NEWSLETTER

Volume 12

July 2007

P.O. Box 2, 7990 AA Dwingeloo, The Netherlands
Tel: +31 (0)521 596 599 / 598
Fax: +31 (0)521 595 101
www.skatelescope.org

FROM THE INTERNATIONAL SKA PROJECT OFFICE

The first half of 2007 has been another eventful six months for the SKA as the project ramps up around the world. The month of May was particularly noteworthy in this respect – the PrepSKA proposal was submitted to the European Commission (EC), the host institute for the International Project Office (ISPO) was selected, and substantial additional funding for Australian SKA activities was announced by the federal government there. In June, the National Science Foundation in the USA announced that the Technology Development program for the SKA was to be funded for 4 years. Details of both these additional grants are given in the section on news from Consortia and Institutes later in this Newsletter. On the ‘workfloor’, very pleasing progress continues to be made on all the contributing technologies for the SKA in the national and regional projects, and more detail is being put into the description of the science plan for the SKA program as it evolves from the Pathfinder phase through the first 10% of the SKA and into the full array.

The Preparatory Phase funding line for research infrastructures within the EC’s 7th Framework Program provides a golden opportunity to integrate the SKA engineering and site characterisation activity around the world into a coherent design for the telescope, while at the same time providing support for the investigation of funding and governance issues that are crucial to approval for construction. The PrepSKA proposal was prepared by Phil Diamond and a global team of writers, and addresses the 5 key issues for the SKA project: What is the design and cost for the SKA? Where will the SKA be located? What is the legal framework and governance structure under which the SKA will operate? What is the most cost-effective mechanism for the procurement of the various components of the SKA? How will the SKA be funded? PrepSKA will run for 4 years, 2008-2011, and most of the proposed funding will go towards the establishment of a Central Design Integration Team (CDIT) within the ISPO. Twelve institutes around the world signed up to PrepSKA and to provide matching funds, as did eight funding agencies and government departments; the UK Science and Technology Facilities Council, successor to PPARC, formally submitted the PrepSKA proposal. The reports by Peter Hall and Yervant Terzian elsewhere in this Newsletter go into more detail on the design and site characterisation aspects of PrepSKA. The EC expects to announce the results of their evaluation of Preparatory Phase proposals early in July.

In view of the proposed expansion of the project office to include the CDIT, the International SKA Steering Committee (ISSC) called for proposals to host the ISPO. Three proposals were received, and following extensive discussion, the ISSC selected the University of Manchester as the host organisation for the ISPO. A Memorandum of Agreement between the ISSC and the University of Manchester is in the final stages of approval. It is likely that the ISPO will move to the new Turing building in Manchester, also home to the Jodrell Bank Centre for Astrophysics, early in 2008.

At the 17th ISSC meeting in San Juan, Argentina, in March, members adopted a resolution on the phased implementation of the SKA that will govern the development of the SKA during the design and construction phase. The three main points of the resolution are to:

- Support a phased development of the SKA which progresses from the Pathfinder telescopes, to the first 10% of the SKA (designated Phase 1) with a restricted frequency range at a cost of about €250M, to the full SKA with the full frequency range
- Develop an SKA plan with a Phase 1 stage that focuses on the mid-band frequencies and options for low-band frequencies
- Use the Phase 1 results to guide the development and construction of the full SKA

The ISSC together with the Funding Agencies is in the process of generating a new agreement on international collaboration on the SKA that will replace the current agreement when it expires on 31 December 2007. It is likely that the ISSC will be renamed the SKA Science and Engineering Committee in the new agreement. A related agreement on the ISPO is also in preparation, and again the name is likely to change, to the SKA Program Development Office. Further details of the agreements will be given in the next Newsletter.

The specifications of the SKA are undergoing a thorough review at the time of writing. A Tiger Team has been formed under my chairmanship to generate a set of initial specifications for the SKA and SKA Phase 1, which are to be reviewed by an external committee, chaired by Roy Booth, in January 2008. The draft document and the trade-offs involved will be the principal subject of discussion at the SKA2007 meeting in September in Manchester. The cost of the various options for the SKA is a primary constraint for the work of the specifications Tiger Team. Use is being made of a costing tool developed in an international context in Australia, Europe and South Africa; this is described in Peter Hall's report on the Engineering Working Group.

I'm very pleased to use this forum to introduce Colin Greenwood and Nanushka Csonka to the SKA community. Colin joined the ISPO in June as Executive Officer, and is already making his presence felt in many of the project office activities. Nanuschka succeeded Astrid Marx as ISPO Office Manager in February, as many of you know from contacts with her since then.

I look forward to seeing many of you at the SKA2007 meeting (27-29 September) and/or the Modern Radio Universe Symposium (1-5 October) in Manchester.

Richard Schilizzi
Director

NEWS FROM THE WORKING GROUPS

ENGINEERING

Following the rather extensive update in Newsletter 11 this report outlines a few key international engineering activities undertaken recently. For brevity no discussion of technical developments is included but a review of the various regional reports on subsequent pages should leave no doubt about the productivity of SKA engineering programs.

Perhaps the most important international efforts have centred around the FP7 PrepSKA proposal (see p.2), in particular participation in the drafting of WP2 (SKA Design), WP3 (SKA Site) and WP5 (Procurement and Industrial Involvement). WP2, the largest of the PrepSKA work packages, required considerable engineering strategy development and exposition. The writing team consisted of Jim Cordes, Dave DeBoer, Peter Dewdney, Andrew Faulkner, Peter Hall, Anita Loots, Richard Schilizzi, Jim Ulvestad and Marco de Vos. Implementation of WP2 would see the establishment of an SKA Central Design Integration Team (CDIT) consisting of 16 people co-located in the ISPO host institute at the Jodrell Bank Centre for Astrophysics (JBCA) in Manchester, UK.

Consisting of 10 projects and numerous constituent tasks, WP2 covers aspects such as SKA system design, sub-system specification and integration, construction of an SKA Phase 1 initial verification system, various hardware development and optimization projects, and software and computing specification and prototyping. It is designed to leverage and complement the very significant regional SKA Pathfinders and Design Studies now being undertaken around the world. Expected to run in the period 2008-11, WP2 involves over 2000 person-months of effort, of which 420 are slated to be supported by EU funding.

WP2 will produce designs suitable for implementation in an SKA Phase 1 construction effort beginning in 2012. It will adopt a base system design which uses conservative technology but, via links with regional projects, will factor in developments in wide field-of-view technologies as these become available. One of the big practical challenges lies in filling engineering positions within the CDIT. Please ensure that you and your colleagues know of the likely opportunities, and contact Richard Schilizzi or Peter Hall with any enquiries.

Outside FP7, the joint ISPO-ATNF cost - performance (c-p) estimation work has been proceeding well. A significantly augmented project is now underway following the addition of new personnel to the team. Paul Alexander, Rosie Bolton and Andy Faulkner (SKADS), together with Adriaan Hough (KAT) have joined Aaron Chippendale, John O'Sullivan, Tim Colegate (ATNF, Curtin University), and Peter Hall (ISPO) to form an expanded group. The first working session of the group will be held in Cambridge (UK) in the period June 25 – July 6. The aim is to refine a c-p "engine" capable of handling all SKA Reference Design technologies and accessible to those working in the SKA specification area. While the engine supports easy script interfacing, a trial web-based interface is also available at http://www.atnf.csiro.au/projects/ska/cost/. Both the engine and its interface are under continuing development and comments are welcomed by the team. A summary of SKADS and ISPO-ATNF work in the period leading up to ISSC17 was presented in Argentina; related discussion documents will be available shortly as SKA memos.

In other engineering and associated work, a concluding report from the "Options" Tiger Team was produced for ISSC17. In addition, with recent Australian effort complementing initial South African input, the SKA Infrastructure Tiger Team will shortly publish its completed report as an SKA memo. EWG task force activity continues, with a productive Focal Plane Array (FPA) workshop being held in Sydney in March (see p.8). Organization and sponsorship aspects of the FPA meeting were shared between the ISPO/EWG (Antenna and RF Systems Task Forces) and CSIRO. Subsequent to working group and task force meetings at SKA 2007, a further round of in-depth engineering assessment of key SKA technologies is likely to be held in South Africa in early Q2, 2008.

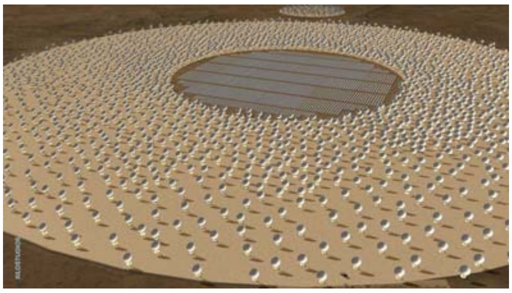
Over the next few months the EWG will be involved principally in advancing the SKA cost – performance estimation process and, along with the SWG, in a specification drafting exercise which will produce a series of “strawmen” designs for assessment at SKA2007. Results of these assessments will be critical in the final framing and review of specifications for SKA and SKA Phase 1.

