NEWSLETTER

Volume 09

January 2006

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FROM THE INTERNATIONAL SKA PROJECT OFFICE

Much has happened in the international SKA project in the last 6 months. A very successful SKA2005 + ISSC meeting was held in Pune from 31 October to 5 November, hosted by the National Centre for Radio Astrophysics. More than 100 people attended from around the world and heard presentations on SKA science including a keynote address by Prof Joe Silk, engineering progress, and the project status, followed by intensive discussions at Working Group and Task Force level. A highlight of the meeting was a visit to the GMRT. You can read reports on the results of the WG and TF meetings in this Newsletter. Such was the success of the SKA2005 meeting that we will call the WGs together again in 2006 and increase the time allotted to inter-WG discussions. Thanks to our hosts, in particular Pramesh Rao and Reena Shrikumar, for their faultless organization of this large international gathering.

At its Pune meeting, the ISSC decided to define a Reference Design for the SKA telescope, and asked the ISPO to organize a Tiger Team to work out the details and write a report prior to formal adoption of the design by the ISSC. The purpose of defining a Reference Design is to focus engineering and science efforts around the world, provide a basis for detailed costing of the SKA, and a visualization of the telescope for discussion with colleagues and policy-makers, and for outreach purposes.

The Reference Design approved by the ISSC in mid-January 2006 is described in SKA Memo 69. Here is the summary from that Memo:

"The Reference Design for the SKA is a radio interferometer array capable of imaging the radio sky at frequencies from 100 MHz to 25 GHz, and providing an all-sky monitoring capability at frequencies below 1 GHz. Half of the total collecting area is concentrated in a core of 5 km diameter, with the remainder in array stations at distances up to at least 3000 km. These requirements will be implemented with three receptor components:

- a Small Dish array with "smart feeds". The dish diameter is of the order of 10m, and the feeds comprise phased arrays in the focal planes of the dishes for frequencies between 0.3 and 3 GHz, and wide-band feeds at higher frequencies up to 25 GHz. This "radio camera" is the basis of the Reference Design;
- Aperture Array tiles in the core of the array. This innovative technology provides a "radio fish-eye lens" for all-sky monitoring in the frequency range 0.3 to 1 GHz, and multiple independent field observations; and
- an Epoch of Reionisation array in the ÿ.1 to 0.3 GHz range, also in the core of the array. This array will make use of broad-band dipoles similar to those developed for LOFAR, MWA, and LWA, and will be constructed as part of the second phase of the SKA.

These three receptor components all make use of the same data transport, processing, and software infrastructure."

A major milestone for the project was passed at the end of 2005 with the submission of the four expected proposals for siting the SKA, from Argentina+Brazil, Australia+NZ, China, and South Africa+ 6 other countries. The documents have been distributed to the Committees and Working Groups that have been assigned responsibility for assessing the proposals. The RFI monitoring campaign at the candidate sites, carried out by Rob Millenaar, Bou Schipper, and Harm-Jan Stiepel from ASTRON, was completed successfully in early January, and reports on the RFI environment at the sites are now in preparation and will be circulated to the reviewers when completed.

Other reports in this Newsletter detail the considerable progress made in the SKA pathfinder projects, including SKADS, the SKA Design Study in Europe, which got underway late in the year. Coordinating all these engineering efforts and preparing for the international review in late 2007 is the major task for the ISPO in the coming two years. As outlined by Peter Hall in his report, the first steps are being taken with the generation of White Papers on the various SKA system elements.

Richard Schilizzi
Director

ENGINEERING

Since the last Newsletter report in July 2004 the Engineering Working Group has gained two new members, taking the total membership to 19. Andrew Faulkner, Project Engineer for SKADS joins us as EWG Vice-Chair, while Anita Loots, the Project Manager for the Karoo Array Telescope, provides an important channel to another of the major SKA demonstrators. In other news, Ralph Spencer, from Jodrell Bank Observatory, has taken over from Ron Beresford as Chair of the EWG's Signal Transmission Task Force; thanks to both Ralph and Ron for their continuing contributions. A full list of EWG and task force members is available via the SKA web site.

Most of the EWG's recent activity has involved reviewing 2005 SKA demonstrator updates and continuing work on SKA system white papers. The demonstrator review, together with submitted documents, is now available as SKA Memo 67. Among many other matters, the review notes significant progress in the past year, the need to accelerate the pace of critical technology (especially phased array) demonstrators, and the challenge of finding key personnel for SKA Phase 1 in the face of slippages in national and regional demonstrators. Notwithstanding these issues, the flow of significant funds to key large-scale SKA pathfinders over the next few years guarantees an exciting and productive period.

One consequence of the increasing workload in the demonstrator projects is that time allocations for international activities are being squeezed. Nevertheless, six out of eight EWG task forces now have draft white papers available. This work was discussed extensively at SKA 2005 in Pune and it is expected that final versions of EWG white papers will be available by March 31, 2006. Work beyond that time involves intensive cost and performance modeling, with white papers and estimation tools being available to authors of SKA technology proposals. It is hoped that international project resources can be found to advance the critical modeling work fast enough to guarantee quality technology proposals by the time of an external engineering review in late 2007. The system design and modeling tasks are also an essential foundation for SKA Phase 1 tasks scheduled to begin in 2008.

In other engineering work, the ISPO has been active in managing, with ASTRON, the international RFI site characterization program. In addition to providing uniform, high quality, data sets for the various sites, the ASTRON program has been instrumental in forging working engineering relationships around the world. Still on the collaboration theme, the ISPO has helped proponents of the Small Dish – Focal Plane Array SKA concept organize their concept white paper; the paper is being edited by Colin Jacka and is available in draft form at http://www.jb.man.ac.uk/ska/SD-FPA/index.html When complete, the SD-FPA proposal will be reviewed by the EWG and SWG. In the spirit of promoting convergence within the SKA community, much ISPO effort has gone into framing the proposal for an SKA Reference Design. Finally, the Experimental Astronomy reprint volume entitled "The SKA: An Engineering Perspective" was published in October. Thanks to all authors and reviewers for their efforts. Owing to higher than expected demand, 300 copies of the book were

published in the first print run; details of volume availability are posted on the SKA website. Individual papers in the book are also available via the publisher's on-line subscription service and the SKA web site again provides links.

Over the past months the ISPO has been active in extending our community's insight into industry collaboration and engagement issues. As well as taking a main role in producing the white paper by the EWG's Industrial Liaison Task Force, the ISPO has been negotiating a "template" collaborative R&D agreement with a major international company. This will be a valuable in the short term as an enabling step for demonstrator projects but it has also proved useful in furthering our understanding of critical issues such as intellectual property and procurement management. In addition to continuing facilitation of pre-competitive collaboration initiatives, the ISPO expects to take a leading role in casting the SKA project into a form suitable for economical delivery by industry – an essential exercise if the telescope is to be feasible on the desired timescales.

In forthcoming 2006 events, the EWG is co-ordinating with other groups in planning an extended working session in the second half of the year. The idea is to give engineers several days over which to interact, with at least another day set aside for joint science – engineering matters. Watch the SKA website for details.

Peter Hall
International Project Engineer
and Chair EWG

OUTREACH COMMITTEE

The activities of the outreach committee in the past six months were diverse, preparing the ground for a busy year 2006 ahead. A road-map was developed that outlines the outreach strategies for the coming years. On the short term, the production of an SKA animation and still images of the SKA reference design is high on the agenda in order to support articles featuring the SKA in science magazines and newspapers. On the long term, the coordination of the outreach work by a professional Outreach Officer must be the goal. Despite good teamwork in the committee and the SKA community (thanks to all for a productive year 2005!), it is clear that successful outreach work is a full-time job that needs professional people.

