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ASKAP Update

CSIRO Astronomy and Space Science

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The ASKAP Update is a regular series dedicated to conveying the latest news about the Australian SKA Pathfinder (ASKAP) project to international science and engineering communities. It is available online at www.atnf.csiro.au/projects/askap.

ASKAP dishes exceed accuracy specifications

Final site acceptance tests carried out on all 36 of the ASKAP antennas now standing at the Murchison Radio-astronomy Observatory (MRO) have confirmed reflector accuracy more than twice the required ASKAP specification.

The ASKAP antenna reflectors were designed to a surface accuracy of 1.0 mm, to allow for astronomy-capable operation up to 10 GHz. The surface accuracy actually achieved on all 36 delivered antennas has been close to, or better than, 0.5mm, effectively increasing the range of astronomy-capable operation up to 20 GHz.

According to ASKAP Project Director Ant Schinckel, the assembly of all 36 antennas at the MRO is an important milestone for the ASKAP team which allows the project to transition from construction mode to focus on more on-sky commissioning activities.

"Following the completion of other construction activity at the MRO, we're now able to concentrate on the fit-out of the complex receiver and computing systems that will enable ASKAP to survey the sky faster than any other radio telescope."

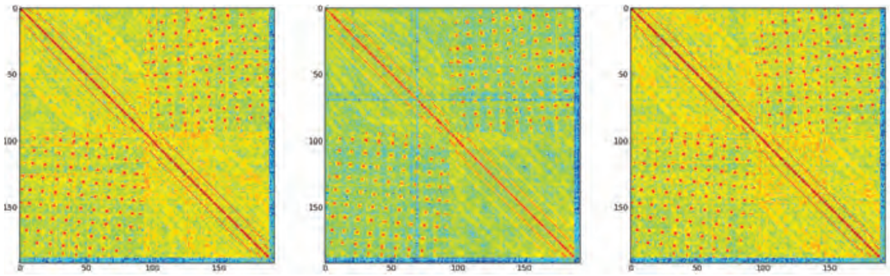
Other essential infrastructure works on site include the completion of the MRO Control Building, a unique facility that will house the complex digital systems of ASKAP, including the ASKAP beamformers and correlator, as well as termination points for approximately 7600 high-bandwidth optical fibre links from ASKAP and the other international projects on site, and the fibre link to Geraldton.

Another major activity at the MRO was the recent launch, installation, testing and support of the bespoke ASKAP Telescope Operating System (TOS) software into all on site computers.

This version of the TOS allows remote operation, monitor and control of the ASKAP antennas from the CSIRO Astronomy and Space Science (CASS) headquarters in Sydney, and will be developed for commissioning of the Boolardy Engineering Test Array (BETA).

Antennas of CSIRO's Australian SKA Pathfinder at the Murchison Radio-astronomy Observatory. Final site acceptance tests on the antennas have returned surface accuracy results better than design specification.

Credit: John Tuthill, CSIRO.



Array Covariance Matrices (ACM) captured for the first time simultaneously on (L-R) ASKAP Antennas 1, 3 and 6. This result is an important precursor to obtaining PAF-to-PAF fringes using data capture and software correlator.

System verification due in coming months

Three of the six ASKAP antennas that will make up BETA are now fully equipped with phased array feed (PAF) receivers and all associated beam-forming electronics, in preparation for the first phase of systems commissioning. The three PAFs form a real-time three-baseline system, which, along with the software correlator highlighted in the previous edition of the ASKAP Update, will allow for system verification tests in the coming months.

Firmware and software have made it possible, for the first time, to synchronise the capture of an Array Covariance Matrix (ACM) – a diagnostic that captures most of the vital signs of the PAF receiver in pictorial form. Each of the three PAF receivers now on site was tested individually, and recorded at the same moment.

The positive stability results reflected by the ACM and the verification of event-driven beamformer synchronisation are another step on the path towards simultaneous beamformed data capture and subsequent correlation.

"We're getting a lot of good quality data," says ASKAP System Engineering, Integration and Commissioning (SEIC) team leader John Reynolds, "The team is now poised to link antennas together and obtain the first fringes, or correlation, on an astronomical source between two PAF receivers. The next goal will to repeat the correlation procedure with a three PAF baseline to form a complete triangle, and achieve phase closure between the receivers."

The correlations will be performed in software using data captured simultaneously from the three beam-formers and post-processed using standard astronomical imaging software.

This first demonstration of PAF-to-PAF fringes on three antennas will be followed by delivery and commissioning of the next three antennas making up the full BETA array, and commissioning of the six-antenna BETA hardware correlator.

Next generation PAF under development

Since August 2011, development of a second generation (MkII) receiver chain for ASKAP has been underway through a work package known as the ASKAP Design Enhancement (ADE). Design optimisation of a new PAF has been the focus of the team, with an emphasis on reducing total system costs (including utilising new cost effective technologies) – design for manufacturability and testability was also given careful consideration. By creating a highly reliable and modular design, the ADE system will also provide ASKAP with a high degree of availability, provide significant benefits in system performance, will reduce manufacture complexity and increase maintainability.

Enhancements to the system include improved performance across the ASKAP band for the PAF receiver, signal transmission using RF-over-fibre, direct sampling of the RF signal at the MRO Control Building, and hardware for digital signal processing that uses the latest in FPGA (field-programmable gate array) and high speed communication devices.