Peter Hall
International Project Engineer, and Chair EWG.

OUTREACH

In the last six months the activities of the Outreach Committee have been mostly concerned with updating and developing new outreach material. This is done in order to reflect the giant steps that are taken internationally to make the SKA a reality. Apart from technical activities all over the world, the site decision is one step closer, as only Australia and South Africa are left in the running to host the SKA. Simple examples of how this affects the outreach material can be found in slightly modified versions of the SKA bookmark and the SKA flyer containing the reference design as a poster on the backside. Similarly, the main SKA brochure ('White Brochure') is undergoing the same update, with the new version being expected for the (northern hemisphere) autumn.

On the same timescale, we will be able to present a new and extended version of the SKA animation. The new animation will show more of the outer stations and will also indicate the signal flow from the sky, over the antennas to the central computing facility. The new animation is produced by the Italian company XILOSTUDIOS, who also produced the previous version. We decided to create it in the HDTV format because, over the last six months, we received several requests to show the animation in various television programmes. Two still images are shown in Figure 1.



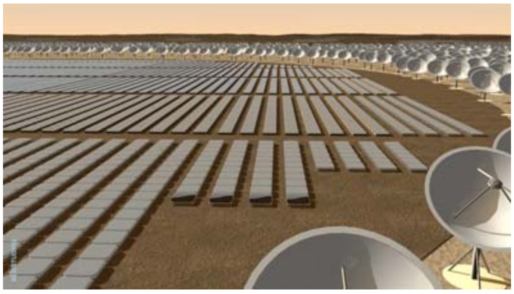


Figure 1. Images from the new SKA animation, which will be released later this year. Produced by XILOSTUDIOS.

Indeed, the SKA is being mentioned at various, unexpected places, like in the very recent Techno/SF thriller 'The Lure' by Bill Napier. With a number of conferences coming up, expect the SKA to be visible at most of them, even if it is just in the form of the popular SKA sticker on someone's laptop. Requests for the sticker, bookmarks or any other outreach material to support your conference will be gladly received by the ISPO.

Michael Kramer
Chair Outreach Committee

SITE EVALUATION

Last August, Australia and South Africa were short listed as acceptable sites for the SKA after a long process that involved various studies, including independent RFI monitoring at the proposed sites. Given the importance of the final site selection, the ISPO will organise and conduct further studies to characterise the two final sites.

The ISPO will convene a Site Characteristics Working Group, chaired by the new ISPO Site Engineer (to be appointed), to co-ordinate the additional studies. These studies will investigate the RFI environments with deep integrations at the central, and a few remote, stations. It is hoped that the radio frequency spectrum will be measured down to as close to the International Telecommunications Union (ITU) specified levels as possible.

In addition, preparations will be made to establish a Radio Quiet Zone (RQZ) for the central region of the SKA. These efforts will be pursued by South Africa and Australia independently. The ISPO/SEWG Regulatory Affairs Task Force will provide comments and advice as needed. The Task Force will also work with the ITU to prepare for a future recommendation to establish the necessary RQZ.

The site characterisation studies will include detailed studies of ionospheric fluctuations; the effects of tropospheric turbulence on high frequency measurements; optimisation of the array configuration to maximise the Key Science Project requirements; the site physical characteristics that may affect the telescope design, operations and cost. Demographic studies will determine the long term sustainability of the science environment in the face of potential RFI threats.

The studies described above have been proposed as ‘Work Package 3’ in the proposal, “A Preparatory Study for the Square Kilometre Array”, recently submitted to the EC’s FP7.

Yervant Terzian
Chair SEWG

SCIENCE

The Science Working Group (SWG) welcomed Benedetta Ciardi (MPA), Andrew Hopkins (U. Sydney) and Scott Ransom (NRAO) as new.

A first draft of the SWG's science case for a Phase I SKA was presented to the ISSC at their meeting in Argentina in March 2007. Based on feedback from that meeting, along with other additional comments and updates, the science case is now almost complete and will shortly be submitted to the SKA project office.

The SWG is also continuing to develop a series of reports that lay out how the science drives the instrumental specifications, and how the specifications affect the science. Current focus is on two documents being developed in parallel by Jim Cordes: a detailed report on "The SKA as a Synoptic Survey Telescope", and a shorter memo on trade-offs between sensitivity and field of view.

Looking ahead to the rest of 2007, much of the SWG activity will be directed toward assessing and comparing various proposed SKA concepts with regard to their scientific return (especially for survey science). At the joint working group meetings that will take place in Manchester in September, SWG representatives will present the SWG's response to each of the proposed concepts, and compare them against the SKA specifications that have emerged from on-going simulation work.

Bryan Gaensler
Project Scientist,

Joseph Lazio
Deputy Project Scientist

SIMULATIONS

The Simulations Working Group (SimWG) has recently been reconstituted to consider the optimal configuration scheme for the SKA. Significant work in this area was carried out by the previous incarnation of the SimWG under the chairmanship of Steve Tingay in support of the ISSC's investigation into the suitability of the candidate SKA sites.

Further work in this area is already being carried out under the auspices of SKADS. In the near future, other groups are likely to begin looking at the configuration of both the SKA and the new pathfinder instruments. The role of the Simulations Working Group is to ensure that there is good communication between the various groups working in this area and to advise the Science Working Group on the likely implications of any proposed configurations for SKA science.

Confirmed members of the SimWG are: Robert Braun (CSIRO), Jaap Bregman (ASTRON), John Conway (Chalmers), Sheperd Doeleman (MIT), Andrei Lobanov (MPIfR), George Nicolson (Hartebeesthoek), Cormac Reynolds (JIVE), Steven Tingay (Swinburne), Mattieu de Villiers (KAT), Maxim Voronkov (CSIRO), Craig Walker (NRAO), and Melvyn Wright (Berkeley).
Configurations work within SKADS has been underway for some months and the team (led by Andrei Lobanov at MPIfR) are busy implementing an estimator of the "Spatial Dynamic Range", an imaging figure-of-merit outlined in SKA memo 39.

The exercise to date has largely been one of selecting the most appropriate software platform (finally adopting a system based on the aips++ simulator) and implementing the additional software infrastructure required to carry out the numerical investigations. The first quantitative results and some early conclusions are expected in the coming months. Undoubtedly these will stimulate some active debate within the SimWG!

Cormac Reynolds
Chair SimWG

MEETINGS

Technical Challenges of SKA FPA Pathfinders
Sydney, Australia (12 - 14 March 2007)

ISSC17
San Juan, Argentina (29 - 30 March 2007)

Pulsar Thai-ming
Krabi, Thailand (29 March - 5 April 2007)

SKA2007 Inter-WG meeting
Manchester, UK (27 - 29 September 2007)
www.jb.man.ac.uk/ska2007/

From Planets to Dark Energy: the Modern Radio Universe
Manchester, UK (1 - 5 October 2007)
www.jb.man.ac.uk/mru2007/

ISSC18
Manchester, UK (6 - 7 October 2007)
www.jb.man.ac.uk/issc18/

Deep Surveys of the Radio Universe with SKA Pathfinders
Western Australia, AU (31 March - 4 April 2008)
www.astro.uwa.edu.au/news_and_events/meeting1

URSI General Assembly
Chicago, USA (7 -16 August 2008)

NEWS FROM THE CONSORTIA AND INSTITUTES

AUSTRALIA

CSIRO and ISPO host the Third International Focal Plane Array (FPA) Workshop
Sydney 12-14 March 2007

A workshop to review and discuss the Technical Challenges of SKA FPA Pathfinders was held over the three days 12-14 March 2007 in Sydney, Australia. The meeting was made possible thanks to generous sponsorship from the International SKA Project Office (ISPO), CSIRO Australia Telescope National Facility (ATNF) and CSIRO's Information and Communication Technologies (ICT) Centre.

The meeting attracted 96 participants, representing a wide interest group of astronomers, engineers and industry representatives from Australia, Europe, Canada, USA, South Africa and New Zealand. Representing the radio astronomical FPA development projects world-wide there were 9 participants from NL, 12 from Canada, 6 from UK, 1 from NZ, 3 from South Africa's SKA project, 3 from USA and 1 from ISPO.

Figure 2. Participants at the FPA meeting. [Credit: T. Sweetnam].

The ultimate success of FPAs depends crucially on accurate simulation and modelling, but arrays with order 100 or more elements present particular challenges in this respect. Invited talks from R. Mittra (Pennsylvania State University) and Jin-Fa Lee (Ohio State University) presented a range of techniques that are increasingly making large antenna arrays amenable to practical modelling. Other interesting invited talks from T. Liebsch and B. Elmegreen of IBM covered a range of topics, from manufacturability and reliability of large systems, to FPGA vs. ASIC tradeoffs and high-performance processing using the Cell processor.

