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Project news
Preparations for the transition into the Pre-Construction Phase have really gathered momentum in the last three months. At its initial meeting in early April, the Founding Board set up work streams to focus activity in the areas of governance and resourcing of the project for the next phase, and both have made considerable progress. Time is now pressing to establish the legal entity for the SKA organisation well before 31 December when the current governance agreements end. On the funding side of things, we are well on the way to identifying the required resources for the Pre-Construction Phase for both the new SKA Project Office to carry out overall project management, system-level engineering design, and final design integration, and the Work Package Contractors - consortia of academic institutes and industry - to carry out work packages on sub-system engineering design.

The inspirational surroundings of Banff in the Canadian Rockies served as backdrop for the annual SKA Forum event in July, as well as a two-day workshop on SKA science and frontiers of astronomy in the era of massive datasets, another two-day workshop on engineering and industrial challenges for the SKA, and meetings of the Founding Board and the SKA Science and Engineering Committee. Thanks to Russ Taylor and his colleagues at the University of Calgary for a superbly organised event!

The engineering highlights in the last three months have been the conceptual design reviews (CoDRs) for the following sub systems - aperture arrays, signal transport and networks, and the dish array. These, along with the signal processing CoDR, held in April 2011, were the first in the series of sub-system CoDRs following the system-level conceptual design review held in February 2011 (see the article by Tim Stevenson on system engineering in this newsletter). All three ran the gauntlet of an expert review panel and passed with varying levels of comment and recommendation. A further two CoDRs are planned this year.

The final details of site evaluation process were approved at a meeting of the Founding Board in May. The evaluation itself will take place over the last four months of this year, with a final decision scheduled for February next year.

The final months of 2011 should keep us all on our toes!

Richard Schilizzi,
Director
How do galaxies get their gas?

Jacqueline van Gorkom and Lister Staveley-Smith

Galaxies grow by merging with other galaxies and by accretion of gas. Until a decade ago the standard paradigm was that, in hierarchical structure formation, galaxy growth is dominated by mergers. However modern simulations show that smooth accretion of gas dominates growth at all redshifts and therefore determines the star formation history. The question now being discussed is: how do galaxies get their gas? Does the gas get shock heated to the halo virial temperature as it enters the dark halo, or does it remains cold as it enters the halo. If it remains cold, does it reach the disk, or do the cold flows get disrupted through interaction with the hot halo gas? Observers already try to answer these questions with a wide variety of techniques, but it is likely that the definitive observations will only come with deep SKA imaging of the neutral hydrogen in the local Universe and with pointed SKA surveys out to higher redshifts.

A meeting on ‘gas in galaxies: from cosmic web to molecular clouds’ was held during June 14-18 at Kloster Seeon near Munich. The meeting, hosted by the Max Planck Institute for Astrophysics, brought together theorists and observers to talk about gas in galaxies. The goal of the meeting was to explore issues surrounding the accretion of gas onto galaxies throughout cosmic time.

A consensus among theorists appears to be that contrary to what was thought a decade ago, galaxies mostly grow by smoothly accreting relatively cold gas, and that the accretion rate determines the star formation history. The importance of this accretion varies with redshift, with halo mass and...
with environment. For the larger halos, accretion, galaxy growth and star formation peak between redshifts of 1 and 3. This is confirmed by observations of the star formation history over time. For lower mass halos and in low density regions the cold mode accretion continues until the present.

The theorists have not completely solved all problems. To produce luminosity and mass functions that are compatible with those observed, mechanisms need to be invented to make accretion less effective for the smallest and the largest galaxies. The most popular mechanism is feedback by active galactic nuclei (AGN) and supernovae.

The holy grail is now to detect the accreting gas, determine its temperature and image the flows into the galaxies. At higher redshifts Ly-alpha imaging and absorption will be the main observational technique. ALMA is expected to play a major role in imaging the large amounts of molecular gas inside galaxies at those redshifts. Observations with the IRAM Plateau de Bure interferometer already indicate that the molecular gas content is readily detectable at these redshifts.

Quasar absorption line studies are extremely important for probing diffuse gas outside galaxies at all redshifts and here the new results come from the COS spectrograph newly installed on the Hubble Space Telescope (HST), combined with a huge increase of the number of known quasars thanks to the SLOAN Digital Sky Survey.

Perhaps most interesting will be the studies that can be done in the local Universe. There are still many questions concerning the physics of the gas (gastrophysics) that can observationally be addressed by the upcoming SKA pathfinders and eventually with the SKA. Some major questions are: how much of the gas is at temperatures low enough to be mostly neutral and what happens to this gas when it enters the supposedly gaseous hot halos of the disk galaxies? Will the flows be disrupted or will they make it into the disks directly? High surface-brightness sensitive wide-area surveys such as can be done with ASKAP and APERTIF will be able to begin to address this question. The FAST telescope will be ideal to image the flows to very low column densities in the local Universe. Lastly, MeerKAT and EVLA will be able to probe the gas near the galaxies in deep pencil beam surveys out to redshifts of 0.4. This will give the first optically unbiased inventory of where cold accretion occurs and how it depends on halo mass and environment.