As a more immediate action, the committee produced a new, slightly revised version of the SKA booklet describing the exciting science and technology related to the SKA project. The first version was produced in the first half of 2005, but high demand for the booklet triggered another print run. We used the opportunity to modify the booklet by taking recent developments (and one missed typo!) into account. The international character of the SKA project was also visible in this activity: after the first copies of the brochure were printed in the UK, over 7000 copies were produced in superb quality in India! Our thanks go to Kingsly Samuel from Olympus and to Astrid Marx from the SKA Project Office for their efficient and professional handling of the production and shipping of the brochure to so many different parts of the world.

The new booklets were printed in time to find their way into the conference

bags of the participants at the SKA 2005 workshop in Pune. That was not the only way the attendees came in contact with SKA outreach: the LOC headed by Pramesh Rao did a superb job in raising the attention of the local and national media, resulting in various newspaper articles and TV appearances of the SKA and its scientists and engineers.

During the conference, an open meeting of the Outreach Committee was attended by many of the conference participants, giving valuable input to and comments on the planned activities. As mentioned earlier, the activity at the moment is focused on visualizing the reference design which has been approved by the ISSC. This SKA reference design will be presented in an animation and still images. The SKA as constructed may differ from the reference design in some respects, depending on the results of the various design studies and the experience with the SKA pathfinders, but the animation will serve as an important tool to reach out to the public and our colleagues by showing them what we actually want to build. Watch the SKA web-site (thanks to Stephanie Voegele as usual!) to see a first glimpse of the animation coming soon!

We aim to convert the SKA reference design into an actual physical model of the SKA that we can present, together with a newly updated display, at future conferences. Indeed, there is not much time, but it is clear that with such important meetings like the IAU General Assembly in Prague, 2006 will be another important year to look forward to.

Michael Kramer
Chair Outreach Committee

SITE EVALUATION

The SEWG met in Pune, India, early November 2005 and discussed the detailed process of the evaluation of the siting proposals. Proposals from Argentina, Australia, China and South Africa were due by the end of the calendar year 2005, and they have all been received at the International SKA Project Office.

The RFI campaign by ASTRON has been completed and all the necessary measurements at the four sites have been obtained. The data is being prepared to be received by the ISPO on or before March 17, 2006. The RFI measurements by the proposers are also due at that time. All the RFI data will be examined by the SEWG Task Force on RFI Assessment, chaired by Prof.Steve Ellingson. This Task Force will report their analysis to the SEWG Chair by May 15, 2006. At the same time the Regulatory Issues Task Force, chaired by Dr. Willem Baan, will analyze the relevant parts of the siting proposals and report to the SEWG Chair by May 15, 2006. In the meantime, the SEWG will advise the ISPO Director on the analysis of the proposals. In addition, the Configuration Simulation Task Force of the SimWG will analyse the proposed siting configurations and report their findings to the ISPO Director.

It is anticipated that all necessary documents will be available to provide to the International Site Selection Advisory Committee by June 1, 2006.

The ISSAC will meet with the proposers early in July and it is hoped

that they will present their evaluations to the ISPO/ISSC by August 1, 2006. The ISSC may be prepared to announce a ranking of the sites by September 1, 2006.

The ISPO/ISSC has prepared detailed protocols to guide the sitting evaluation process.

According to the Request For Proposals for sitting the SKA the evaluation principles are:

--The ability to maximize the science return
--The construction cost
--The operational cost
--Physical and political issues

The criteria to be used to make evaluations include:
1) The quality of Science
   (a) Short and long term RFI and protection issues
   (b) Array configuration and performance
   (c) Ionospheric and tropospheric conditions

2) Infrastructure, Climatic and Costing Issues
   (a) Climatic issues
   (b) Physical site characteristics for stations
   (c) Impact of land-use and urban centers
   (d) Existing infrastructure
   (e) Data interconnects
   (f) Costing – capital and operational

3) National Attributes for Sitting the SKA
   (d) General issues
   (e) Government and departmental interaction
   (f) Support for astronomy and the SKA facility

The ranking of the proposed sites by the ISSC will be communicated to the appropriate Funding Agencies sponsoring the SKA in various countries. It is then hoped to agree on a process to make a final selection within a couple of years.

Yervant Terzian
Chair, SEWG

SIMULATIONS

The recent activities of the SimWG have been dominated by the SKA site proposal process. In particular, a subset of the SimWG, the Configuration Simulations Task Force (CSTF) has been working with the four SKA site proposers via a set of guidelines that aim to give proposers advice on the SKA configuration investigations that need to be made toward any site proposal. These guidelines aim to ensure that different proposers are using the same assumptions about the basic technical parameters of the SKA configuration.

Site proposers are due to submit their proposals by the end of 2005. At that point the CSTF will produce a summary report covering the proposals and submit it to the ISPO, to be passed on to and considered by the various appointed bodies that will start the SKA site ranking process in 2006.

At the recent annual international SKA workshop in Pune, India, the SimWG and the CSTF had a number of discussions about the process by which the CSTF will produce their report, the timescales, and the content. This process in now underway. The Pune meeting was highly useful and timely in this regard. Also in Pune, the SimWG had a joint meeting with the SWG, to discuss areas in which overlap between the two groups would be useful. One area of particular interest is using science simulations with models developed by

members of the SWG, as input to simulations of the SKA instrumental performance. This is starting to become relevant to those groups simulating some SKA demonstrators such as the xNTD, KAT, and EMBRACE.

The joint SimWG/SWG discussion in Pune has strong parallels with the activities just starting to get underway as part of the European SKA Design Study (SKADS). One of the SKADS work packages (DS2) will aim to undertake science and technical simulations relevant to the SKA. In mid-November the SKADS project was kicked-off at a meeting near Brussels, in Belgium. The detailed activities of the DS2 simulations work package will be closely defined in the first two months of 2006 and work will subsequently proceed in earnest.

Steven Tingay
SimWG and CSTF Chair

SCIENCE

At the end of 2005, Steve Rawlings stepped down as chair of the SWG. Bryan Gaensler has now taken up the reins as chair, with Joseph Lazio as vice-chair. The SWG also welcomes several new members for 2006 - see www.skatelescope.org for details.

Members of the SWG spent much of the second half of 2005 planning conferences to promote and develop the SKA Key Science Projects (KSPs). A summary of the progress on this for each KSP is below.

Probing the dark ages

At the end of June 2005, over 120 people attended the meeting "Reionizing the Universe" in Groningen, at which theorists and observers came together to discuss the many exciting developments now taking place in this new field. The synergies between the various prototypes and pathfinders and the challenges of data analysis were extensively discussed.

Strong field tests of gravity

A workshop was held in Sydney in August 2005 to discuss the requirements for pulsar surveys and timing with the SKA. About 20 pulsar experts attended, including many young scientists who were becoming involved in the SKA project for the first time. The detailed requirements which emerged from this meeting demand a large collection of further studies and simulations, which the science team for this KSP is now undertaking. Interaction with the gravitational wave community is crucial - a joint LISA/SKA meeting on "Gravitational Waves, Radio Pulsars and Astrometry: Testing Gravity in the Next Decade" will take place in Birmingham on 30-31 March 2006. A larger KSP conference on pulsars will follow in Thailand in January 2007.

Cosmic magnetism

Over 100 people attended a very stimulating conference organised by the SWG magnetism team, held in Bologna in Aug/Sep 2005. A wide variety of topics were discussed, covering magnetic fields from the inflation era through to fields in nearby galaxies. Some excellent reviews, plus presentations of the latest simulations and laboratory work, made it clear that many of the remaining unanswered questions in cosmology and in fundamental astrophysics are closely tied to the questions of the origin and evolution of magnetic fields, and that the SKA is critical to making further

progress in this area. This was the first time that many of attendees had heard about the SKA, so the goal of promoting the project was certainly a success.