Performance of FPAs in terms of efficiency, noise figure and accuracy of the achieved reflector plus array beams will be an important determinant of the ultimate use of FPAs where the benchmark has long been provided by high-performance horn feed designs for reflector telescopes. A range of approaches to these problems was presented, including system modelling of beam-formed beams and array noise performance, and methods of calibrating and measuring array behaviour. Low-noise amplifiers will also be crucial to achieving best sensitivity, and a number of potential designs and competing technologies were presented.

Groups from ASTRON (Netherlands), ATNF, and DRAO (Canada) showed results from modelling and measurements of the arrays under development at those institutions.

Signal processing architectures and calibration were discussed to place the performance and cost of FPA's in the proper framework.
Theory and measurement are now corresponding well, but arrays will have to be improved further to match the performance of the best cryogenically cooled, single-pixel horn feed systems.

Different implementation technologies for the processing hardware were discussed, as the speed and power budgets for the processing hardware are becoming the limiting issues.

It was clear from this meeting that many innovative and impressive programs are underway to tackle this important challenge to allow us to more efficiently assay the skies. A link to the meeting page and the talks presented can be found at http://www.atnf.csiro.au/projects/ska/fpa.html

Dave DeBoer,
Carole Jackson,
John O'Sullivan, and
Diana Londish,
CSIRO ATNF

Increased Federal Government Funding for the Australian SKA Pathfinder

In May 2007 the Australian Minister for Education, Science and Training, the Hon. Julie Bishop MP, announced A$56.7 million in Australian Government funding for the Australian SKA Pathfinder (ASKAP). The announcement is consistent with the priority placed on SKA that was articulated in the Australian Astronomy Decadal Plan 2006-15. This new funding takes the Australian Government's commitment to ASKAP to A$100.9 million over the next four years. The funding includes A$5 million for Australian Government engagement in the international SKA program, including participation in the proposed EU FP7 PrepSKA program.

The Australian Government is also working closely with the Western Australian State Government to further develop the Western Australian candidate SKA site being established in the Midwest of Western Australia – for further details and images see the UWA and ATNF SKA webpages at http://www.astro.uwa.edu.au/ska and http://www.atnf.csiro.au/projects/ska/mileura.html.

Figure 3. The Australian candidate SKA site, Murchison Shire WA. Copyright University of Western Australia

The proposed ASKAP core site is located within the area protected for radio astronomy by Section 19 of the WA Mining Act, submitted in the Australian Proposal to Site the SKA in Australia. The selected location for the core of ASKAP is closer to power and optic fibre infrastructure than the initial location of Mileura Station where testing was carried out, and is further from RFI-generating local towns.

The mid-frequency component of the Australian SKA Pathfinder, implemented with phased array feeds on dishes, formerly called the xNTD, will have up to 45 small parabolic dishes and "smart feeds". For details, see the new ATNF web pages at http://www.atnf.csiro.au/projects/mira. This project is being led by CSIRO ATNF, in collaboration with CSIRO ICTC, Canada's National Research Council (NRC), University of Western Australia (UWA) and Swinburne University of Technology. Negotiations are underway with other potential national and international partners.

MIRA Widefield Array

The core site will also be home to the MIRA Widefield Array, or MWA, previously known as the Low Frequency Demonstrator (LFD), and this project is being led by Haystack Observatory from MIT. A recent major milestone for MWA has been completing the redesign of the tile elements for mass manufacture and assembly. The first two of these new designs have now been manufactured in a facility in China. One has now been taken to the site, and the second shipped to Boston (USA) for electromagnetic testing.
The MWA project has recently undergone its first review by external technical experts. The primary aim over the coming months is to develop all critical systems in the project to a point where a 32-tile system (the so-called 32T system) can be installed. The 32T system will include advanced prototypes of most of the MWA systems.

Diana Londish (CSIRO ATNF) and Bob Sault
(University of Melbourne),
MWA collaboration

Science with the Australian SKA Pathfinder

Following the third Focal Plane Array Workshop in Sydney (see article above), a two-day science meeting was held to discuss design priorities for the SKA pathfinder instruments in the light of the key science drivers identified by the astronomy community. The wide-ranging program featured talks by 27 different speakers from 14 different institutions worldwide. It was particularly pleasing that Canada was well represented. The two days were divided into five main science topics: "neutral hydrogen", "pulsars and transients", "continuum", "magnetism" and "synergies". These science topics are closely aligned with the SKA Key Science goals. The meeting was closed by Bryan Gaensler, Chair of the Science Working Group for the SKA, who outlined the next steps towards making the SKA a reality.

The meeting gave the ASKAP project team an excellent overview of the requirements of the scientific community and triggered extremely useful discussions between the Australian, European, South African and Canadian participants. A comprehensive science case has now been put together to take us forward to the next stage – see http://www.atnf.csiro.au/projects/ska/newdocs/MIRANdAscience_may1.pdf .

Simon Johnston,
ASKAP Project Scientist

First Australian e-VLBI a success

Australia has made its first trial of e-VLBI (i.e. VLBI with signals from several antennas correlated in "real time") with great success. For a total of 16 hours during March 23-25, 2007, data from CSIRO's Parkes, Mopra and Compact Array antennas, and the University of Tasmania's antenna near Hobart were streamed to Parkes, where it was processed with a unique software correlator developed by Swinburne University of Technology, running on a cluster of PCs. Data rates during the experiment were up to 256 Mbps per telescope. The software correlator development by the Swinburne University of Technology was funded by the MNRF SKA project. Mr Adam Deller (Swinburne), Dr Chris Phillips and Dr Shaun Amy (both CSIRO) provided critical technical expertise in getting the experiment to work.

Tasso Tzioumis,
ATNF VLBI Coordinator

News from New Zealand

The New Zealand research network, KAREN (Kiwi Advanced Research and Education Network), was launched at the end of 2006. The Centre for Radiophysics and Space Research (CRSR) at Auckland University of Technology (AUT) collaborates with KAREN. The network is capable of 10 Gbps and connects all New Zealand universities and research institutes. CRSR has successfully applied to the KAREN Capability Building Fund for funding for "Real-time Trans-Tasman eVLBI" (http://www.reannz.co.nz/assets/Uploads/Documents/2.6m-for-advanced-networking.pdf). This will involve connecting the two research networks, AARNet (the Australian Academic Research Network) and KAREN, into one Trans-Tasman eVLBI network, and will allow us to demonstrate the technical feasibility of extending an Australian SKA to New Zealand; this will expand the maximum baseline of the SKA from 3000 km to 5500 km.

The New Zealand SKA Committee (SKANZ) has recently launched a website, www.skanz.org; this website also allows industries to register their interest in the SKA.

Auckland University of Technology is investing US$500,000 in a prototype 12m radio telescope, which will boost New Zealand's participation in the SKA project (see http://www.scoop.co.nz/stories/SC0703/S00002.htm). The antenna, from US firm Patriot Antennas Ltd, will be a 12m shaped Cassegrain, operating at up to 32 GHz, with a slewing rate of 5 deg s^{-1} in azimuth and 1 deg s^{-1} in elevation. The antenna will be located north of Auckland and be commissioned in January 2008.

Sergei Gulyaev,
SKA New Zealand

CANADA

SKA Technology Development in Canada

In Canada, SKA-related technology development is targeting low-cost, high-performance solutions in three areas vital to the SKA: wide field-of-view, low system temperature, and large collecting area. These three areas are being addressed respectively by phased focal plane array feeds (the PHAD project), novel CMOS LNAs, and reflector antennas fabricated with composite materials (the CART project).

PHased-Array Demonstrator (PHAD)

Steady progress is being made on the PHased-Array Demonstrator (PHAD), a prototype engineering demonstrator of a phased focal plane array at the Herzberg Institute for Astrophysics (HIA). PHAD will not have the sensitivity or bandwidth of a science-capable feed system, but will be sufficient to demonstrate the technology and to explore design issues applicable to a science-ready system. One of the key design features is the ability to store all the data from all of the elements in the array. This enables tremendous flexibility, both in system diagnostics, and in beamformer algorithm development. Initial beamformer design will be done off-line with a software beam-former that will work with stored data. Once the algorithm has been tuned, it can be uploaded into the FPGA-based data acquisition system and real-time beamforming can then be used for deep integrations.

The PHAD array has 180 elements (90 for each orthogonal linear polarization) along with a row of "dummy" elements around the periphery of the array (Figure 4). The array is 76 cm wide (or 5 wavelengths at 2 GHz) with element spacing of half-wavelength at 2 GHz. The elements are "Vivaldi" antennas, working over the frequency range 1-2 GHz. There are no active components on the antenna element boards. The array is modular and is assembled by sliding antenna elements into slotted posts supported by the backplane.

The receivers used in PHAD take advantage of modern radio frequency integrated circuits which provide a large amount of functionality with a small number of components. For example, on the receiver chip there is, in addition to the usual chains of amplifiers and mixers, a complete synthesizer to tune the receiver. Low-noise amplifier chips are also on this board.