We received a first glimpse of how interesting these surveys will be in presentations on the Galex Arecibo SDSS Survey, which showed remarkably tight relations between HI mass, galaxy stellar mass and star formation rate for a large SDSS sub-sample, the ATLAS 3D survey which relates stellar kinematics to HI properties of early type galaxies in different environments, and the first results of the ongoing EBHIS survey, which showed interesting evidence for Rayleigh-Taylor instabilities along the surface of intermediate velocity clouds in the Milky Way halo.

The SKA will be able to image the local universe with enough sensitivity to actually see the denser HI in the cosmic web with high enough resolution to probe the gastrophysics as the gas enters the galaxy halos and with enough sensitivity to probe large cones in redshift space out to at least redshifts of 1 or 2. The meeting was a welcome update on the exciting science the SKA pathfinders and the SKA phases 1 and 2 will be able to deliver.
The backbone of the SKA engineering development is presently being devised and implemented. This comprises requirements engineering, configuration control and verification engineering. These system engineering disciplines ensure that the as-built SKA will do what is expected of it, and will be the discovery machine that the community has long wanted. Meanwhile the review process continues to examine technology concepts for key elements of the observatory in readiness for a selection and specification stage.

As recommended by the report of the ‘European expert group on cost control and management issues of global research infrastructures’, the SKA project uses state-of-the-art engineering management techniques to maximise the efficiency of the development and build process in the face of challenges to flexibility and of technical risk. A key element of these techniques is system engineering, and its subsidiary disciplines of requirements engineering, configuration control and verification.

The SKA is a large, complex and costly project which, despite stringent risk management, must deliver what future astronomers will need for world class science – thus the process of capturing, maintaining and complying with requirements that reflect the necessary flexibility is a tricky one. With reference to approaches taken by large radio astronomy projects under current development such as ASKAP, the EVLA and MeerKAT, the SPDO is deriving a comprehensive set of requirements that will allow us to go ahead with development whilst maximising potential science return. These requirements will be critically reviewed in the frame of a system requirements review before significant investment is made in further development. Prior to that review, more mundane requirements will need to be documented, such as statutory/regulatory and environmental requirements.

System engineering disciplines ensure that the SKA will do what is expected of it, and will be the discovery machine that the community has long wanted.

The difficulty of obtaining workable requirements in good time and the unexpected twists and turns of technical development and integration inevitably result in changes. Whilst the system engineering process attempts to anticipate the manifestation of technical risk, design and other changes will occur. In a large and complex system, many changes will be in the process of implementation at any one time, and sophisticated systems and tools will be required to keep track of change and to fully appreciate the impacts. Again lessons are being learnt from current radio astronomy projects and other science infrastructure projects where configuration control has been necessary and has been implemented with varying success.
If a project has a set of formal requirements (which the SKA most certainly will), compliance is formally demonstrated through a process known as verification. Verification comes in two distinct flavours – qualification shows that a design meets the requirements, and acceptance shows that the delivered hardware and software has been built to the design. The SKA will have many thousands of requirements ranging from survey speed to waterproofing of antenna mechanisms. These requirements will be deemed to be in compliance by demonstration, test, analysis, review of documents and inspection. In most cases, this is a contractual necessity, but in some it will also be a legal requirement.

SKA system engineering attempts to bring pragmatic practice to the challenges of building the world’s largest radio-telescope in the desert. The approach is being continuously refined, based on current best practice when undertaking engineering development in the service of science, and those large scale radio-astronomy projects where reality has begun to bite. To this latter end, the SPDO provided Tim Stevenson as a Review Panel member for two recent major ASKAP and MeerKAT project reviews, thus making a strong link with these projects and allowing an effective exchange of views and experience. It is expected that this interaction will continue and develop, as it is a major product of the precursor activity, intended to make such lessons learnt crucial to the success of the SKA.

Tim Stevenson,
SPDO System Engineer

The importance of verification cannot be understated, and furthermore the timing of a formal verification is key to development cost control. If compliance with a critical requirement remains in doubt, and is proved not to exist at a late stage, resources will have been wasted. The SKA system engineering process, in support of risk management, provides a basis for efficient and timely verification. It indicates, for instance, the level of integration required to verify a particular requirement, and suggests whether special test articles or test rigs will need to be built.
The SKA project engineering work continues with assembly requirements, see Tim Stevenson’s article on system engineering, and concept designs at the level of major sub-systems. Since the last newsletter, we have conducted concept design reviews (CoDRs) for aperture arrays, for signal transport and networks, and for the dish array.

**SKA CoDRs**

In all cases the concept design reviews, which focus on SKA Phase 1, have been successfully passed, but all have gaps that will be filled early in the next stage of work. The reports from most of the CoDR review panels have been submitted and are available from the SPDO.

The design reviews represent a significant effort for the participants, the review panel, and the host institution. The participants produce up to 1000 pages of detailed review material, which the panel study in advance. Presentations of the material last about two days, after which the panel provides immediate feedback, followed by a formal written report. The host institution makes all local arrangements and we especially thank them for these major contributions.

**International Engineering Advisory Committee (IEAC) meeting**

The IEAC held its annual meeting on Jun 14-15 to review overall progress in SKA engineering. The eight-person panel, made up of leading engineering professionals
from around the world and chaired by Peter Napier, of the National Radio Astronomy Observatory, heard presentations from SPDO staff on progress, decisions to be made and issues to be resolved. The purpose of the IEAC is to provide experienced advice on issues that arise, or that have been flagged in preparations. The findings are then reported to the SKA Science and Engineering Committee (SSEC).