The cradle of life

A special session on the importance of radio astronomy for astrobiology has been organised by SWG members, to be held in March 2006 at the Astrobiology Science Convention in Washington DC. "AbSciCon" is a large interdisciplinary meeting, so this session should greatly increase the dialogue between the astrobiology and radio astronomy communities, and can highlight the capabilities of radio telescopes in studying planet formation, organic biomolecules, pristine relics of our own solar system and SETI.

Galaxy evolution, cosmology and dark energy

A large meeting is being organised for April 2006 in Oxford, covering cosmology, galaxy evolution and astroparticle physics. There will be sessions on science with the SKA, as well as with the 1% pathfinders and the 10% SKA (Phase 1).

In addition to organising these meetings, the SWG are close to completing memos on site considerations for KSP science, on the "discovery space" opened by the SKA, and on the overall matrix of instrumental specifications demanded by the KSPs. Reports are also being prepared on a variety of other specific issues, such as field of view requirements at high angular resolution, the science case for the 200-500 MHz band, and the feasibility of all-sky transient detection.

Looking ahead to 2006, the main task of the SWG will be to develop a detailed science case for exploiting the first 10% of the SKA. The experiments that make up this case will need to be compelling in their own right, but must also act as a strong argument for building the full SKA. The SWG plans to converge on the topics to be included in the 10% SKA science case by April 2006, with the final detailed document completed by the end of the year.

Bryan Gaensler
Chair SWG

Attendees to the Bologna conference on cosmic magnetism

MEETINGS

NEXT SKA MEETINGS

> Gravitational Waves, Radio Pulsars and Astrometry: Testing Gravity in the Next Decade
30-31 March 2006 / LISA/SKA - Birmingham

> ISSC-15 Meeting in Socorro
15 - 17 March 2006 / New Mexico, USA

> Radio Astronomy: New Instruments And Their Importance For Astrobiology - Astrobiology Science Convention 2006
26- 30 March / Washington, USA
http://abscicon2006.arc.nasa.gov/abscicon2006.html

> Cosmology, galaxy formation and astro-particle physics on the pathway to the SKA
10-12 April 2006 / Oxford, UK
http://www-astro.physics.ox.ac.uk/LOSKA/CONFERENCE/

> 3rd RadioNet Engineering Forum Workshop: Next Generation Correlators for Radio Astronomy and Geodesy
27-29 June 2006, in Groningen, The Netherlands
http://www.radionet-eu.org/rnwiki/NextGenerationCorrelator

> XXVIth General Assembly of the International Astronomical Union (IAU)
14 - 25 August 2006 / Prague, Czech Republic
http://www.astronomy2006.com/

> ISSC meeting
28 - 30 August 2006 / Dresden, Germany

NEWS FROM THE CONSORTIA AND INSTITUTES

AUSTRALIA

New Technology Demonstrator (NTD) and xNTD Project Reports (December 2005)

CSIRO's New Technology Demonstrator (NTD) project made highly visible progress in late 2005, with the erection of two 14-m antennas at the ATNF headquarters in Sydney. As described in the Australian SKA Planning Office Newsletter 2 (http://www.atnf.csiro.au/news/aspo-newsletter/ASPOnewsletter2.pdf), the dishes were originally built for the Fleurs radio observatory in Western Sydney, and have been rescued and refurbished for the NTD project by *Sydney Engineering (Sales) Pty Ltd.*

The NTD project is funded by the Australian Government's Major National Research Facilities (MNRF) program.

The NTD project provides initial R&D for a SD-FPA concept using all-digital

beamforming. A CDR for the NTD is due in March 2006. Funding for NTD runs until July 2007, and deliverables from this project are critical components for the extended NTD (xNTD), the project recently initiated with additional funding from CSIRO to develop Australia's SKA Demonstrator. During the last 12 months a 24-input, 24 MHz BW prototype digital beamformer has been produced, along with 24 prototype receivers. These will be used in a 2-element interferometer, being equipped with at least one focal plane array at the ATNF site at Marsfield in Sydney.

The dish of one of the NTD antennas being lifted onto its pedestal

We have refurbished two 13.7 metre diameter parabolic dish antennas. New mesh surfaces, control systems, quadrapod (to contain various FPAs), cabling and software have also been developed. We have taken delivery of a THEA tile purchased from ASTRON.

The main activity for the next quarter is to commission and develop this test-bed system and engage in assessment of various FPA research activities. Some of the measurement goals of the NTD include obtaining a better understanding of FPAs, reconcile antenna range measurements with astronomical measurements, validate models for reflector / FPA / coupling / RX / beam-former, determine optimum / practical beamformer parameters, and develop calibration methods.

Prototype receiver for the NTD project.

xNTD

Major funding from CSIRO for the development of the xNTD, Australia's SKA Demonstrator, is planned to begin in July 2006. This funding, together with infrastructure support from the Western Australian Government will allow the deliverables obtained from the NTD R&D to be extended into a useful working radio telescope at the Australian proposed SKA site at Mileura in WA. The xNTD aims to demonstrate that FPAs on small dishes can meet key cost and performance goals applicable to the SKA core. Completion date of 2009 is in accordance with the planned global SKA timeline for National SKA Pathfinders.

Meeting the cost requirements for the xNTD antennas is a major challenge. The xNTD budget calls for twenty 15m antennas for AUD5m. An SKA Industry Mapping Project has been set up to help meet this challenge. During the past few months CSIRO has hosted two industry open days and is developing detailed specifications for the xNTD antennas (see Industry report later in this section).

The present NTD/xNTD activities include:

- Commissioning of the 2-element interferometer test-bed at Marsfield
- Initial FPA experiments with the THEA tile

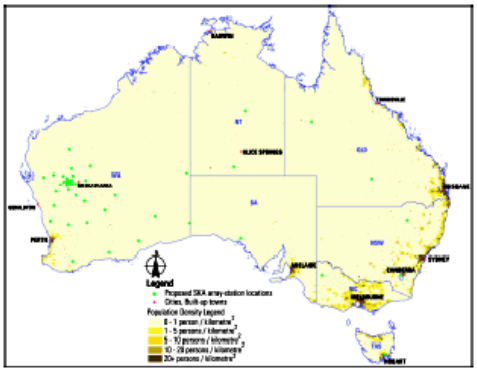
- Development of alternative FPA designs
- Integrate the prototype beamformers and receivers into the test-bed
- Design of full 100-input (dual polarisation), 300 MHz beamformer
- Development of RFI mitigation strategies
- Development and assessment of antenna design proposals for xNTD

It is recognised that data transmission and processing are significant issues for xNTD, but the SKA will be yet another major increase in scale.

Australasian siting proposal submitted

The formal proposal to site the SKA in Australia was submitted to the International SKA Planning Office (ISPO) on 5 December 2005. The proposal was developed by the Australian SKA Planning Office on behalf of the Australasian SKA Consortium, with the assistance of a large number of organisations and agencies.

Under the proposal, the core site for the SKA would be on Mileura Station in the Mid West of Western Australia, while remote array-stations would span the continent with maximum east-west baselines in excess of 3200 km. Further array-stations in New Zealand would provide for an east-west baseline of more than 5 500 km.



The proposed configuration for the SKA in Australia, overlaid on a map indicating population density. The Australasian SKA proposal places array-stations in very radio-quiet locations, with good access to infrastructure and excellent geophysical conditions. *(Map credit: Connell Wagner).*

The proposed configuration is a 5-arm, symmetric, log-spiral arrangement of array-stations out to a distance of 350 km from the core. This ensures optimum *uv*-coverage and beam-shape for this fraction of the array. A deliberately 'dithered' 5-arm asymmetric logarithmic spiral configuration would extend beyond 350 km to over 3000 km, in a predominantly east-west configuration. The vast and very sparsely populated interior of Australia allows enormous freedom in selecting the final configuration. All array-stations for the principal configuration lie within Australia, greatly simplifying administrative arrangements for establishing and managing the SKA.

The Australian sites for the SKA array-stations satisfy all the international evaluation criteria of scientific and technical considerations and infrastructure cost.