PHAD is now built, and an extensive series of tests and measurements have started, beginning with array radiation patterns measured in an anechoic chamber. Ultimately, we are aiming to test the system on a radio telescope.

Figure 4. The 180-element PHAD array

CMOS Low-Noise Amplifiers

The availability of very-low-noise amplifiers operating at room temperature is key to producing sensitive, low-cost, phased-array receiver systems, since they do not require potentially costly cooling systems. Although traditional HEMT technology has had little improvement over the past decade, the CMOS technology used in computer chips has been advancing at an exponential rate described by Moore's Law. As transistors are made smaller, they not only work at higher frequencies, but they also have lower noise.

Although this reduction in noise has been predicted for some time, only recently has it been demonstrated. Figure 5 shows an amplifier fabricated with 90 nanometre CMOS that has achieved a noise temperature of less than 14K between 800 and1500 MHz, operating at room temperature. This has been attained through a combination of clever circuit design and careful layout of the chip. This very promising result suggests that as CMOS technology progresses to smaller device geometries, there are excellent prospects for room temperature CMOS amplifiers to be competitive with traditional cooled low-noise amplifiers. Leo Belostotski and Jim Haslett at the University of Calgary are leading this work.

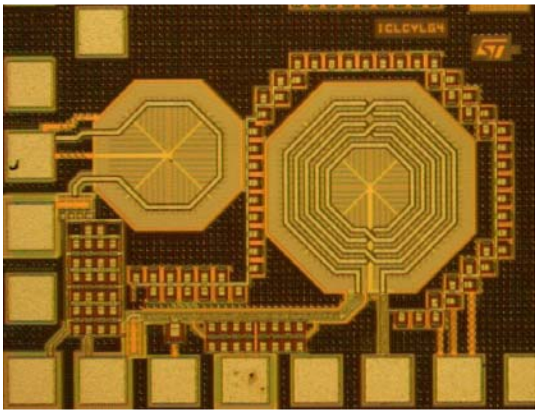


Figure 5. Die photo of a CMOS LNA that has attained a noise figure of less than 14K between 800 and 1500 MHz. The actual size of the device is approx 1mm.

Composite Reflectors

The ability to build large collecting areas with cost-effective reflectors having excellent radio-frequency performance remains a significant technology challenge for future radio telescopes. At HIA, the CART project (Composite Applications for Radio Telescopes) is addressing this challenge by applying composite materials and fabrication techniques to low cost-per-unit-area radio-telescope applications.

Work on a 10-m prototype is progressing well. In the past 3 months, the 3-piece mould for the reflector surface has been installed in our fabrication facility. To ensure the fabrication process would work as designed, a section of the integrated reflector surface and beam structure was successfully built. This prompted the lay-up of the first full 10-m reflector, now well underway. The reflector surface has been laid (Figure 6), and the team are currently installing the structural beams on to the mould (Figure 7). The reflector should be ready for pulling from the mould by mid-July.

Once off the mould, the reflector will be placed on a telescope mount (from the MV-1 mobile antenna formerly located in Yellowknife, in the Northwest Territories) for testing. The opportunity to acquire this antenna arose during the winter months, and one of our engineers spent a week in -30°C temperatures supervising the dismantling of the antenna for shipment to the DRAO site (Figure 8). It arrived in late March and is now undergoing refit for the CART project.

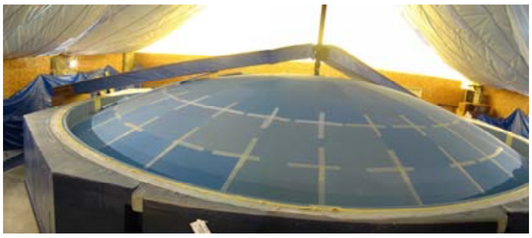


Figure 6. The reflector surface of the 10-m prototype laid in the mould. The blue material is foam core.

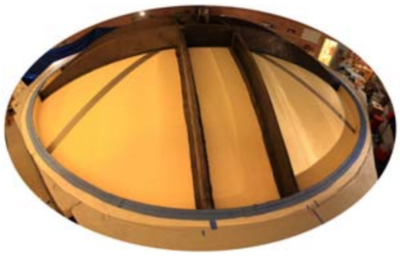


Figure 7. The integrated structural beams are put into place.

Figure 8. The MV-1 antenna being disassembled in -30C conditions in Yellowknife. At least it was sunny!

The University of Calgary Centre for Radio Astronomy

In June, the Office of the Vice-President Research of the University of Calgary approved the formation of a Centre for Radio Astronomy at the University of Calgary. The Centre for Radio Astronomy combines groups in the Faculty of Science and the Schulich School of Engineering, and builds on a long-standing research partnership between the University of Calgary and the National Research Council of Canada, Herzberg Institute of Astrophysics. As part of establishing the Centre, the University of Calgary will provide $2.1M of direct monies and in-kind support toward a mandate to promote and facilitate Canadian participation in the next-generation of international radio astronomy facilities prioritised in the Canadian Long-Range Plan for Astronomy, including the SKA.

Sean Dougherty
Herzberg Institute of Astrophysics,

Russ Taylor
University of Calgary

CHINA

Construction of a 50 m scaled model of FAST commenced in 2005. The aim of this model is to prove the feasibility of the FAST design. Located in Miyun, north of Beijing, the 50 m model has now passed acceptance checks and is being used as a test model for the full-scale FAST.

Reflector Design of the FAST Model

Many innovative features have been incorporated into the model's reflector design, including the cable structure, panel elements, and actuators. In fact, the design has been effective at reducing the quantity of reflector panels required. The reflector design is shown in Figure 9.

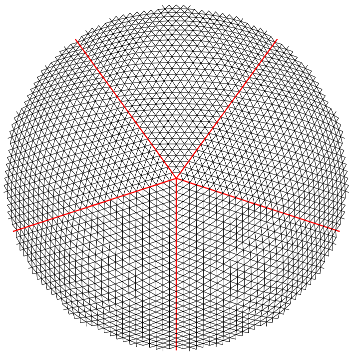


Figure 9. Reflector design, illustrating the cable structure's five axis symmetry

The model incorporates a cable structure with five-axis symmetry in which the centre of the reflector is also the central element. Theoretical calculations show that five-axis symmetry is better than two- or three-axis symmetry in terms of handling stresses created when loads are applied to the cable net to change the shape of the reflector.

The beam string structure (Figure 10) adopted provides a panel layout which is as light as a double-layer structure, but as easy to manufacture as a single-layer structure. The full scale version of this reflector panel element is currently at the design and manufacture stage of development.

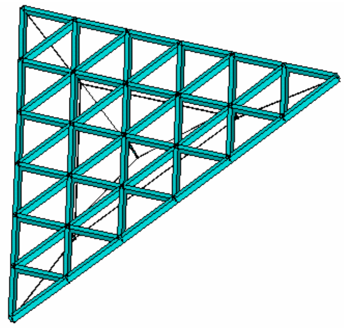


Figure 10. Reflector panel layout in a beam string structure

A design for testing the reflector panel, as shown in Figure 11, involves hanging the reflector panel element from three towers to simulate the pose and position when mounted. Such a test device ensures that the design of panel elements conforms to specifications in a variety of mounted poses and positions.

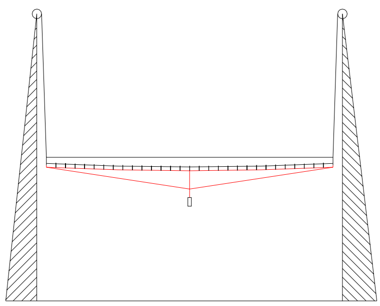


Figure 11. Reflector panel hanging from 3 towers

Several types of actuator are undergoing detail design and model making. The final design of the actuator will depend upon test results and analysis of efficiency, reliability and cost. An actuator layout under consideration is shown in Figure 12.

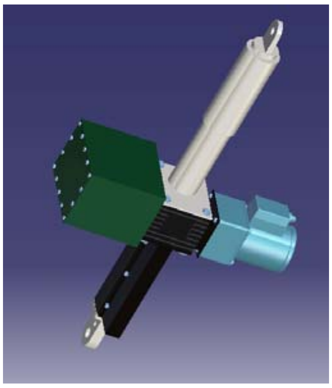


Figure 12. Illustration of a layout actuator design

Feed Suspension Experiment

A laboratory has been set up to test the stability of the FAST model's feed suspension. The configuration of the feed suspension system consists of two main parts: (i) a cable-driven system controlled by a central computer which adjust the lengths of the cables as required, and (ii) a Stewart platform in the focus cabin which serves as a stabilizer to provide fine adjustment, in the order of several millimetres to some tens of millimetres, to the cable-driven system. The experimental model of the Stewart platform is shown in Figure 13.

In order to test the dynamic characteristics of the stabilizer, a series of vibration control experiments will be conducted.