The IEAC report that has recently been submitted to the SSEC, contains detailed recommendations, but in general reports “significant progress in the Project since the previous IEAC meeting one year ago”. Among other points, it mentions the execution of the CoDRs, the delivery of the Project Execution Plan for the next phase of the SKA design work, and engineering support of the site selection process.

This will be the last meeting of the IEAC, as currently constituted. In the re-organisation of the project for the pre-construction phase, a successor committee is likely to be required. Peter Napier has also decided that this will be his last meeting as chair of the IEAC (or its possible successor). We would like especially to thank Peter for his enthusiasm for the SKA project, and for the level of effort he has put into the IEAC. His deep engineering experience will be missed.

**SPDO involvement in precursor reviews**

SPDO staff continue to be involved in external reviews including the recent major reviews in the ASKAP and MeerKAT projects. Tim Stevenson, SPDO System Engineer, served on Preliminary Design Review (PDR) panels for the ASKAP System Engineering, Integration and Commissioning, and for the MeerKAT System.

**Engineering involvement in the SKA2011 meetings in Banff, Canada**

The engineering highlight of the week of meetings in Banff in July was the two-day engineering and industry meeting - a walk through the SKA system. Attended and facilitated by SPDO engineering staff, this was an opportunity to bring a large audience of people from industry and governments up to speed on the engineering and programmatic developments of the SKA. Judging by level of participation in the discussion sessions and the nature of the discussions, the audience was clearly knowledgeable and engaged. See Phil Crosby’s article on industry engagement and participation for a more complete description of this meeting.

**URSI General Assembly, Istanbul, August 2011**

A special session - technology development for the SKA program - will be held at the General Assembly of the International Union of Radio Science (URSI) between 13 – 20 August 2011. This should prove to be a very interesting session, providing an opportunity to highlight new work on technology as well to report progress on key technology aspects of the SKA. Because of the huge cross-section of radio engineers involved in URSI meetings there is also plenty of opportunity for new ideas to flow across technology and institutional boundaries.

*Peter Dewdney, Project Engineer.*
Recent industry engagement activities have been dominated by meetings in Canada at the annual SKA Forum week. Held in the picturesque town of Banff, near Calgary, SKA2011 once again brought together representatives from science, national agencies and other stakeholders to review and discuss progress. This year saw a new focus on industrial participation, following the release of the pre-construction phase project execution plan (PEP).

**PrepSKA WP5 procurement policy**

The PrepSKA WP5 group met prior to the main programme to review progress with procurement policy. The need for a broad industry capability scouting activity was confirmed, and planned to commence later this year. An in-depth look at global procurement models was tabled in a document ‘Towards a procurement strategy for the SKA’. While some expansion is required to describe the practical aspects of the proposed Work Package allocations, this important document met with general approval.

**SKA2011 meetings**

On the Tuesday afternoon, the organisers of the various regional/national industry clusters each gave an overview of their profile, structure and benefits to their members. Speakers from Australia, South Africa, Italy, Britain, the Netherlands, and Canada described how their clusters were growing in maturity and cohesiveness as they gain involvement in the global SKA project. Delegates at the mid-week forum day were treated to stimulating keynote presentations from R & D executives from IBM and Boeing each expressing the opportunities and challenges associated with large, complex, high-technology projects of the scale of the SKA.

The following two-day industry and engineering event was considered by many to be the highlight of the week, with over
50 companies joining a similar number of science and institutional delegates to conduct a ‘deep-dive’ into industrialisation aspects of the SKA project. After several scene-setting talks by SPDO staff and a guest speaker from CISCO, participants were offered a choice of seven break-out sessions, each focusing on a particular technical domain. Each session was led by senior personnel from firms including Intertronics, Selex-Galileo, Nokia-Siemens, BAE Systems, Intel, TATA Research and Horizon Power.

Next day the groups each reported back to the forum, offering extremely useful feedback concerning the value industry can bring in terms of R&D, strategic participation, supply, programatics and experience. Groups were also asked to comment on future direction for their technologies. The summaries from this part of the conference will be consolidated into a report for dissemination to the nominated industry engagement representatives in coming weeks. Subsequent feedback from SKA2011 delegates indicates that they found the Industry and Engineering event very beneficial, and instrumental in the success of the whole event.

The SKA2011 Forum week also offered an appropriate venue for several industry-related announcements. CISCO International became the fourth international icon company to sign a Statement of Mutual Interest (SoMI) arrangement with the SPDO, thus opening the way for specific interactions concerning advanced digital signal transport technologies.

BAE Systems recognised Phil Crosby and Georgina Harris for their efforts in early industry engagement with the SKA though a Chairman’s Award.

Representatives from the US SKA Consortia announced their intent to assemble a US industry cluster.

And John Humphries from the Australian Industry Consortium (ASKAIC) is to be congratulated for achieving signup of several regional industry groups to a global ‘cluster of clusters’ network to support the SKA project.

**Phil Crosby,**
Manager - Industry Participation Strategy
Outreach update

The summer of 2011 has so far been a very busy one for SKA outreach. The new international SKA conference stand has been out and about at conferences and events across a range of disciplines including astronomy, technology and journalism as well as at the international SKA meetings in Banff that took place in July. We are also pleased to announce the launch of the very first issue of the SKAnimals which has been designed to engage younger audiences and is now available on the SKA website.