The Australian site for the SKA Facility exhibits:

- *excellent sky coverage*. Assuming an elevation limit of ten degrees for the telescope, a declination range from –90°to +48° will be visible;

- *radio-quietness* at the very high sensitivity levels needed for the SKA. At the low- to mid-SKA frequencies, signal levels of order -220dBm/Hz would cause significant interference to the SKA. Interference at these levels could be detected from typical transmitters sited up to 550km away. The nearest large urban centre to the candidate central site is Perth, at a distance of 620km;

- *ionospheric stability*, with Total Electron Content (TEC) values less than 100 TEC Units (a conservative upper bound), and with no strong scattering overhead; and

- a *troposphere* that will not significantly affect observations below 17GHz, with sky brightness temperature <5K at frequencies below 10GHz. Precipitable water vapour is less than 20mm from May to December inclusive and less than 10 mm from June to September inclusive at the central site; sufficient time for the SKA projects requiring high-frequency observations. Results are similar on the other side of the continent at Narrabri in NSW, indicating that uniformly good troposphere results can be expected, enabling long-baseline high-frequency observations.

  The New Zealand SKA committee has proposed remote SKA sites that would make it possible to extend the array into New Zealand, increasing the available baselines to over 5 500km. It would also be possible to make inter-continental VLBI observations with current facilities in China, Japan, Korea, India and South Africa.

  The siting proposal also noted:
  - the international strength of Australia's radio astronomy community, and continuing strong Australian Government support for radio astronomy, including radio-quietness protection;

  - Australia's ability to provide reliable and cost-effective infrastructure and maintenance to the SKA throughout its lifetime; and

  - the Western Australian Government's commitments to provide legal protection to preserve the unique, radio-quiet environment at Mileura Station through establishment of a Radio Astronomy Park.

SKA industry activities

The SKA cluster mapping project was first described in ASPO newsletter 2 (http://www.atnf.csiro.au/news/aspo-newsletter/ASPOnewsletter2.pdf). The key activities of this project are to:

- produce an industry cluster map of companies with SKA capabilities;
- produce a technology roadmap of Australian capabilities regarding the Extended New Technology Demonstrator (xNTD) project;
- identify projects and prototyping activities suitable for SKA cluster development; and,
- produce the investment profile for xNTD-SKA development in collaboration with overseas entities.

On 5 December 2005 CSIRO ATNF hosted, at its Sydney headquarters, a first meeting for parties interested in participating in the cluster. The main purpose of the meeting was to brief attendees on the system requirements of the CSIRO-led extended New Technology Demonstrator (xNTD) project, discuss the potential for industry collaboration, and initiate networking among the participants. The event attracted 60 attendees. A list of their names and organizations, and details of the presentations, can be found at http://www.atnf.csiro.au/projects/ska/industry_2/cluster1_followup.html

Participants at the SKA cluster mapping meeting on 5 December

The cluster mapping project has now been funded by AusIndustry's Industry Cooperative Innovation Program

(ICIP). The ICIP funding amount is AUD54k: this will be added to other contributions for the cluster mapping project from industry and other partners (AEEMA, CSIRO & the facilitator GIC) of cash (AUD54k) and in-kind (AUD45k). More details of the ICIP grants can be found via www.ausindustry.gov.au .

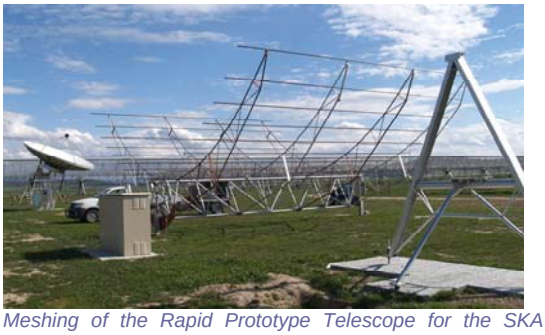
SKA Molonglo Prototype (SKAMP) Update

All three stages of the SKAMP project are progressing well. The 96-station continuum correlator has seen 'first light' in the form of a drift scan of the Sun. The spectral-line correlator has been designed and is now being built. Calibration and image processing software is in the planning stage. Construction of the Rapid Prototype Telescope is nearing completion, and the new wire mesh has now been installed.

The prototype laser drivers for the 850nm fibre (both analogue and digital) are in the final design and layout stage. Attention to detail in these high-speed parts is critical to achieve 3 Gbit/s throughput.
.The need for quality assurance at each stage is evident. Given the large number of antennas in the system, error/fault detection systems are required that will automatically probe to the bit level. This means installing logic analysers in the field-programmable gate arrays that can easily be accessed by Ethernet or USB.

In addition to carrying out this impressive program of R & D the staff at Molonglo hosted a BBQ on site to celebrate the telescope's 40th birthday (18th November 2005). The cake was cut by Bernie Mills, inventor of the original Mills Cross telescope at Molonglo.

Michelle Storey & Helen Sim
Australian SKA Consortium



Meshing of the Rapid Prototype Telescope for the SKA Molonglo Prototype

Bernie Mills, the inventor of the original Mills Cross telescope, cuts the cake to celebrate the telescope's 40th birthday, at Molonglo in November 2005.

During 2005 the Canadian SKA Consortium was established. The Consortium is a partnership between the National Research Council (NRC), the Association of Canadian Universities for Research in Astronomy (ACURA), and three industrial partners. The Consortium is governed by a Board of Directors established by a Memorandum of Understanding between the partners. A Canadian SKA Science Advisory Committee established by the Canadian Astronomical Society advises the Board on scientific issues impacting priorities. The CSSAC membership includes scientists from NRC and nine Canadian Universities. Currently, the Canadian SKA Consortium is working with the

Canadian Coalition for Astronomy to secure funds for the Canadian SKA technology development as part of the Canadian Long Range Plan for Astronomy.

Large Adaptive Reflector

The LAR work at DRAO has made a number of significant steps in the past year. In conjunction with Meyer Nahon's group at McGill University, we have now completed the first session of tethered-aerostat flight tests using active control of the tether system, using feedback based on the differential GPS position of the confluence (focus) point of the tethers. The results of these tests are very encouraging. With a simple PID controller, the confluence point motions were reduced to below the rms of the differential GPS measurements (a few cm) as a result of active winch control (see figure 1).

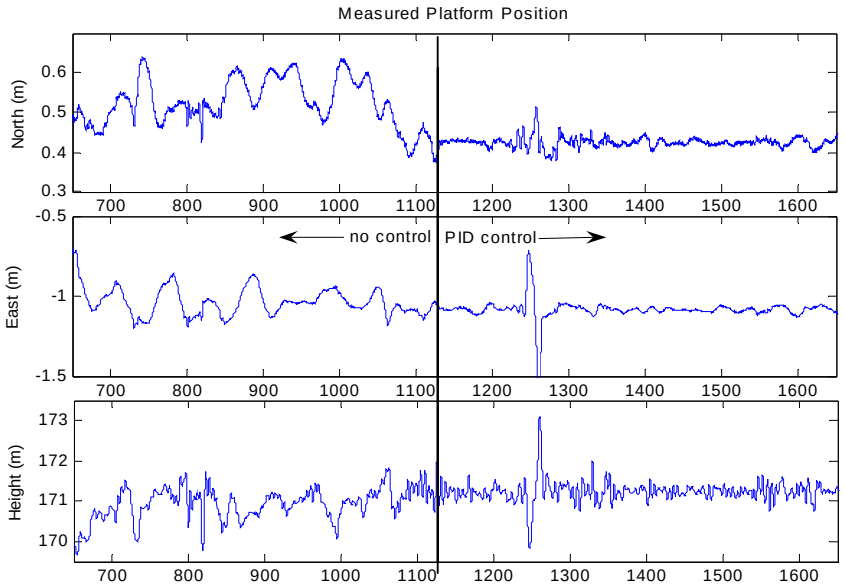


Figure 1. Confluence point motions with and without active tether control. Active control was switched on at 1125 seconds. The perturbation at 1250 seconds is a software glitch. The mean wind speed during the test was 4 m/s.