Figure 13. Experiments are conducted on the secondary stable platform of the FAST model's feed suspension system. Excellent vibration curbing effects have been achieved.

In order to meet the required accuracy for tracking and pointing the model, 3-dimensional movement of the upper plate must be monitored to ensure that it moves precisely with the cabin. Data on the position of the upper plate is fed back, in real time, to drivers which deform the structure of the secondary adjustable system whilst keeping the lower plate on the desired track. However, accuracy requirements for tests conducted on the model will be less stringent. Three total stations (TS1, TS2 and TS3)[1] measure the position and orientation of the cabin.

Several tests have been carried out to ensure that the measurement system will perform as required when used on the model. These tests include sample rate, delay time, static properties, dynamic characteristics, and investigating the frequency spectrum. Two modes of operation can be used: static and dynamic. For example, the total stations might track three targets on the edge of the upper plate of the stabilizer and then send the data back to the measurement computer as quickly as possible. In static mode, the stabilizer is kept stationary, but in dynamic mode it is vibrated deliberately using a counter weight. Results have shown that, despite some problems such as sampling rate and accuracy, the total stations have an important role to play in testing of the model. The following results have been obtained from tests conducted:

- Delay time: 150 groups of data show that delays are consistently about 240ms. The stability of the system is improved significantly when the delays are eliminated.
- 62 groups of data show that the rms static position error is less than 0.4mm in horizontal direction and less than 0.1mm in vertical direction, and the rms orientation error is less than 120 arc-seconds in the horizontal direction and less than 280 arc-seconds in the vertical direction.
- Frequency spectrum: resonance frequencies of 1.6Hz and 2.0Hz were found, caused by TS1 and TS2. There was no obvious resonance frequency for TS3.
- 150 groups of the data were taken in dynamic mode and the results are

[1] A total station is an optical instrument for survey. It is a combination of a theodolite (measuring two positional angles) and a laser ranging (measuring distance).

shown in Table 1, where dx, dy and dz (dx', dy' and dz') stand for the average position errors (rms, mm) with (without) the delay time. dα, dβ and dγ denote average orientation errors (rms, arcsecond). The data were collected when targets were approximately 5m from the total stations and the move field of the target was more than 50mm. Results improved when the distance between targets and total stations was increased to 15m.

dx	**Dy**	**dz**	**dx'**	**dy'**	**dz'**
1.85	2.25	3.00	1.1	0.85	1.14
dα	**Dβ**	**dγ**	**dα'**	**dβ'**	**dγ'**
2222.3	1756.7	666.4	982.3	938.1	582.2

Table 1. Test results in dynamic mode (see text).

FAST Progress

The FAST project has passed its initial appraisal (Appraisal Review of 2006), conducted by China International Engineering Consulting Corporation (CIECC) on behalf of the National Development and Reform Commission (NDRC). FAST received positive comments about the scientific significance of its proposal and has subsequently sought to improve the proposal in line with newly issued engineering design guidelines for big scientific projects. Chinese Yuan 600M (~ €60 M) is to be allocated to FAST by the NDRC.

In response to a request by NDRC, a FAST scientific user meeting was held from 9-11 May 2007, in Hang Zhou, south of China; approximately 30 astronomers and engineers took part (Figure 14). Users helped to establish requirements for FAST facilities needed to meet scientific targets, including pulsar observations, neutral hydrogen mapping, large scale surveys, galaxy and star formation studies, etc. The user base is not only within the radio astronomy community but also extends to other disciplines, such as environmental and geophysical sciences. FAST operational and management needs were also discussed at the meeting.

Figure 14. FAST User Meeting in Hang Zhou

Outreach work has been carried out to help build dialogue and understanding of the FAST project.

NAOC, China

EUROPE

ESKAC

European activities in this report period focused on the ongoing work related to SKADS and on the completion of the international PREPSKA proposal. This project, if funded, will make a major contribution to completing the project definition to the point that it is ready for major funding requests. Major partners in the global SKA community have joined this effort that will bring funding agencies and radio astronomy institutions to the table.

A. Zensus
Chair ESKAC

SKADS

SKA Design and Costing

A major milestone in the SKADS project was the recent submission of the SKADS Design and Costing document to the ISSC. This document now appears as SKA Memo #93.

The SKADS design and costing is based on a projected realistic system and is implemented in an extensive Excel spreadsheet which shows the individual contributions of various subsystems to the overall cost. The spreadsheet can also be used to adjust a number of design decisions to see how changes affect cost.

In parallel to the SKADS costing work, a costing exercise has been undertaken by Aaron Chippendale for the International SKA Project (see p.4). The SKADS costing team is now contributing to the continued development of the SKA costing tools. A future version of the SKADS costing and design will utilise the costing tools developed for SKA.

Radio Astronomy Summer Schools

The French science funding agency sponsored a summer school on low frequency radio astronomy, which took place at Goutelas Castle during the week of 4-8 June. The school covered basic topics in radio astronomy, including science, antennas and receivers, and interferometry. The purpose of the school was to educate French astronomers on the upcoming projects and prepare the next generation of astronomers to use these instruments. Highlights of developments and science for SKA and LOFAR were covered, in addition to the developments in ultra high energy astronomy by radio detection of atmospheric particle cascades (the CODALEMA project). There was also a well attended public lecture by Steve Torchinsky on Dark Energy and the SKA.

The first SKADS Marie Curie Conferences and Training event will take place in Medicina, Italy (23 - 29 Sep). This week-long event will cover SKA science, as well as fundamentals of radio astronomy and radio interferometry, and technical developments in radio astronomy.

4 Years in the Life of SKA / Simulations for the SKA

The University of Oxford, led by Steve Rawlings, has been conducting a thought-experiment to schedule time on the SKA in three stages leading up to the full implementation of the SKA. Proposals were solicited from the astronomical community and 24 were received.

Aside from the science topics directly related to the SKA Key Science goals, a number of ideas have been proposed, and now the scheduling exercise must begin. The proposals will be published together in a volume on Early Science with the SKA.
SKADS is sponsoring a workshop at the Pushchino Radio Astronomy Observatory within the context of the SKADS Science Simulations design study. The "4 Years in the Life" exercise will be an important topic at this meeting, as well as the Simulations for the SKA telescope configurations and pure science simulations. The meeting will take place in Pushchino (30 Jul - 1 Aug).

SKADS Workshop and Mid Term Review

The annual SKADS Workshop will take place in Paris again this year, during 10 - 11 October. This two day event will focus on SKADS accomplishments over the first two years, and will outline our plan for the final two years of the project. Although this will be a busy time for SKA scientists and engineers, with meetings in Manchester during September and October, we hope you will join us for the SKADS Workshop.

The SKADS Workshop will lead into the formal Mid-Term Review which takes place on 12 October, also in Paris. The Mid-Term Review is a major milestone for SKADS, and it must be passed successfully if we are to continue.

EMBRACE and other Tile Developments

The primary technology demonstrator for SKADS is the Electronic Multi-Beam Radio Astronomy ConcEpt (EMBRACE). The prototype tile is almost fully integrated and has 64 Vivaldi antenna elements mounted on four circuit boards, which are half populated with their electronic components.

As part of the SKADS technology development studies within DS4, there are parallel efforts at ASTRON and Nançay to develop analogue beamformer chips. A first run of the Nançay beamformer chips have already been fabricated and are currently under test. Eventually, the Nançay chips will be integrated into one of the ASTRON development tiles.

Meanwhile, characterisation of the EMBRACE front-ends is fully underway at ASTRON in Dwingeloo. The EMBRACE Project expects to have several working tiles by the end of this year, with tests of the multi-tile prototype starting early-2008.

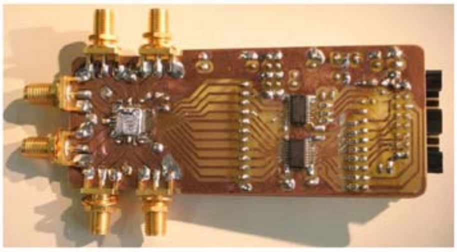


Figure 15. The beamformer chip developed in Nançay is shown here in its test module.

Figure 16. Arnold van Ardenne demonstrates one of the potential technologies for aperture-array tiles under development at ASTRON. The primary radiators are Vivaldi feeds printed on flexible circuit board and inserted into a foam support structure.

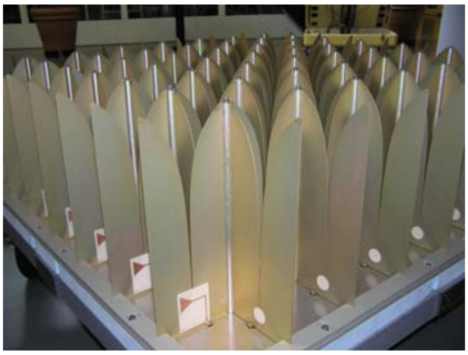


Figure 17. Another solution under development at ASTRON has the Vivaldi feeds as self-supporting solid structures made of anodised aluminium.