International SKA project on tour

The international SKA project has been out and about this summer exhibiting at conferences across a range of disciplines. So far the tour has taken us to:

- NAM National Astronomy Meeting, 17-21 April, Llandudno, Wales
- World Conference of Science Journalists, 26 – 30 June, Doha, Qatar
- SKA 2011 meetings, 4 – 8 July, Banff, Canada
- APRIM 11th Asian-Pacific Regional IAU Meeting, 26-29 July, Chiang Mai, Thailand

The new international SKA conference stand had its first outing at the SKA 2011 meetings in Banff and, in combination with our new interactive touch screen iTable, it proved a big hit with visitors.
A smaller section of the conference stand was also on display in Thailand at the Asia Pacific regional IAU meeting (APRIM) in Chiang Mai where SKA Africa, anzSKA and the international SKA project exhibited together.

If you would like the international SKA conference stand to be present at a conference that you are organising please get in touch.

Check out the brand new SKA comic series

We are pleased to announce the launch of the brand new SKA comic series, The adventures of the SKAnimals. Issue one is now available to view and download from the SKA website. The comic series is designed to give 9-14 year olds an introduction to the SKA, show what the telescope will look like, what it will do and what the benefits will be.

The adventures of SKAnimals follows four animal friends, and their teacher Bryan, at a school in the desert as construction of the SKA begins.

Please feel free to distribute the comic either electronically or in print and look out for Issue 2 which will be coming soon!

If you would like to translate the comic into another language, versions with blank speech bubbles are available. Please get in touch to find out more.

SKA week at Jodrell Bank Discovery Centre

If you are in the UK between the 22 - 26 August, there will be a week dedicated to the SKA at the new Jodrell Bank Discovery Centre in Cheshire. Aimed primarily at families, the event will offer the public the chance to find out more about the SKA, make some mini-SKA antennas and find out about the new SKA Project Office that will be built at Jodrell Bank in 2012. Find out more about the Jodrell Bank Discovery Centre here: www.jodrellbank.net/

Get involved!

If you have an idea for an outreach activity, can help with translation of outreach materials or would like advice on how to go about SKA outreach in your region, contact:

Jo Bowler  
Outreach Officer  
bowler@skatelescope.org  
+44 (0) 161 275 4130.
The SKA Founding Board has now approved the timetable for the site decision process. The SKA Site Advisory Committee (SSAC) of appointed independent experts will make a recommendation on the preferred site based on reports from expert panels and consultants together with the submissions from the candidate sites; a final decision on the location is expected to be made in early 2012 by the SKA Board of Directors.

The technical assessment and evaluation phase of the site selection process is being overseen by the SKA Siting Group (SSG), which reports to the SKA Founding Board.

Information for this assessment work will be submitted to the SPDO as a response to the request for information - a questionnaire that was sent to the site proponents of South Africa and Australia and included questions relating to:

- Science and technical factors.
- Other factors, including legal, customs and security.
- Plans and costs of implementing infrastructure, including power supply and distribution.

In order that the SKA Site Advisory Committee (SSAC) and the SKA Siting Group (SSG) have the best information available to advise the SKA Board on the site decision, the submissions will be broken into individual areas of expertise and assessed by independent experts; either expert panels or consultants.

These assessments, together with the original site submissions, will be used by the SSAC in reaching its recommendation on the preferred site for the SKA.
News from around the world
This issue reports on progress with KAT-7, which is undergoing successful commissioning, and updates on SKA infrastructure preparations in the Karoo. There is also news of the four SKA research chairs that have recently taken up positions in South African universities as well as information updates from the African partner countries.

**KAT-7**

By the end of July all seven receivers mounted on the KAT-7 antennas will be cryogenically cooled, with the four currently installed receivers working reliably and well within specification. All of the other subsystems, including the 8-station correlator, are being commissioned successfully. At the recent meeting of MeerKAT large survey principle investigators there was great enthusiasm to begin early science on KAT-7 to test out data pipelines and on-line signal processing technologies.

**MeerKAT PDR in July**

Following on from the successful Concept Design Review (CoDR) last year, the MeerKAT engineering team took part in a preliminary design review (PDR) from 18 - 22 July. The PDR was overseen by an international review panel, chaired by Prof Marco de Vos (ASTRON). The engineering team have been contributing to the various SKA subsystem CoDRs that are being organised by the SPDO. Material from the MeerKAT PDR documentation has been used extensively for these inputs.
Karoo infrastructure ready for the SKA

The infrastructure team, with assistance from the MeerKAT engineering team and consulting engineering company Aurecon, are preparing for a critical design review (CDR) process that runs until September. The scope of this CDR covers the Karoo site buildings, electrical power conditioning plant, reticulation systems, and antenna foundations. Although primarily focussed on MeerKAT infrastructure requirements, the infrastructure would also support SKA Phase 1. The installation of the ‘last mile’ optical fibre link for MeerKAT will be completed during July. This cable follows the railway line from the Hutchinson railway station, where it connects to a major data trunk connecting Cape Town and Johannesburg, to a point of presence (PoP) in Carnarvon. This PoP is already linked to the MeerKAT site via a cable that follows the power lines. The completed link between Cape Town and the site will initially operate at 10 Gb/s. The capacity of the installed fibre is sufficient to service the requirements of SKA Phase 1.