Figure 2. The commercial digital acquisition system being used in PHAD. Seven cards, each with 16 input channels, and 105 MSamples/s at 14 bit resolution are shown. Each card has 128 MByte RAM and an onboard FPGA. The complete system has 12 cards, giving 192 channels.

Phase-array feeds

The work on phased array feeds at DRAO has been rapidly advancing on a number of fronts over the past year. Significantly, DRAO secured $900k CDN especially for the PHased Array Demonstrator (PHAD) project. PHAD is a modest-size, engineering demonstrator consisting of a 200-element, dual polarization Vivaldi array, designed for flexibility and quick turnaround of results. We are using simple, low cost, narrow band (1 MHz) COTS receivers, with modest system noise (~100K) The RF outputs will be digitized immediately with a commercial data acquisition system, with on-board FPGAs. Initially, we are storing data in a general-purpose computer with off-line beam-former processing, but plan for real-time beam forming with the FPGAs once an optimum beam forming strategy is defined. In the near-term, we plan to experiment with PHAD using a near-field scanner before attempting on-the-sky tests with the 26-m telescope at DRAO.

Work is progressing for "beyond PHAD", where we believe substantial effort will be required to achieve a practical realization of phase-array systems, particularly integrated LNAs. A group led by Jim Hazlett at the University of Calgary is researching the possibility of using room temperature CMOS and SiGe LNAs in phased array feeds. The CMOS and BiCMOS technologies have been selected primarily for their relatively low cost and the high level of integration, which is advantageous when a large number of receivers are required. Initial work has been focused on analyzing the noise performance of CMOS MOSFET transistors. The work resulted in new LNA optimization techniques that will be verified shortly with a fabricated IC. A novel wide-band LNA topology has been introduced (see Belostotski et al., 2006 IEEE International Symposium on Circuits and Systems, May 21-24) that theoretically achieves noise temperature levels below 40K over 700-1400MHz. 180nm and 90nm CMOS designs have been implemented to confirm the performance of this topology, with fabrication targeted for May 2006. Currently, SiGe HBT transistors are being studied for performance comparison with MOSFETs.

One of the challenges of array feeds is the data transmission between the receivers and the beamformer and/or correlator. BreconRidge Manufactoring Solutions of Ottawa have been contracted to examine potential solutions to this problem, which is particularly extreme for the large feed array proposed for the LAR.

Small reflectors

One of the challenges facing the SKA "reference design" is the cost of the significant collecting area required to address the exciting science represented in the SKA science case. A small R&D project has been started, with the goal of building an inexpensive (<1000$/m^2), high-performance centimetre-wave reflector in the ~10-15 m diameter range. Perhaps of most interest is the goal of a simple construction method to permit low cost, on-site fabrication. Initial engineering designs for a reflector have been completed and materials testing is underway.

Sean Dougherty
Canadian SKA Consortium

CHINA

The international RFI monitoring session had been carried out successfully by the ASTRON team at the potential SKA core region in July 2005 in the province of Guizhou in China. In the past half year, some progress has been made on constructing the FAST demonstrator at Miyun radio astronomical station of the National Astronomical Observatories, CAS.

International and national RFI monitoring at candidate SKA core

Antennae of the ASTRON team on the ground, and that of the Chinese RFI team on the top of the house

The international RFI calibration group from ASTRON in The Netherlands started its monitoring sessions at the Dawodang depression in the Guizhou province on July 4 2005. The ASTRON monitoring team was accommodated in a hotel at Tongzhou town, which is about 20 minutes by car from the selected KARST depression. Three staff members from NAOC in Beijing and a group of people from the Guizhou radio monitoring center, had assisted the ASTRON team until the end of the monitoring and calibration sessions by July 30 and had seen off the equipment, together with the ASTRON team, on the way back to The Netherlands on August 1.

International and national staff members inside the RFI monitoring house in Guizhou China

An internet connection has been established in this remote mountain area that allows the RFI measurements to be carried out (quasi-) automatically. Since late August 2005, the RFI monitoring session has been performed daily to get denser and more complete data sampling with remote control by the local RFI team from the Guizhou radio monitoring center, to continue the one-year-term monitoring program following the "RFI Measurement Protocol for Candidate SKA Sites".

Progress on the Miyun FAST model

The FAST team is continuing to develop the FAST demonstrator at the Miyun astronomical observatory, i.e., MyFAST. Some progress has been made recently:

1. The control room for the MyFAST was established in August 2005.

The control room established for MyFAST

2. A cable-car driven system to locate the focus cabin was built successfully during September to October. A new Stewart platform to stabilize the MyFAST receivers is under construction.

The cable-car driven system for the focus cabin

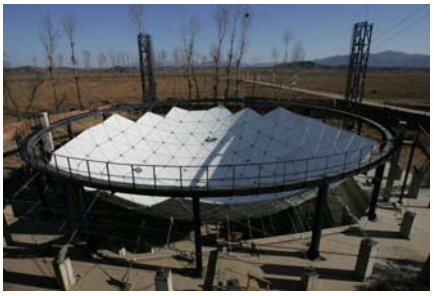
3. A wiring network for signal and power supply to the control system of the main reflector was distributed by Oct. 11 in the man-made depression, together with the car to mount the focus cabin supported by four towers with cables. There are 131 adjustable nodes of the cable-mesh structure controlled by a half closed loop system. A field bus technology is involved to communicate between the main control computer and the nodes. A different measuring network has been established for tensile force of cable-mesh structure and the position of the reflector respectively.

The wiring network around the depression for signal and power supply to the main reflector, the measurement and control components, together with the cable-car to mount the focus cabin supported with cables to the towers.

4. The downward actuators to pull cable-mesh structure were transferred to Miyun site on Oct. 20. And cables and connecting nodes for the main reflector were tested and installed by November.

Downward actuators to pull cable-mesh structure.

5. The reflector panels were manufactured by Oct. 10, and installed onto the cable network on December 6, 2005.



Status of the FAST demonstrator on Dec.6 2005

6. The effective collecting area of this demonstrator would offer sensitivity for some observations, such as bright pulsars, HI line and some luminous AGNs. We plan to carry out pulsar observations at 610MHz and 1400MHz. The RF and IF parts were tested, and a commercial A/D card ordered in 2005. Based on a raid hard disk system, a baseband recording system that is able to cope with sustainable data rate of 40MB/s is being built.

This results in a digital backend where the observed data are to be recorded and processed afterwards. We will assemble all components in the first half year of 2006.

Other

The 15 hard copies and 70 CD copies of the "Proposal for siting the SKA in China" were completed and delivered to the ISPO on time; a summary report on site spectrum monitoring at potential SKA sites in China is under preparation.

The FAST proposal was reviewed in the CAS Presidential meeting on 4 November 2005, and was officially approved by the CAS to be the only one of the three competiting astronomical projects to go forward into the formal process requesting finance from the National Committee of Development and Reform of China.

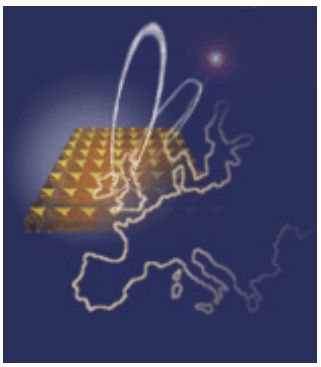
Following the decision of CAS President's Board, funding for 15 new positions for the FAST project has been made available. The FAST team has just received the relevant funds of 10 M RMB from the CAS for the year 2006.

