant stations will be located as far as 3,000 km from the central one (Figure 1). The total estimated cost of the array is 1.5 billion Euros, with an annual budget of $>$ 100 million Euros. The array should be concluded in 2021.

At present there are only two site candidates: Australia and South Africa. There are substantial differences between the proposed sites. Australia may hold the whole array, while South Africa can only install the core station, and should spread the rest in 7 other countries to achieve the 3,000 km base lines. The final decision will be known in 2012.

The Brazilian Participation

Brazil was proposed as a site candidate to the SKA Steering Committee on 2004. A national committee led by Jacques Lepine (IAG, USP) was in charge to write the proposal which had the official support of the National Science Minister and of many scientific societies. The SKA steering committee refused the Brazilian candidature but suggested that it could join Argentina, and a joint proposal was presented on 2006. Unfortunately after the SKA steering committee rejected also this proposal there was no continuity in the efforts to maintain connections to the SKA program, although it is clear that: *1)* SKA is the most ambitious radioastronomical project and intends to signalize the future of the Radio Astronomy, *2)* it is a key project for astronomical and physical areas where the local community has an active

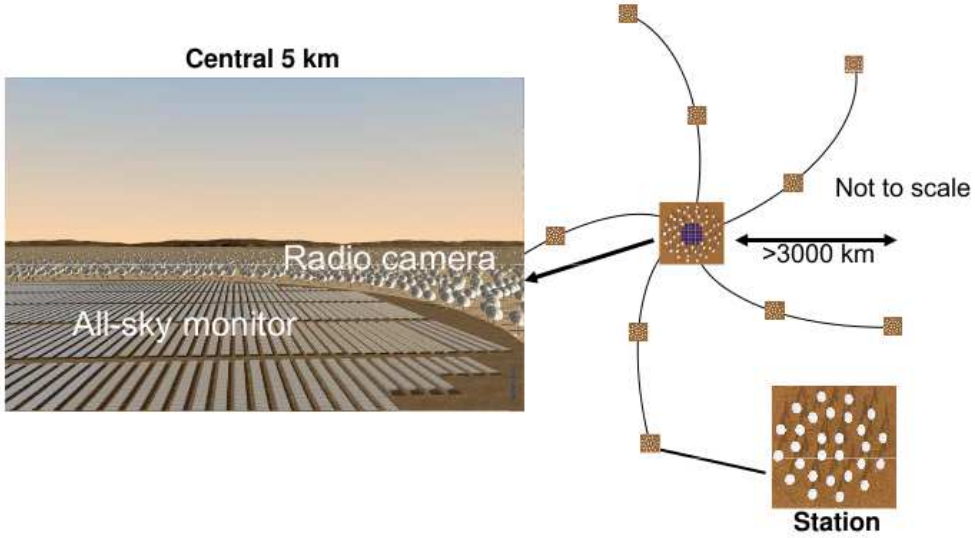

Figure 1: Schematic view. SKA will be built out of the center. In Phase 1, baselines will have $\sim$ 50 km, at the end, $\sim$ 3,000 km.(From a presentation of R. Schillizzi, SKA Development Office, Dec 2008)

international participation and *3)* several new SKA technical approaches are being permanently implemented, signalizing to the establishment of state-of-the art radio astronomy facilities, at different sites and locations, not necessarily at a single country. For these three reasons it should be very important that Brazil remains taking active part in the SKA project. On the other hand it is known that the SKA program is highly interested in the Brazilian participation, as it was demonstrated during the visit that the Secretary of the Steering Committee, Dr. Schillizzi, made to Brazil on occasion of the annual SAB meeting of 2006 as well as during discussions held during the Chicago URSI General Assembly, in 2008.

In order to maintain Brazil in active connection with the SKA initiatives we suggest:

1. Establishing a permanent National SKA Committee (or Consortium)

2. Signing *The Memorandum of Agreement to establish the Square Kilometer Array Development Office* (**MoA**) and become a *party*. Presently, Australia, Canada, China, Europe, India, New Zealand, South Africa,

and the United States of America are participants of the Memorandum. The annual cost to be a party is different for distinct countries, but as a reference, in 2008 India paid 30,000 Euros; Australia, Canada and South Africa 45,000 Euros, Europe and USA 225,000 Euros (Annex 2 of the MoA)

3. Resuming the site tests conducted at the time of the Brazilian candidature, to find a good place to hold a SKA station. With the possibility that South Africa be the selected site, one (or more) station(s) might be placed in Brazil. This possibility was raised by the Director of the Technology and Space Science Department of South Africa, Dr. Valantham Munsami in ocassion of the Workshop on Space Science and Astronomy (Pretoria, Dec 2009). The cost of site tests should not be very expensive and projecting and building a prototype array can be done at a reasonable cost. The high and dry plateau in central Brazil might become a particularly adequate site for high frequency SKA accomplishments.

The involvement in this pioneer international project may boost the Radio Astronomy in Brazil, acquiring new expertise, developing new technologies, training engineers, opening new scientific collaborations and, in general, creating a demand of highly capacitated personnel in both the technological and the scientific areas. This is an opportunity that cannot be lost.

References

The Memorandum of Agreement to establish the Square Kilometer Array Development Office (**MoA**),
`http://www.skatelescope.org/PDF/ISSC/SKA-Agreement-2004-FINAL.pdf`,
accessed on 4 Jan 2010.