SKA research chairs

Four highly regarded researchers have recently taken up SKA research chairs established at South African universities. Key criteria for selecting these individuals were their academic excellence, their ability to develop productive research programmes relevant to the SKA and MeerKAT, and their record of student training. The research chairs were awarded to:

• Prof Roy Maartens has been appointed SKA Research Chair in the Astrophysics Group at the University of the Western Cape (UWC).
• Prof David B Davidson is the new SKA Research Chair in Electromagnetic Systems and EMI Mitigation at Stellenbosch University.
• Prof Claude Carignan heads the new SKA research chair in Multi-wavelength Extragalactic Astronomy at the University of Cape Town. Prof Carignan helped set up of the African Astronomical Society.
• Professor Sergio Colafrancesco will take up his SKA research chair in Radio Astronomy at the University of the Witwatersrand in August 2011.

An announcement regarding the fifth research chair in radio astronomy techniques and technologies at Rhodes University is imminent.

African partners

At the sixth meeting of the SKA Africa Working Group and Steering Committee in Pretoria, partner countries confirmed their commitment to build a pan-African astronomy education and research infrastructure. The participants also worked on practical issues related to the SKA site selection process. In May, a week-long workshop involving academics from African universities and Oxford was held in Carnarvon to discuss the development of course curricula and academic partnerships.

A project to convert redundant satellite telecommunications antennas in radio news from around the world
telescopes has been started. The goal is to establish an African very long baseline interferometry (VLBI) network (dubbed the AVN). Over 20 dishes have been identified that could form part of this network. Ghana is currently refurbishing the 32 metre satellite telecommunication antenna at Kuntunse and converting it into a radio telescope, and similar plans are afoot in South Africa for converting a 30 metre antenna at the Hartebeesthoek satellite tracking station. An AVN consisting of just five such antennas would fill a gap in the global VLBI network, and would have excellent sensitivity when linked to MeerKAT.

Participants at the African Working Group meeting held in Pretoria in June 2011.
Australia and New Zealand

Recent highlights for the anzSKA team include an Indigenous naming ceremony for six of CSIRO’s ASKAP antennas, the first A-NZ eVLBI, receiver chip fabrication, the ‘Discover SKA’ outreach initiative, industry engagement as well as various achievements and developments for anzSKA science.

Ministers showcase SKA project progress in Banff

Federal Minister for Innovation, Industry, Science and Research, Kim Carr and West Australian Minister for Science and Innovation, John Day recently attended the ‘SKA Week’ in Banff, Canada. In his address to the public SKA Forum on 6 July, Minister Carr praised the significant advances of the SKA project since the previous Forum in the Netherlands, but urged the partners to maintain their focus on consolidating plans for the pre-construction phase.

Forum delegates saw a lively presentation on developments in the anzSKA project headlined by two of the young scientists leading the project, CSIRO’s Lisa Harvey-Smith and ICRAR’s Steven Tingay. They also saw a fascinating insight into the cultural traditions and connection to land of Western Australia’s Wajarri Yamatji people, the...
traditional owners of the site of the Murchison Radio-astronomy Observatory (MRO). Wajarri man Godfrey Simpson also gave his blessing to the SKA project.

Meanwhile, at the A–NZ industry display, a miniature Australian SKA Pathfinder (ASKAP) array built from LEGO attracted much attention with every antenna given away to toy building brick enthusiasts; many of whom were the daughters and sons of delegates.

**Wajarri Yamatji names for CSIRO ASKAP antennas**

CSIRO’s first six ASKAP (Australian Square Kilometre Array Pathfinder) antennas were officially given Wajarri Yamatji names during a ceremony at the MRO on 2 June 2011. The names were bestowed by representatives of seven Aboriginal families and according to the Chair of Wajarri Yamatji Native Title Group, Gavin Egan, “will be a permanent reminder that this is the land of the Wajarri people.” See: [http://www.ska.gov.au/news/Pages/110613_ASKAP_naming.aspx](http://www.ska.gov.au/news/Pages/110613_ASKAP_naming.aspx)

**First A–NZ eVLBI achieved**

The discovery potential of the SKA was glimpsed following the commissioning of a working optical fibre link between six radio telescopes across A–NZ. Four CSIRO telescopes, including ASKAP, along with a University of Tasmania telescope and another operated by the Auckland University of Technology were used together to observe a radio source. Data from all sites were streamed in real time to Curtin University in Perth (a node of ICRAR) where a system built by Professor Steven Tingay and his research team processed the data to make an image. See: [http://www.ska.gov.au/news/Pages/110707_eVLBI_Big_StepForward.aspx](http://www.ska.gov.au/news/Pages/110707_eVLBI_Big_StepForward.aspx)

**New Zealand to increase connectivity with US and Australia**

In an important step towards the A–NZ long-baseline component of the SKA, New Zealand’s Research and Education Advanced Network (REANNZ) and Pacific Fibre have announced plans for a long-term international high speed capacity service. By 2014, the fibre system is expected to provide New Zealand with effectively unconstrained capacity to Australia and the USA.