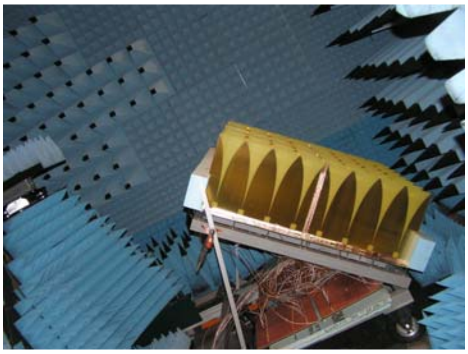


Figure 18. The EMBRACE prototype tile under test in the ASTRON anechoic chamber.

Steve Torchinsky
SKADS Project Scientist

LOFAR

The challenge, as well as the excitement, has begun. Since December 2006, ASTRON has deployed a total of 96 antennas (the equivalent of a full LOFAR station) in the core of LOFAR, near Exloo in the province of Drenthe in the North-East of the Netherlands.

The 96 low-band antennas (LBA) are optimized for operation in the 30-80 MHz frequency range, and are distributed over four fields, which are up to 400 metres apart, providing good uv-coverage for calibration and imaging capability. In March 2007, 32 individual High-band Antennas, optimized for operation in the 110-240 MHz frequency window, were made operational by ASTRON staff and 6 prototype tiles (each consisting of 4x4 antennas, combined with an analogue beam-former) were delivered in late May. Initial processing of the signals takes place on location with dedicated digital hardware. Afterwards, the signals are transported to the central processing facility at the University of Groningen, some 60 km away, where they are correlated on the IBM BlueGene/L supercomputer and stored as AIPS++ Measurement Sets.

On 23 - 24 February 2007, 29 hours of data were acquired using 16 micro-stations. One of the 16 micro-stations beam-formed the digital signals of 48 dipoles in the direction of CasA. The other 15 micro-stations processed single dipole signals. Data were taken at frequencies ranging from 44 - 60 MHz. The total effective bandwidth was about 0.5 MHz. The data were calibrated using the MeqTrees package developed at ASTRON, and imaging was done using AIPS++ software. Separate self-calibrations were made on both CasA and CygA. The sources were then subtracted from the visibility data and the residual visibilities were transformed to the image shown in Figure 19.

What makes this image so impressive is the field-of-view and the reasonable dynamic range attained at this early stage. At least 40 other sources, all much fainter than CasA, can be seen in this image, which has a noise level of about 5 Jy. The flux density of CasA is about 20,000 Jy, giving the image a formal 'dynamic range' of several thousand to 1. The image clearly demonstrates the capability of the current end-to-end processing system, and bodes well for the future.

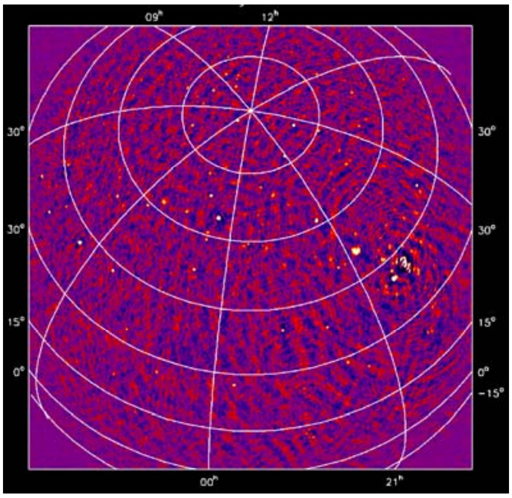


Figure 19. First deep, wide-field image made with the first LOFAR stations at a frequency of about 50 MHz. The angular resolution of the image is about 0.5 degrees. The image is centred on CasA, the brightest radio source in the sky, which was removed from the image. The image was obtained by Ger de Bruyn (ASTRON & Kapteyn Inst. Groningen) and Sarod Yatawatta (Kapteyn Inst. Groningen).

The first international LOFAR station (IS GE-1) has been built in the direct neighbourhood of the 100-m Effelsberg radio telescope, in a collaboration between ASTRON and MPIfR. The costs of the station are borne by the Max Planck Society. At the moment, 96 dipole antennae for the low frequency range of 30 to 80 MHz are operational. The first successful test of the Effelsberg LOFAR station was performed on March 21, 2007 during a meeting of GLOW, the German Long Wavelength Consortium. Eight of the 96 antennae of the low-frequency array were connected in a live demonstration. Snapshot images, made at a frequency of 25 MHz, were generated. The connection of the Effelsberg station to the international LOFAR array, via an optical fibre line (10 GBit/s), will be ready by the end of 2007.

The quality of the results from CS1 confirm LOFAR's scientific potential and were an important demonstration of the design that was presented at the system Critical Design Review (CDR) held in Assen on 17 - 18 April 2007. A panel of experts, chaired by Ed van den Heuvel, reviewed the status of the project and gave the green light for the first phase of construction which will start in the second half of this year. The advice of the panel was to start initially with the construction of the first 20 full LOFAR stations. Ultimately the ambition is to build 77 LOFAR stations, but funding still has to be secured for the final phase of an additional 20 - 30 stations. The science team is also considering the option of deploying smaller stations at all previously targeted station locations.

Following the LOFAR system critical design review, and the release of the first high quality image from CS1, it was timely to hold an international scientific workshop to discuss the potential science goals that can be realised with LOFAR. On 23 -27 April 2007, the radio astronomy community met near Emmen (NL), only 20 km from the final location of the core of LOFAR. With 120 participants from 15 countries in attendance, this telescope is already attracting a lot of attention. A broad variety of the different astrophysical topics that can be addressed by LOFAR was presented and discussed by a very enthusiastic audience, all of whom are eager to see LOFAR coming "on-line". One of the conclusions of the workshop was that the topics presented span almost the whole age of the Universe, from the Epoch of Reionisation to Lightning occurring in real time right over the antenna fields and astronomer's heads!

Besides the exciting science which can be done with LOFAR, an important topic of discussion at all times during the workshop was the extension of LOFAR to much longer baselines: E(uropean)-LOFAR. With the first low-band station now complete in Effelsberg, and with LOFAR's roll-out team preparing for the delivery of more stations to Germany (e.g. Garching and Potsdam), the UK and France; plus the declaration of more interest from other European countries, e.g. Sweden, Italy, Poland and most recently the Ukraine, the emergence of E-LOFAR as a serious and potentially transformational instrument becomes ever more apparent.

The LOFAR Team

INDIA

NCRA has placed an order with the Electronics Corporation of India, Hyderabad, for the fabrication of a conventional low cost 15 metre diameter antenna to operate at frequencies below 8GHz. The antenna, which has a mesh surface, is the result of a cost optimisation study that has been carried out with Tata Consulting Engineers. The fabrication of the antenna has begun and it is expected to be assembled on the shop floor by September 2007 for mechanical testing. The antenna will be transported and erected in the Pune campus of NCRA for astronomical tests by the end of the year.

Pramesh Rao

SOUTH AFRICA

MeerKAT

Meeting in Amsterdam

More than 40 South African and European scientists gathered in Amsterdam, The Netherlands, on 20 and 21 April 2007 for a meerKAT science workshop hosted by the South African SKA Project Office, with the cooperation of colleagues at ASTRON. The South African SKA prototype is now called "meerKAT ", since the country is planning to build a much larger Karoo Array Telescope than the 20-dish array originally planned.

"The meeting was a great success and we made significant steps towards a convergent specification process," said Dr Adrian Tiplady of the South African SKA project office. "We hope to arrive at a final meerKAT specification through consultative meetings with the entire SKA community soon."

In addition to updating international partners on meerKAT, including its reference specifications and project timescales, the South Africans were keen to discuss key science themes and explore opportunities for collaboration and partnerships, as well as to explore linkages between meerKAT and other SKA Pathfinder projects and programmes such as the SKADS and LOFAR, etc. Workshop delegates also discussed an evolution process for the meerKAT specification to ensure that the instrument is optimised for science delivery.

The 'meerKAT reference specification' was used as a starting point from which presenters could deviate in order to optimise performance in their specific science discipline. The specification calls for the construction of a few percent SKA, operating in a low frequency (~0.5 - 3 GHz) and high frequency (somewhere between 8 - 22 GHz) band.

Day One of the workshop was dedicated to key science areas for meerKAT, with presentations by invited speakers. Topics included galactic and extragalactic studies in continuum and HI, pulsars and transients, gravitational lensing and cosmic magnetism. The presentations from the meeting are available at http://www.ska.ac.za/events/presentations.shtml. Day Two started with additional presentations of science opportunities for meerKAT and concluded with open discussions about the specifications, modes of collaboration, and the status of meerKAT as an SKA demonstrator.