FAST Laboratory in NAOC, China

EUROPE

SKADS

The European SKA Design Study (SKADS) began with a kick-off meeting on November 18/19 2005 in the Chateau Limelette near Brussels. It was appropriate to choose this setting, so near Brussels and the EuropeanCommission for this pan-European effort. The EC funding is beginning to flow, and indeed the project formally started on July 1st 2005.



SKADS is a design study focussed on the development of phased arrays for the SKA. A major thrust of the study is a large aperture-plane array in the shape of the EMBRACE demonstrator. This follows on from ASTRON work with the "Thousand Element Array" and will use Vivaldi antennas in compact tiles.

EMBRACE will comprise two arrays - a larger one (several hundred square metres) in Westerbork, and a smaller one in Nancay and linked to WSRT.

Complementing the EMBRACE activity is the UK-led 2-PAD dual polarisation all-digital phased array tile project - this aims to explore more ambitious technology but on a much smaller scale (1 square metre) than EMBRACE.

The BEST concept, involving the production of multiple beams on a large cylindrical concentrator, will be based in Medicina, Italy; it should produce useful results within the next two years

The development of hardware demonstrators is an exciting part of the overreaching goal of SKADS: to fully study and design the concept of a "Fully Digital SKA". To this end, a number of Design Studies are focussing on requirements and the development of new technology. In parallel, scientific simulations are underway to better specify the capabilities necessary for SKA, and to ensure that a fully digital phased-array can undertake the SKA Key Science Projects.

The presentations at the kick-off meeting showed that everyone had not been waiting for a formal meeting to get started! There has already been progress. All the presentations are available at the SKADS website: http://www.skads-eu.org

ASTRON continues to play the central management role in SKADS under the coordination of Arnold van Ardenne. His management team has been augmented by two positions, with a third expected imminently. Andrew Faulkner from the University of Manchester (Jodrell Bank) is well known in the pulsar community. He brings his unique industry and radio-astronomy experience to the role as SKADS Project Engineer.

Steve Torchinsky joins SKADS as the Project Scientist and will be based at the Paris Observatory, splitting his time between the Meudon and the Nancay sites. Steve was recently at the Arecibo Observatory where he was the Project Manager for ALFA, the Arecibo L-band Feed Array, and he was also the interim Head of Astronomy at Arecibo.

SKADS is overseen by a Board composed of representatives from each of the contributing partners. The first meeting of the SKADS Board was held in Zaandam near Amsterdam on January 26th, 2006. Peter Wilkinson agreed to take on the role as Chairman of the SKADS Board, to the great satisfaction of all present. The Board members were also very pleased to have Franco Mantovani, director of IRA-Bologna, take on the role as vice-chair.

During this meeting, the SKADS Consortium Agreement was discussed and agreed in principle, and the positions of Project Engineer and Project Scientist were confirmed.

SKADS Board

ESKAC

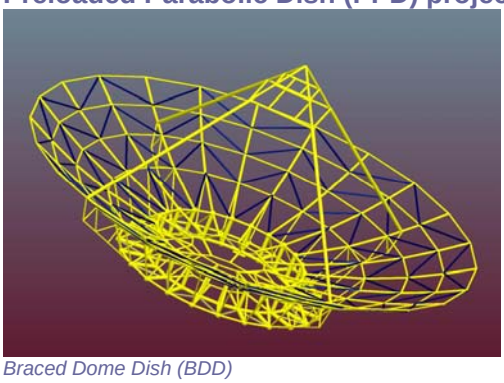
At its Pune meeting in November 2005 the European SKA Consortium discussed the role the ESKAC might play in Europe with the SKADS initiative now well underway and taking a major profile in the international SKA effort. It was concluded that the Consortium has a continued important role to play in the coordination and promotion of SKA related activities that is complementary to the funded pathfinders and design study activities.

The ESKAC premier remains to coordinate the European participation in the ISSC. To that end, it is noted that Prof. Harvey Butcher of ASTRON stepped down from the ISSC effective January 1, 2006. A successor will be nominated in the spring. Pune was the last meeting chaired by Peter Wilkinson.

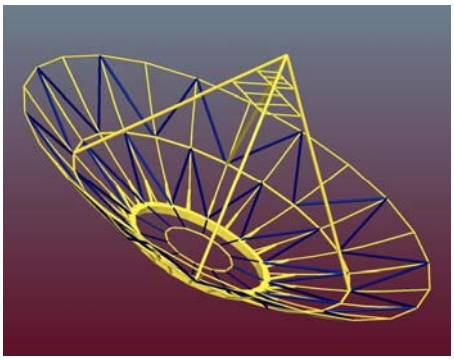
The new ESKAC Chair is Anton Zensus of the Max-Planck-Institut fuer Radioastronomie in Bonn, Germany.

Anton Zensus
Chair ESKAC

Preloaded Parabolic Dish (PPD) project update



Braced Dome Dish (BDD)



Preloaded Parabolic Dish (PPD)

The TCE Consulting Engineers Ltd., Mumbai, were entrusted with an assignment of carrying out a systematic engineering study to compare the merits and costs of different dish concepts and thereby identify a concept best suited for low frequency operations in the range of 0.5 to 8 GHz (Refer Newsletter, Vol. 8, June 2005). TCE have come out with their preliminary results:

Four dish concepts with 12m diameter were studied and optimized:

1. Bent Parabolic Dish (BPD)
2. Triangular Truss Dish (TTD)
3. Braced Dome Dish (BDD), and
4. Preloaded Parabolic Dish (PPD)

All these dish concepts were studied with a 24 radial arms for its back up structure, a quadripod to support a sub-reflector /prime focus feed with a maximum weight of 200 kg. It was decided to have a reflector surface made of 108 wire mesh panels spread in five rungs to bring down the facet error to ~1mm rms. An antenna mount with screw drive arrangement for elevation axis and anti-backlash drive using a slew ring bearing for azimuth axis, with a maximum speed of 40° per min. about each axis was considered.

After the first round of study the BDD concept among the BPD, TTD and BDD was short-listed for further optimization in view of its less weight, less number of structural members / joints and ease of manufacturing. In addition to this, the PPD concept with some modifications was also considered for further optimization.

The above two short-listed dish concepts have been optimized for a dish dia of 15m and the results are tabulated below:

Sl.No.	Antenna Dish Concept	No. of structural members	Total joints	Max. no. of members connected at a joint	Weight (kg)	Max. RMS error of reflector surface at 50 kmph wind (mm)	Max. beam pointing error at 50 kmph wind (arc sec)	Max. beam pointing error @ 20 kmph wind speed (arch sec)	Lowest natural torsional frequency (Hz)
1	BDD	744	193	9	4280	1.70	-149.4 to 158.4	-20.4 to 24.6	4.27 (3.74)
2	PPD	317	197	8	3134	1.71	-98.4 to 66	-21 to 16.8 (at 25 kmph)	4.22 (1.63)

The estimated cost of the antenna system including dish and antenna mount with its tower is $700 per sq.m for BDD concept and $ 600 per sq.m for PPD concept. TCE has prepared a detailed technical report for submitting to NCRA, Pune and RRI, Bangalore.

Installation in progress

Antenna base and the control room

The installation of the 12m PPD at Gauribidanur (GBD) was slowed down by delays in the delivery of the mount system. Right now the site preparation is complete and the installation of the mount with its drivers and the receiver system is in progress.

N. Udaya Shankar (RRI)
A. Pramesh Rao (NCRA-TIFR)

NEW ZEALAND

In ASPO newsletter 2 (http://www.atnf.csiro.au/news/aspo-newsletter/ASPOnewsletter2.pdf) we reported the success of the first Trans-Tasman VLBI experiment, using the Australia Telescope Compact Array (ATCA) near Narrabri and a 6-m dish in Karaka, South Auckland. Further experiments have since taken place: on Friday 4th November a quasar PKS1921-293 was observed for 2 h using the 6-m dish with the ATCA, Mopra and Parkes. Fringes were confirmed by Adam Deller and Steven Tingay (Swinburne University of Technology).