**Memorandum of Understanding signed**

A Memorandum of Understanding (MoU) was signed in April between the Fraunhofer Institute of Solar Energy (Fraunhofer), Max Planck Institute for Radio Astronomy (MPIfR) and CSIRO Astronomy and Space Science (CASS) during a workshop on ‘Renewable Energy Concepts for Mega-Science Projects demonstrated by the SKA and its Pathfinders’ in Germany. A key focus of the MoU is to promote scientific and research cooperation in renewable energy capture, storage and management, and also looks to advance collaboration on the development of renewable energy systems for the MRO and ASKAP as a precursor facility to the SKA.

**iVEC supercomputer launched**

The iVEC@Murdoch supercomputer (‘Epic’), consisting of a Hewlett-Packard POD (Performance Optimised Data) Centre linked to iVEC’s 10Gb/s network, was officially launched in June. The supercomputer’s design allows rapid setup compared to similar-sized systems, creating a ‘plug and play’ computer cluster and will support the Australian radio astronomy research community, as well as researchers in other
areas of data-intensive science. A number of early adopter researchers, such as CSIRO and ICRAR, are already trialling the capabilities of the supercomputer.

HPC facility donated to the MWA

IBM has donated a high performance computing facility to researchers at Victoria University (Wellington, NZ) and counterparts at ICRAR (Perth, Australia), to be used to process data from the MWA (Murchison Widefield Array). The IBM facility forms part of a critical sub-system that will produce images for the MWA archive for use by science teams. The work exemplifies both the strengthening of trans-Tasman links in radio astronomy and cooperation between research and industry for SKA.

First science fields characterised for ASKAP BETA

Characterisation observations of two well-known radio sources were performed using CSIRO’s Australia Telescope Compact Array (ATCA) in preparation for first science with the six ASKAP antenna engineering prototype BETA (the Boolardy Engineering Test Array). The two control sources were used to determine unknown calibration systematics and provide data for ASKAP survey science teams to begin testing calibration and imaging pipelines, and compare quality and integrity of the future BETA observations.

Revolutionary receiver chip developed through R&D partnership

A revolutionary receiver ‘system-on-chip’ (SOC) was successfully produced through collaboration between CSIRO and Silanna Semiconductor. The low-cost, highly-integrated device was designed and fabricated with a high level of integration which allows the electronics for Phased Array Feed (PAF) receiver systems to be miniaturised. Each of the PAFs to be installed on CSIRO’s ASKAP antennas requires hundreds of receivers; by using silicon chips, a 75% size reduction can be achieved, lowering costs by 80%.

Industry delegations show support for the SKA

In April, Chairman of the Chinese People’s Political Consultative Conference, His Excellency Mr Jia Qinglin visited CSIRO’s Marsfield site and toured the ASKAP labs. The six day tour of Australia was aimed at strengthening cooperation in high technology. The following month, Italian industry and science representatives visited Australia to discuss the SKA initiative, assess opportunities for coordinating efforts with anzSKA and to illustrate various Italian activities and technology ideas in connection with the SKA. During the week-long visit, the delegation showed deep interest in industry–consortia engagement and the development of advanced applications for radio astronomy.
‘Aspire to Astronomy’ for Discover SKA

Over recent months, the SKA has attracted the attention of thousands of people across Australia–New Zealand. As part of Discover SKA, over 40 organisations joined the initiative to host hundred’s of events and activities which saw leading project scientists and outreach professionals sharing their passion for the SKA. One event saw representatives from ICRAR, the University of Western Australia, SPICE and Scitech visiting schools and communities on a two-week tour throughout Western Australia’s Pilbara region. Townships and communities in Port Hedland, Roebourne, Karratha, Tom Price and Newman took part in daytime astronomy-themed activities as well as night sky viewing events.

For more information, see: http://www.ska.gov.au/DiscoverSKA/
**Dish Verification Antenna**

Collaboration continues between the NRC-HIA DRAO CART group and the US TDP on the design of a 15 m Gregorian offset antenna, or dish verification antenna (DVA). A 4.2 m offset test part has been successfully built. Of fundamental interest is the prediction of process induced distortions and comparison of these predictions with our 4.2 m test part. This work is in progress and preliminary results look good.

Material property measurements are also on-going. We are now able to measure the coefficient of thermal expansion (CTE) of panels. Results are preliminary and indicate the CTE of the chosen composite structure is a fraction of any metal structure.

Documentation was submitted for the SKA dish array Concept Design Review (CoDR) that was held in Penticton in July 2011 and preparations are well underway for the DVA Design Review scheduled for autumn 2011.

**Correlator**

A correlator concept design was presented at the SKA Signal Processing CoDR in early April 2011 in Manchester. The design was an expansion of the Giant Systolic Array (GSA) concept described in SKA Memo 127. Included was a specification for a correlator ASIC, and a concept for ‘visibility based addressing’ (VBA) permitting gridding image processors to be subsumed into the correlator. In addition, a central beamformer concept that uses the GSA correlator architecture was outlined.

The GSA provides a mechanism for construction of very large correlators, virtually unlimited in size that use reliable, low-cost copper printed wiring connections and emerging technologies. It can be built today and does not require Moore’s law growth. The GSA concept is a complete design, and addresses the enormous real-time image processing challenges that SKA Phase 2 presents.

A brief introduction to our current 8 TMAC/s

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**Canada**

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4.2 m test part set up for measurements.