Prototype antenna installed at HartRAO

The South African meerKAT team have successfully taken the project from the concept of a year ago to the complete installation of the Karoo Array Telescope (meerKAT) 15-metre prototype antenna in April 2007. This is the first time that a radio astronomy antenna of this size has been manufactured on site from composite materials. This project has enabled South African industry to build competence in the manufacturing of antennas of this size for radio astronomy, strengthening our participation in the global SKA programme.

"We have a 15 m diameter antenna that shows great potential and promises to be significantly better than originally specified," says Willem Esterhuyse, the subsystem manager for antenna structures on the project. "We look forward to having a fully functional antenna structure installed by August 2007."

Over the next three months, the team will install the remaining sub-system components and will commission and test the antenna. "We will only know whether the antenna has fulfilled its current promise once all this is done," Esterhuyse adds. Measurements are currently underway to test the performance of the reflector over a range of frequencies up to 12 GHz. It is hoped that results from these early tests will be available during July.

The story of how the antenna took shape can best be told by a series of photos (Figures 20 - 30) taken during its construction.

Figure 20. The completed pedestal

Figure 21. Assembly of the backing structure

Figure 22. Manufacturing of the yoke

Figure 23. Manufacturing of the feed support legs

Figure 24. Placing the last segment of the dish mould

Figure 25. The completed dish mould

Figure 26. Flame-spraying the mould

Figure 27. Installing the yoke

Figure 28. Transferring the dish resin

Figure 29. Lifting the dish onto the pedestal; followed by installation of the feed support legs

Figure 30. The MeerKAT prototype on site with all major mechanical components installed. The prototype is at the Hartebeesthoek Radio Astronomy Observatory in South Africa.

Feeding the meerKAT Prototype

The design of the meerKAT prototype feed horns was described in the January/February SKA/KAT Update – see http://www.ska.ac.za/newsletter/issues/05/04.html.

Each stepped circular horn will create an axis-symmetric antenna pattern with linear polarisation when excited by a TE_{11} mode propagating in a circular waveguide.

On receipt, the signal in the TE_{11} mode must be converted to a coaxial cable mode before it can propagate to the low noise amplifiers and all the signal processing. This transition occurs in a component called an ortho-mode transducer (OMT) which conveys the two orthogonal polarisations to separate coaxial connectors. We decided to use a quad-ridged OMT to create a high fidelity transition, enabling us to gain experience with this type of structure, which will be needed for future (wider) meerKAT bandwidths. Since the prototype bandwidth is moderate (1.4 - 1 67 GHz), we used a stepped transition instead of the normal taper between the ridged section and the input to the horns. This makes the completed horn shorter.

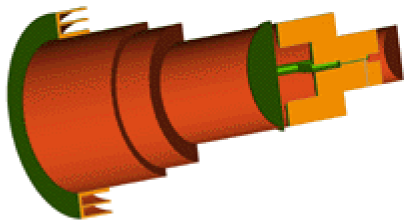


Figure 31. Cross-section of the full assembly, showing the horn, radome and quad-ridged OMT. While the model looks simple, it is electromagnetically complex. It required numerous runs of our in-house CEM software package, FEKO, on a SGI Altix 450 to develop the required insight into the physics of the structure.

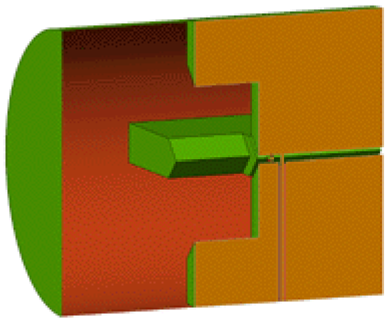


Figure 32. A cut through the back section of the OMT. The ridges are excited by passing a coaxial cable through the ridge and connecting the centre conductor to the opposite ridge. This high-precision pin was made by Thys Willemse, a watchmaker from On Time Watch Services in Cape Town.

Calibration requires the ability to inject known noise signals into the system. Thus each feed horn has a third connector with very low coupling to the two signal ports. This is usually done with a short pin near the mouth of the horn where the fields are quite small. In our design we've placed the pin between the ridges at the back, where the fields are also quite small. This places the three connectors much closer together.

To protect the OMT against the environment, a radome is added just in front of it. Instead of using the usual quarter wave transitions required for radomes supporting a vacuum, the prototype radome is anchored into a small slot cut into the inside of the waveguide wall - the reflection from the slot is less than that from the radome sheet.

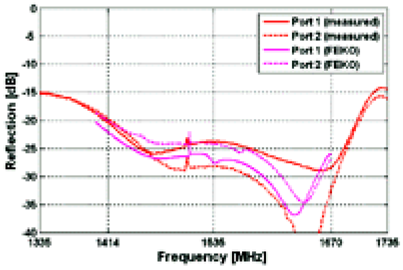


Figure 33. The predicted reflection coefficients agree quite well with the measured values - including the frequency of the trapped TE21L mode resonance. This resonance is caused by the asymmetry of the feed pin and was not apparent in initial coarser frequency sweeps. With the insight derived from this prototype and the agreement with numerical analyses, the next step is to remove the resonance.

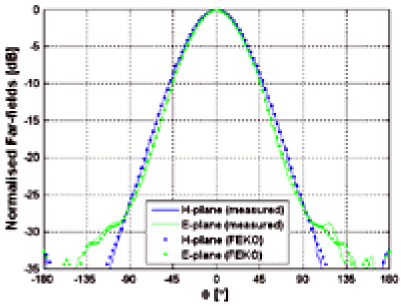


Figure 34. The measured far field pattern (shown here at 1 542 MHz) agrees very well with the values predicted using FEKO. These patterns will result in about a -13 dB edge taper on the 15 m prototype meerKAT dish.

PED Dish First Light

The Phased Experimental Demonstrator (PED), a small test radio telescope array built by the meerKAT team, produced its first results on 26 March 2007. Enthusiastic meerKAT team members connected up the receiver chain and dish drive electronics on the first dish for the first time and performed a scan across the sun. This was later followed by a longer spectral integration on, and off, the galactic plane in order to detect the neutral hydrogen radio signal.

The PED will be used primarily as a risk reduction facility for the bigger meerKAT project. It will be a testbed for meerKAT software for monitor and control, remote operations, basic scheduling, basic tied array and interferometric imaging processing, and RFI mitigation.

The PED will consist of an array of six steerable dishes and one fixed dish. The full array should be installed on the grounds of the South African Astronomical Observatory (SAAO) by July 2007. PED has a narrow instantaneous bandwidth of 4 MHz, with the centre frequency software adjustable within a 40 MHz bandwidth range (determined by the bandwidth of the low noise amplifier) and centred around the HI radio astronomy spectral line at 1420 MHz.

Since "first light", the team has focused on development of the site infrastructure and work towards more automated end-to-end single dish experiments, to be followed by interferometric experiments with the 6-dish array later in the year.

For updates, visit:
www.kat.ac.za/public/wiki/PED

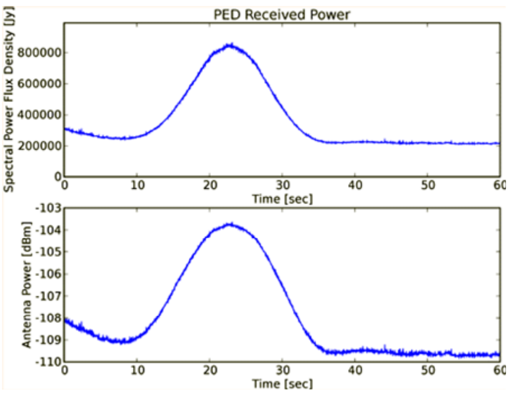


Figure 35. Calibrated drift scan results through the sun.
Top: Measured spectral flux density versus time.
Bottom: Measured power in dBm at antenna terminal. The data was calibrated by relating the received power to the LNA gain, the receiver gain, the signal bandwidth and the effective antenna area.

Figure 36. The PED team, with one of the PED dishes at the SAAO on the day of the first light measurements for PED dish 1. Back row, left to right: Thomas Bennett, Ncedo Mkondweni, Jasper Horrell, Robert Crida, Front row, left to right: Simon Ratcliffe, Richard Lord, Rudolph van der Merwe.

SKA South Africa Outreach and Capacity Building

The South African SKA and meerKAT team is using the excitement of designing and building a new telescope to generate interest and inspire a new generation of scientists in the country. They collaborate with the Science Awareness group at the Hartebeesthoek Radio Astronomy Observatory to participate in public science events across the country. The joint exhibit showcasing SKA, meerKAT and HartRAO features several information banners, scale models of the KAT prototype, a KAT terrain model, and a DVD of a virtual visit to the KAT. Cartoon-style astronomy posters and a do-it-yourself planisphere kit are distributed free of charge at events where the exhibit is erected. Download materials at www.ska.ac.za/education/resources.shtml.