Now the push is on to develop New Zealand's radio-astronomy capability. We plan to:
- extend the 6-m dish to 10-12 m over the next few months;
- develop a plan for building a bigger dish and establishing a national radio astronomy facility; and
- develop VLBI and eVLBI in New Zealand.

Venture Southland, a regional development group, has acquired an 11-m dish for its site at Awarua and is working with AUT to prepare it for radio astronomy. A high–speed network linking NZ research institutions is expected to be up and running in the second half of 2006, and will facilitate eVLBI.

The New Zealand submission to the Australasian SKA Consortium, outlining four proposed array station sites for the SKA, two in the North Island and two in the South Island, was presented at the end of November. The following gives some background to the most favoured North and South Island sites.

Awarua (South Island)

Venture Southland has been a strong supporter of New Zealand involvement in the SKA for the past two years, having already seen the benefits of trans-Tasman collaboration with UNWIN, a radar project built at Awarua. Awarua is a radio quiet rural site bordering on farmland and Department of Conservation reserves. The UNWIN radar, an array of 20 antennas funded by La Trobe University in Victoria, Australia, works together with an identical radar in Tasmania, the Tasman International Geospace Environment Radar (TIGER), to investigate the aurora and related space-weather phenomena. TIGER is operated by a consortium of Australian Research Institutes and also forms part of the international space-weather radar network, known as SuperDARN, the Super Dual Auroral Radar Network. UNWIN's specialised radios were designed and built at La Trobe University, but the towers and antennas were constructed and installed by local NZ manufacturers and contractors to a high standard. UNWIN is one of four space-related projects Venture Southland is working on.

Ardmore (North Island)

In the North Island the two proposed sites are at Warkworth, north of Auckland, and Ardmore (south of Auckland). The latter site was originally bought by the US Air Force for long-distance communication and was an important HF radio site during World War II. After the war it was acquired by Auckland University and used as a research station for studying ionospheric radio-wave propagation. As such it has been a radio-quiet listening site for over 60 years. The New Zealand Navy still use it for calibrating their radio direction-finding equipment because of its favourable radio location. Ardmore encompasses about 5 hectares and includes a number of support buildings and a house. Underground power and telephone connections are deployed across the site.

The site is currently home to a variety of acoustic instruments, a meteorological tower and a mobile weather radar. Research involving the Ardmore site includes the development and testing of mobile radar equipment and subsequent deployment to study the small-scale structure of severe weather.

RFI measurement

The NZ Ministry of Economic Development (MED) is responsible for spectrum management and is currently conducting a research project into the levels of background radio-frequency radiation in the vicinity of the candidate sites. A scholarship was granted by MED to Paul Banks, an AUT postgraduate student, to study the RFI and the background noise level.

Sergei Gulyaev,
Chair, SKANZ

The 6-m dish used for the first successful Trans-Tasman VLBI experiment. Left: Brent Addis, owner of the dish. Centre and right: Tim Natusch and Sergei Gulyaev, both of Auckland University of Technology. Photo: Marilyn Head.

Radio-frequency environment test equipment at the Ardmore site

SKA site proposal

The South African proposal to site the SKA in the Northern Cape was completed and sent to the ISPO in December 2005. The proposal includes a tool which allows the detailed costing of basic infrastructure required for any SKA site which is chosen.

The report on RFI measurements will be submitted to the ISPO by the deadline of 17 March 2006. RFI Mode 2 measurements were made for a year at the proposed core site and Mode 1 measurements were made at a grid of sites at 75km and 150km from the core site, to characterise the whole area. Mode 1 measurements were also made at representative remote sites in South Africa, Namibia, Botswana and Mozambique. The report includes desktop studies based on the up-to-date and complete transmitter lists made available to the South African SKA Project Office (SASPO) by the operators and the Independent Communication Authority of South Africa. This raises interesting questions about the effect of weak signals from large distances which are likely to affect the sites in all of the proposing countries.

Data connections

As part of the South African site proposal, the Minister for Public Enterprises undertook to ensure that the bandwidth required for the SKA to operate in Southern Africa and to connect to the rest of the world is available at rates related to cost, which are less than current international benchmark prices. The South African SKA Project Office (SASPO) is continuing to work with the Department of Public Enterprises on the planning of the optical fibre network, part of which will be provided for the Karoo Array Telescope KAT.

The astronomy geographicadvantage bill

The South African Cabinet approved for public consultation a draft Bill which provides for the Minister for Science and Technology to have the power to declare protected areas for astronomy (both optical and radio). The Bill provides inter alia for the declaration of core areas, where certain activities which could interfere with astronomy will be prohibited, and astronomy coordination areas, where activities which could interfere with astronomy sites (in the core areas) would have to comply with standards laid down by the Minister in regulations. The Bill also allows the Minister to designate certain equipment, such as an optical fibre network, as part of an astronomy instrument, which would exempt it from the normal licensing regulations laid down for communication networks. The Department of Science and Technology has mandated the South African SKA Project Office to manage the consultation process. The next draft of the Bill is expected to go to the Cabinet by May 2006 and thereafter to Parliament.

The Karoo Array telescope

The Minister of Finance announced in February 2006 that a further approximately $38million had been made available for the construction of the KAT. The total now available is approximately $50million.

The KAT engineering team is now fully operational and consists of 30 team members (some of whom are part time), most of whom are based in the Cape Town project office. Team breakdown is as follows:

Project Management: 1
Systems engineering: 6 (one part-time)
Digital signal processing: 8
Software and computing: 10
Dishes: 1
Feeds: 3 (2FTEs)
Administrator: 1

During the February 2006 meeting of the SA SKA Steering Committee, the KAT commissioning experiments, KAT phasing / time schedule, KAT budget and KAT Reference Design (to commissioning at the end of 2009) were approved.
KAT will be delivered in a phased manner, as follows:
- Phase 1: 20 dishes each with a cluster of 7 horns as feeds. Engineered for FPAs as plug and play. Top frequency 1800 MHz
- Phase 2: when FPA technology matures, they will replace the horn clusters. Also included in this phase will be improved LNAs with better noise figure, which will improve the figure of merit for the KAT.
- Phase 3: upgrade to 8GHz top frequency – science case to be reviewed

Prototyping

KAT prototyping in three areas is progressing well:

- Dish

- Final negotiations are under way with two potential suppliers to issue a contract for a 15m diameter prototype dish to be erected at the Hartebeesthoek Radio Astronomy Observatory. (f/D = 0.5, alt/az mount). This dish will be used to test elements of the full system (cluster horn feeds, FPAs) as well as the full system (understanding integration issues).
- The KAT team acquired a digital beam former and radio frequency demodulator from CSIRO for this prototype. Details are as follows:
-- Digital Beam former - 24 Channel Digital Beam former. Each channel is capable of sampling a 24 MHz frequency band. The digital beam former includes all the firmware to sample each channel, form a single beam and channelise the output into a number of frequency bands.
-- Radio Frequency Demodulator - The Radio Frequency Demodulator (RFD) converts the 800MHz to 1700MHz received antenna data (for each element) to a 24 MHz band with centre frequency configurable across the input frequency range.
- Deadline for completion of the dish is June 2007.

- FPA and horn cluster prototypes:

- 4x3x2 FPA prototype with beam former (to develop test environment for the 4x3x2 FPA, conduct FPA tests in an anechoic chamber (near field and far field scans & beam pattern measurements).
- Provide learning for the next FPA prototype (10x10x2).
- Apart from its technical importance, this simple prototype is also used to demonstrate the systems engineering discipline, develop formats for key documents, establish working procedures and processes and address other team issues.
- Progress is ahead of schedule and expected to finish towards the end of June 2006.

- The PED (Production Equivalent Demonstrator) is a 4 element interferometer comprised of commercial satellite dishes to be built at the South African Astronomy Observatory. Its main purpose is to provide a test bed for the development of the KAT operational software. Procurement and testing of equipment has started.