The current DVA concept design.
FPGA-board was also presented. The board, known as the Kermode (pronounced Kurr-mo-dee), is currently being laid out with prototypes available in autumn 2011. Strawman estimates of the number of boards and crates (shelves) required for the current generation and the next generation correlator were presented.

As the GSA is not a good match for SKA Phase 1, and as SKA Phase 2 is likely more than a decade of technology development away, NRC-DRAO’s concentrated focus is the Kermode-series board development for SKA Phase 1 and other potential high-performance signal processing applications.

Advanced Focal Array Demonstrator

The DRAO Advanced Focal Array Demonstrator (AFAD) will be an astronomy-capable phased-array feed with an input band of 0.7 to 1.5 GHz and initial bandwidth of 0.5 GHz (expandable to 0.8 GHz). A number of measures are being taken to minimise receiver noise: mounting the low-noise amplifier as close to the antenna feed point as possible, eliminating dielectrics and other lossy materials as much as possible, and increasing the surface area of the slotline that conducts signals from the Vivaldi flare to the feed point. These ideas are implemented using a thick Vivaldi element, also called a 3D tapered slot antenna, which increases the slot area and provides a well-shielded internal mounting point for the low-noise amplifier (LNA). Development of this novel array element is in collaboration with l’Université Catholique de Louvain (Craeye and Sarkis) and the University of Calgary Institute for Space Imaging Science (Belostotski and Haslett). Studies on using phased array feeds as polarimeters have been published (See: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5722995&isnumber=5779934). This work was based on the earlier Phased-Array Feed Demonstrator (PHAD) and examined beamformer calibration for dual-polarised beams and the impact of errors on system performance.

University of Calgary

Receiver subcomponents & LNAs

Testing of two 65 nm STMicro CMOS amplifiers (one GP and one LP) are ongoing. Initial tests show that LP CMOS LNAs have noise temperatures higher than noise temperatures of the GP counterparts by a few Kelvin. Preliminary results show a 65 nm STMicro GP CMOS LNA achieving <23 K from 0.7 GHz-1.4 GHz and < 25 K from 0.6 GHz to 1.6 GHz at the SMA connectors.

Another 65 nm TSMC LP CMOS design has arrived and its tests will commence shortly. Two 65 nm TSMC GP CMOS systems consisting of an LNA with a gain each have been fabricated and arrived. In simulations the system achieve less than 10 K of noise with 70 dB of gain and should be capable of driving ADCs designed by our group to form a first exclusively-CMOS receiver system. A modified design for the two systems is being prepared for fabrication.
ADC Progress

Work continues on high-speed Flash ADCs, a new Time-Interleaved Dynamic Comparator (TIDC), time-based ADCs, a next generation Voltage to Time Converter (VTC) and Serializer-Deserializer circuits (SerDes) for data transmission.

High-Speed Flash ADC:
A second-generation 40 mW 10GS/s 4-bit Flash ADC in TSMC 65 nm GP CMOS was taped-out with the chips returned for testing. The design employs a number of new features to provide self-calibration and improve conversion speed without interleaving duplicate sampling channels. For flash ADCs, one of the bottlenecks to improving the operating speed is the regeneration time of the comparators.

A new Time-Interleaved Dynamic Comparator (TIDC) introduced by our team is sampling clock skew free, thus no timing correction is necessary. The TIDC is reference-less, thus no reference ladder is required, which saves power and reduces the input signal feedthrough effects to the ladder. The background calibration scheme using one extra comparator as reference allows all of the other comparators to be calibrated in the background with controllable low speed, saving power.

Time-Based ADCs:
Measured results on a previously reported ADC employing a 90 nm CMOS Voltage-to-Time Converter (VTC) and a 90 nm CMOS Time-to-Digital Converter (TDC) to achieve a 3-bit ADC with measured ENOB >2.1 (2.9ENOB at 20MHz, 2.1ENOB at 1 GHz) over 1 GHz bandwidth, sampling at 2.5 Gb/s, and dissipating 9 mW in the two core circuits was presented at the 2011 IEEE International Symposium on Circuits and Systems, (ISCAS 2011) held in Rio De Janeiro in May of 2011.

A next-generation 65 nm CMOS Voltage-to-Time Converter (VTC) and time-to-digital converter (TDC) were designed during the reporting period and have been returned to UCalgary for testing. The 4-bit, 5 GS/s VTC has on-chip calibration circuitry, and simulation shows a power consumption of 26 mW.
Time-Based SerDes Systems:
We believe we are the first to design a serial data communications system based on time-based principles. We have successfully demonstrated the advantages by programming the new system into an FPGA and transmitting data over a 40 inch FR4 data link. Transmitted and received signals for a 1.6 Gb/s link are shown in the plots below. The circuitry is very simple, will consume a very small area of silicon in a monolithic realisation and is low power.

The newest version, dubbed Differential Time Signalling, or DTS, uses modulation on both edges of the data, with an embedded clock, enabling maximum throughput and simple receiver detection circuitry. The PhD student doing the work successfully defended his PhD thesis in April 2011. The circuits now need to be realized in monolithic CMOS.