So far this year, the outreach team has exhibited and presented public talks at three week-long science festivals: SciFest 2007 in Grahamstown, Science Unlimited in Pretoria, and National Science Week in Kimberley. In mid-June the team will engage with the Carnarvon community (closest town to the proposed SKA site). They also participated in ScopeX, an annual event for amateur astronomers and the general public, held annually at the Military History Museum, Johannesburg. Several more career and youth exhibitions are planned for the rest of the year.

The meerKAT project will also have high visibility at the 52nd Annual Conference of the South African Institute of Physics, to be held from 2 - 6 July 2007 at the University of the Witwatersrand.

The meerKAT team has developed a student recruitment poster to attract promising graduates to join the project; it is being distributed to universities and research organisations in the region.

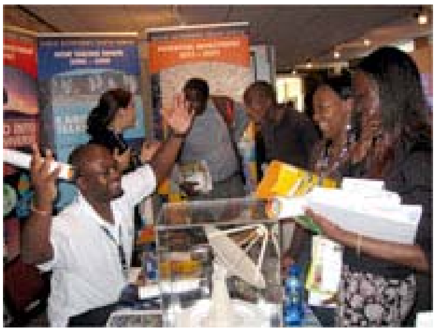


Figure 37. The SKA/meerKAT stand, SciFest 2007.

SKA Champions in South Africa

Richard Schilizzi and Peter Hall visited South Africa during May 2007 to interact with South African scientists and present a series of public lectures. They were hosted by Roy Booth, Director of the Hartebeesthoek Radio Astronomy Observatory, as part of the HartRAO international visitors' programme.

They inspected the close-to-completion meerKAT prototype dish at HartRAO, and met with several scientists, presented general public talks, met with the SKA-SA project office staff in Johannesburg and the meerKAT engineers in Cape Town. At a public talk delivered at the Johannesburg Planetarium on 9 May 2007, Richard Schilizzi noted that he was very encouraged by the preparations for building meerKAT and the level of commitment towards the SKA in South Africa. Over 200 astronomy enthusiasts turned up for his talk on "The SKA - eavesdropping on cosmic whispers".

Figure 38. Richard Schilizzi and Peter Hall inspecting the meerKAT prototype dish.

Justin Jonas

USA

Technology Development Program (TDP) proposal

The National Science Foundation has informed the U.S. SKA Consortium that the TDP proposal will receive $12M; funding starts in November or December 2007 and running through to 2011. At the time of writing, the final work plan and budget have not been produced, but discussions are ongoing and will be finished by mid-July.

The revised TDP is intended to complement the European Seventh Framework Programme (FP7) and other international developments in the SKA Program, with the goal of devising a closely coupled, non-duplicative effort to lay the technical foundation for an SKA construction proposal in the next decade.

Decadal Review and "Chicago-III"

The scientific planning has begun for the third in a series of community meetings designed to develop plans for, and support of, U.S. radio astronomy, particularly as they relate to the preparation for the next decadal review. The first meeting was held in Chicago (hence the name of the series) and the second in Tucson in August 2006. Chicago-II illustrated that the SKA is beginning to have high visibility within the U.S. community. Chicago-III is aimed at developing more concrete plans as they relate to the decadal review.

Chicago-III will be held in Washington, DC, on 14 and 15 September.

Full details on the Chicago-II meeting are at: http://www2.naic.edu/~astro/chicago2/

U.S. Pathfinder Arrays

Allen Telescope Array (ATA)

The ATA now has 42 antennas with power and air cooling in place; all can be driven under computer control. Of the 42 antennas, 27 have feeds, and in the week of 4 June, another six feeds will be placed on antennas. Twenty of the antennas have pointing and baseline solutions. The FX-32 element dual-polarisation correlator is finished and being debugged in the laboratory. It is expected to be put on the antennas later this month. A 16-element beamformer is being tested in the lab. The goal is to have a 42-element array available for astronomical and SETI observations by 1 July. This will entail using the FX-32 on all of the antennas but not on all polarizations. A 42-element beam-former with 2 beams is the goal of 1 July.

During July and August, we expect to have an FX-48 element correlator to provide full imaging and polarization capability for the array. The beamformer capability will be increased on a time line consistent with the SETI backend capability. For the first six months, we expect to continue with commissioning and debugging to enable the full capability of the array. Some minor retrofitting will be done during this time for robustness so that increasing the number of antennas is primarily a matter of replication.

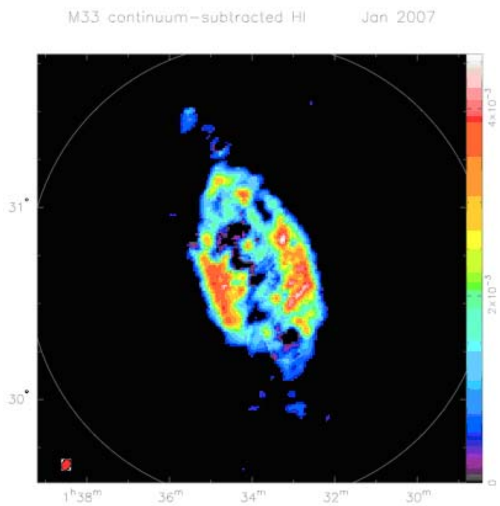


Figure 39. Image of M33 made with the ATA-42.

Deep Space Network Array (DSNA)

The DSN Array study technical activities have focused on evaluation of one candidate antenna manufactured by Patriot Antenna Systems. This 12-m, paneled antenna is being evaluated as part of a three-element breadboard array that includes two 6-m antennas. The evaluation includes performance characterization at the DSN space communications frequencies (8.5 and 32 GHz) for a range of environmental conditions. Additionally, the signal processing group has delivered an FX correlator to support this evaluation. The correlator is architecturally the same as proposed for a many element array and has been used on a daily basis for many months now. This group will add a signal combining function later this summer to perform a combined signal demonstration with various targets of opportunity (spacecraft or extra-galactic radio sources). Programmatically, JPL and NASA are developing plans for the eventual replacement of the DSN 70-m antenna by 2015, with a prototype implementation starting in 2009. The size and number of antennas for this will be finalized as part of that activity.

Expanded Very Large Array (EVLA)

As of the end of May 2007, the Expanded VLA (EVLA) project has completed the retrofit of 10 antennas from VLA to EVLA capabilities and returned these antennas to the array for routine observations. These antennas return wideband data to the VLA control building on a fully operational fiber optic link, before the data are "degraded" to go into the old VLA correlator. The EVLA monitor and control system is reaching a state of completion where it can operate both EVLA and VLA antennas, and the old VLA control computers will be decommissioned within months. A new wide-band capability from 4.2 - 7.7 GHz was advertised in April 2007; 19 proposals were received for the new tuning range for the EVLA antennas, and the first scientific observations were made in May. A new Science Advisory Group for the EVLA met in May to advise NRAO on priorities for bringing up the first full scientific capabilities on the EVLA.

Long Wavelength Array (LWA)

The contract with the Office of Naval Research was signed in April 2007 providing funding for the LWA project. Immediately afterwards, Dr. Lee J Rickard was hired at UNM to manage the project. Dr. Rickard's association with the project actually dates back many years to his management role at NRL during the implementation of the 74-MHz system on the VLA. The LWA Project Office has been created at UNM and staffing should be complete by the end of June 2007.

The Long Wavelength Demonstrator Array (LWDA) continues to operate and to provide a useful testbed for software development, including monitor and control, and software correlation. Installation of LWDA was viewed by ISSC members during their visit to Socorro in March 2006.

A transient monitoring program, taking advantage of LWDA's all-sky field of view, is beginning. Recently we have been testing ground screens, balun designs, antenna designs, and experimenting with a 300 m baseline to reduce confusion levels.

Figure 40. The LWDA interferometer. This two-element interferometer consists of the LWDA itself and a second-generation dipole (BB2) on a 300-m baseline. It is intended as a testbed for both antenna performance and software development.

See additional photos of the LWDA at http://www.phys.unm.edu/~lwa/progress_photos.shtml.

This work, and much more, is described in the LWA memo series at: http://www.phys.unm.edu/~lwa/memos

Mileura Wide-field Array-Low Frequency Demonstrator (MWA-LFD)

Recent funding increases in Australia have led to the Mileura International Radio Array (MIRA) being renamed to the Australian SKA Pathfinder (ASKAP), but the MWA has remained an integral part. MWA dipole antennas are moving into a production phase and are being manufactured in China. Each crossed dipole costs US$50 installed. The array (ASKAP and MWA) was moved about 90 km west of the initial site at Mileura to avoid future mining activity. Construction of 32 tiles has started and should be installed in the field in July; the full array will be 500 tiles.

Software development is progressing better than predicted with a first version, end-to-end test harness anticipated to be up and running this (northern hemisphere) summer. Model skies will be provided by a modified version of the Haystack MAPS package. The first implementation of the harness will provide a stable foundation for elaboration of algorithms and testing of increasingly realistic skies and atmospheres. This will enable support of the 32-tile prototype instrument anticipated before year's end and whose data will be processed off site.

Joseph Lazio
US SKA Consortium