Capacity of development

The Government has made available funds for PhD and MSc bursaries and for travel grants from and to South Africa for work on projects linked to the SKA and the KAT. Bursaries have been granted to a total of two post-doctoral fellowships, 5 PhD and 10 MSc students for study in South African universities and in Madagascar, Mozambique and Mauritius in 2005 and 2006. In addition, funds have been allocated to fund 75 Research Chairs at South African universities. These are available for a range of subjects including astronomy.

USA

The NSF Technology Development Program (TDP) proposal and Related Work

The Astronomy Division of the NSF continues with its "senior review" of the facilities and operations supported by that division. An external panel, chaired by Roger Blandford, has been visiting the NSF-operated astronomy facilities and holding a series of "town hall" meetings across the country. A final decision on funding of the TDP awaits the outcome of the senior review.

In the meantime, various members of the U.S. SKA Consortium have decided to submit proposals to the Advanced Technologies and Instrumentation (ATI) program. These proposals are aimed at work that was initially part of the TDP as well as at SKA aspects that have been identified since then.

These proposals include:

- A proposal for SKA development using the ATA: This proposal aims to characterize the high and low frequency performance and manufacturability of the current ATA feeds vis-à-vis SKA needs, the degree of mutual coupling between antennas, optimization of station beam forming, RFI mitigation, precision calibration, and wide-field imaging.

- Advanced correlation techniques: Colin Lonsdale and collaborators have described techniques by which the computational costs for correlation may be reduced significantly (e.g., SKA Memo #54). This proposal aims to develop these ideas further and begin simulations to verify the performance of advanced correlation algorithms.

- Wideband receiver and feed development: The SKA Reference Design includes "smart feeds," one component of which may be wideband feeds. This proposal aims to develop the wideband feed performance beyond that achieved for the ATA, with the goal of covering an even larger frequency range.

- Multi-purpose signal processing modules: Programmable electronic components (such as field programmable gate arrays, FPGAs) are often considered to be an integral part of the SKA signal transmission and processing chain. This proposal aims to build on initial development of flexible processing boards, with the aim of deploying them to various astronomical arrays either under development or construction.

In addition, while a final decision is pending, work funded jointly by Cornell University and the National Astronomy & Ionosphere Center (NAIC) may begin on a prototype focal plane array for Arecibo covering 5–10 GHz.

U.S. demonstrator arrays

Allen Telescope Array (ATA)

ATA antennas

Construction continues on The Allen Telescope Array (ATA) at the Hat Creek Radio Observatory in northern California. A phased construction schedule has been developed for the ATA: ATA-42, consisting of 42 antennas; ATA-98, consisting of 98 antennas; ATA-206, and ATA-350.

The current schedule is that ATA-42 will be completed by Spring 2006. Additional funding to support construction of later phases of the ATA may have been identified within the fiscal year 2006 (FY2006) U.S. Government budget, however, portions of that budget did not obtain final approval until 2005 December 31. Development has also continued on the wide-band feeds, which has led to a significant improvement in the system temperature T_{sys} at the higher frequencies.

SKA dish

Expanded Very Large Array (EVLA)

The VLA will move into its A configuration in 2006 February. This configuration should represent the first occasion on which EVLA antennas will begin scientific observing. While not yet outfitted fully to cover the entire VLA frequency range, the goal is for two antennas (#14 and 16) to be available for observers to include in their scientific programs, with the possibility of two additional antennas joining by the end of the configuration (2006 May). This will mark the start of the VLA-EVLA Transition Array, during which scientific observing will continue while the upgrade to the EVLA is performed.

Long Wavelength Array (LWA)

A number of tests of LWA prototype equipment have been conducted recently. These include deployment of the antenna to the site of the first LWA station and characterization of the radio frequency interference (RFI) generated by the receiver. (While not planned, the antenna test also illustrated the need for significant animal interference mitigation as the antenna was damaged during the night by an elk or cow, which probably used it as a scratching post.) The site for the first LWA station, and the site of the prototype Long Wavelength Demonstrator Array, had been identified near the antenna barn at the VLA. Additional characterization showed that the geography of this site was less than optimal, but that a significantly flatter location is available some 50 meters away. The LWDA, which will be retrofitted to form the first LWA station, is now planned to be located there.

Mileura Widefield Array-Low Frequency Demonstrator (MWA-LFD)

The MWA-LFD will consist of multiple "tiles" of dipoles phased together. Multiple tiles have now been deployed to the Mileura site in Western Australia, and multiple observing campaigns have been conducted. These campaigns continue to demonstrate the nearly pristine radio frequency interference (RFI) environment of this site with rms noise levels typically more than 30 dB below the Galactic noise. Moreover, fringes have been produced from interferometric tests with the tiles. Finally, a significant fraction of the funding for the MWA-LFD has been requested from the NSF, and a decision on this proposal now appears imminent.

NASA Deep Space Network Array (DSNA)

A breadboard array has been operating in a 2 × 6-m single-dish mode at 8.4 and 32 GHz for the past several months at JPL, and two element interferometer tests have started recently. These 6-m dishes work very well with efficiencies of the order of 55% at 32 GHz and receiver system noise temperatures of approximately 20K at 8.4 GHz and 35K at 32 GHz. The full DNSA is

expected to use 12-m antennas, and Patriot Antenna Systems has delivered a 12-m antenna to JPL. Testing in single dish mode and later as a 3-element interferometer are expected to take place in the next several months. A long-term plan for construction of a DSN array is under review at JPL and NASA Headquarters.

Science

Epoch of Reionization (EoR) Science

Detection of the hydrogen signal from the end of the EoR is recognized as part of the SKA Key Science Project "Probing the Dark Ages." There are now multiple arrays being constructed, either in the U.S. or with significant U.S. involvement, with the aim of either characterizing the low frequency sky and/or detecting the EoR signal.

- Dipoles operating around 196 MHz have been deployed on the VLA. The goal of this program is to search for H I emission from redshifts around 6 to 7, redshifts at which the last remnants of the EoR have been detected in the optical spectra of various quasars. A significant challenge is the RFI environment, which is being made more difficult by the introduction of HDTV in the southwest U.S. The HDTV signals are quite broadband, occupying much of the spectrum allocated for an individual channel.

- The MWA-LFD is described above, and progress on it continues.

- The Precision Array to Probe the Epoch of Reionization (PAPER) is a portable, 32-element, dual-polarization, wide-field imaging array designed to explore many aspects of the low frequency sky that will be important for larger EoR arrays. It will operate over the 100–200 MHz band with a maximum baseline of 300 meters. Its initial deployment will be in Green Bank, West Virginia, in 2006. If successful, plans have been developed for deployment of the next-generation instrument, PAPER-128, to Western Australia.

Astrobiology: Cradle of Life

Planets are thought to form in disks around young stars, and significant evidence for disks, as well as possible planetary effects on those disks, has been amassing in recent years. The standard picture is that planets form when dust grains begin to "stick together" to form small particles (pebbles), which in turn accrete to form larger objects (boulders), which accrete to form planetesimals, which then accrete to form planets. One significant problem with this picture is that it is not clear how pebbles "stick together" to form boulders; current understanding suggests that collisions between pebbles should destroy them rather than form larger objects. One of the key science goals of the SKA is to observe protoplanetary disks with the aim of exploring this regime of planetary formation. The nearby young star TW Hydrae is known to have a disk of material orbiting it. Recent VLA observations have shown that some of the material in that disk is likely to be centimeter-sized particles ("pebbles") (Wilner et al., *Astrophys. J.*, **626**, L109). Unfortunately, TW Hydrae is one of the few young stars close enough that these observations can be conducted. Only with the sensitivity of the full SKA will a large number of disks be able to be probed and this crucial regime in planetary formation explored.

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