NRC-HIA (Victoria)
Low-Noise Amplifiers

NRC-HIA (Victoria) have developed LNAs for the Atacama Large Millimeter Array (ALMA) Band 3 receiver (https://science.nrao.edu/facilities/alma), using Indium Phosphide (InP) High Electron Mobility Transistor (HEMT) and hybrid technologies to achieve ~4 K noise temperature and 38 dB gain from 4 to 8 GHz at 15 K temperature with ~10 mW power consumption.

The SKA presents a unique challenge and NRC-HIA (Victoria) are designing MMIC LNAs in the 1 to 10 GHz band using Gallium Arsenide (GaAs) HEMT technology. In MMIC technology, active and passive components and transmission lines are grown onto a semiconductor substrate material. GaAs MMIC is suitable for realising both high-frequency transistors and low-loss passive components to achieve low noise and low cost for mass production and high-volume applications.
Wideband Single Pixel Feed (WBSPF)

NRC-HIA (Victoria) is also working on a wideband single pixel feed for the SKA. In order to achieve beam characteristics that are constant over a large frequency range, geometry is scaled logarithmically and the ‘petals’ or ‘arms’ of the antenna are self-complimentary. In this 4-arm structure, the antenna receives two linear polarisations; each opposing petal pair is connected differentially.

Consideration has been given to manufacturing using low-cost methods, such as water jet cutting, printed circuit board, and metal spinning for the cone shaped ground surface. A first prototype has been designed and manufactured using these methods and antenna pattern measurements have been completed using the anechoic chamber at DRAO.

Current research is focused on optimising the electrical characteristics of the antenna (beam symmetry, beam purity, and input impedance). Future effort will include cryogenic studies, integration with the CART primary reflector, and mechanical improvements.
In March this year, China, represented by National Astronomical Observatories China (NAOC), joined eight other countries in signing a Letter of Intent and joining the SKA Founding Board. The signatories agreed to work together to steer the SKA into the next phase of development during the meeting in Rome. Following the Rome SKA meeting, the results of a feasibility study, announced at the NAOC headquarters in Beijing, supported the Joint Laboratory for Radio Astronomy Technology (JLRAT)’s continued involvement with the SKA and recommended that Chinese industry as well as Chinese science and technology organisations continue to participate in big science projects like the SKA. Other developments include the submission of the Chinese antenna design, DVAC, to the SPDO as well as the completion of the test installation, and measurement of the FAST reflector prototype, at the FAST telescope site.

China sign SKA Letter of Intent and join the Founding Board in Rome

National Astronomical Observatories China (NAOC) represented China in April 2011 at the SKA meeting in Rome, Italy. NAOC signed a Letter of Intent to establish a Founding Board for the global SKA project along with research organisations and government funding agencies from eight other countries: Australia, France, Germany, Italy, Netherlands, New Zealand, South Africa, and the UK. China will continue its significant role of promoting the SKA, and will share the responsibility with the other Founding Board members of overseeing the project, including funding of the project execution plan, and leading the SKA into the next phase.

Recent Progress of JLRAT

JLRAT is a laboratory collaboration between NAOC (National Astronomical Observatories China) & CETC54 (54th Institute of China Electronic Technology Corporation). Members of JLRAT have worked with officials from Chinese science and technology organisations to acquire the funds for SKA research and for research into key technologies for large telescopes. Further funding will be sought from other channels to support SKA development work in China. A meeting to discuss the results of a feasibility study into Chinese involvement in the SKA
pre-construction phase was recently held at the headquarters of the NAOC, in Beijing. The results of the study supported JLRAT’s continued involvement with the SKA into the pre-construction phase. More than 30 experts from radio astronomy and governmental funding agencies attended the meeting on 17 June, 2011. The feasibility study review committee presented the following recommendation:

‘the relevant government departments in China will support Chinese science and technology and industry to continue participating in big science projects, like the SKA; It is encouraged that the technology department on behalf of the Chinese government participate in the negotiations, coordination and decision-making of international scientific projects; and the construction of SKA technology in the preparation stage should be given special financial support.’.

**Chinese design of SKA antenna proposed**

On 31 May 2011, the Joint Laboratory for Radio Astronomy Technology (JLRAT) submitted the Chinese design proposal for the SKA antenna dishes, DVAC-1, to the SKA program development office (SPDO). The initial draft of the off-set Gregorian dish design concept was completed by JLRAT a year ago. The merits of DVAC include low costs, easy installation and manufacturing trade-offs. The updated DVAC-2 prime focus dish is also finished and supporting materials have also been provided to the SPDO. The final version of DVAC, including both DVAC-1 and DVAC-2, was submitted to the SPDO in time for the June deadline.
FAST reflector prototype finishes the installation and measurement test

On 3 March 2011, the FAST reflector system engineering initiative visited the Guizhou station sites to complete the installation of the FAST equilateral aluminium reflector unit test prototype, together with the test load and surface measurement work. The test prototype installation is an important part of the active reflector system, and the South East Grid Corporation will work together with aircraft manufacturers to complete it. During the prototype installation, the active reflector system was adjusted according to measurement results. After completion of the prototype installation, the results of a simulated wind loading and unloading test, along with surface measurements, were processed. The equilateral aluminium reflector unit prototype test for the subsequent installation and testing of the optimised reflector design unit provides an important reference for the FAST reflector while the long-range surface-based site provides a test platform for measurement studies on the active reflector unit.
Future meetings and events

Visit the meetings calendar page to find out what SKA-related meetings are coming up. More details