An Integration Readiness Review is scheduled for later this year, and will be the final major quality gate before high-level integration testing of the first-of-type ADE system will start.

In the meantime, continued testing of the PAF data capture, beamformers and antenna drive software has been underway with regular observing sessions scheduled on the Parkes Testbed Facility (PTF), a 12-m testbed antenna equipped with a prototype PAF working in conjunction with the multibeam receiver installed on the 64-m Parkes radio telescope.

The testbed remains an invaluable resource for developing new receiver technology and gaining crucial insight into PAF performance. Recently it was used to test a proof-of-concept design for the MkII PAF design, successfully demonstrating excellent performance across the entire ASKAP frequency band. It will continue to be used as this design evolves to the full-sized PAF for ASKAP.

Stay tuned for the next edition of the ASKAP Update, which will feature details of the new ADE PAF.

The assembly of all 36 ASKAP antennas at the MRO was completed in May 2012. The next step in commissioning will be to fit-out the antennas with innovative receiver technology and complex digital and computing systems.
Credit: Steve Barker, CSIRO.

ASKAP's superior software

The three subsystems that make up ASKAP's computing components are the (1) Telescope Operating System (TOS), (2) the Central Processor, and (3) the Science Data Archive.

1. The TOS is responsible for monitoring and control of the physical components of the telescope, including antennas, beamformers, the correlator, and various other hardware sub-systems. In June, a developed TOS was installed at the MRO, which allows remote monitor and control of the ASKAP antennas from the CSIRO Astronomy and Space Science headquarters at Marsfield, Sydney. This version of the TOS is currently being tested and enhanced during the BETA commissioning.

2. The Central Processor will perform calibration, imaging, and other data processing. It is responsible for transforming the output from the correlator into science data products such as images, cubes and catalogues. It is both a hardware and software subsystem, consisting of a high-performance computer and software designed specifically to support processing high-rate data streams in close to real time.

3. The Science Data Archive is the prime repository and access point for fully calibrated and science-ready data products. These include visibility data, images and cubes, and source catalogues. The subsystem provides access to the raw and processed data products for analysis by the ASKAP Survey Science Teams.

ASKAP Central Processor to start installation in 2013

A recent announcement has confirmed the supercomputing suppliers that will build iVEC's Pawsey Centre, the supercomputing facility that includes the ASKAP Central Processor and the Pawsey Petascale system.

The procurement agreement for the Pawsey Centre includes the purchase, installation, integration and commissioning of the petascale supercomputer that provides support to ASKAP and other international projects based at the MRO.

The supercomputer will be a Cray Cascade system capable of processing radio astronomy data in real time with partitions for multi-purpose research. This system, along with hierarchical storage management (HSM) from SGI and tape libraries from Oracle, will form the ASKAP Science Data Archive (see breakout box).

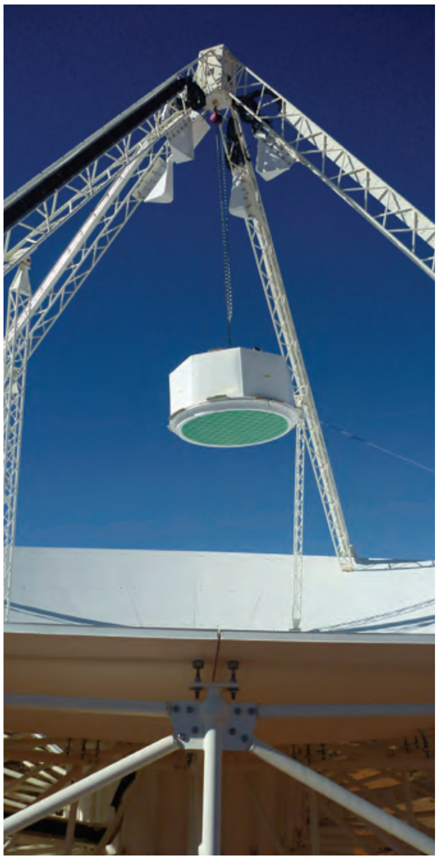
The ASKAP Central Processor, a 200TFlop/s system with a 1 PByte Lustre filesystem, is expected to begin installation in 2013. Coinciding with this will be installation of the first stage of the general purpose research 'petascale' system, with a combined performance of 0.3 petaflops. Expansion of the petascale system will increase performance to 1.2 petaflops in 2014 with additional Intel CPUs and the Intel Xeon Phi accelerator.

Along with the delivery of the ASKAP Central Processor in 2013 will be the first stage deployment of tape libraries and HSM file system, with sufficient capacity – up to 5 PBytes – to support one year of observing with ASKAP. In 2014, this will be expanded to at least 25 PBytes for the ASKAP science data archive.

iVEC's Pawsey Centre represents the third and final phase of the Federal Government's Super Science Initiative to boost supercomputing capabilities and scientific research in Australia.

The first two phases are supercomputers already installed at Murdoch University ('Epic') and the University of Western Australia ('Fornax'). As 'early adopters' of Epic, the ASKAP team has been testing the processing capabilities of this system since July 2011, working with the ASKAP Survey Science Projects to simulate how ASKAP data will be processed to create images of the radio sky.

Supercomputing resources at iVEC's Pawsey Centre will also be available for data-intensive projects across the scientific spectrum, including biotechnology, geosciences and nanotechnology.



Installing the innovative PAF receiver technology on an ASKAP antenna at the MRO. Credit: Steve Barker, CSIRO.

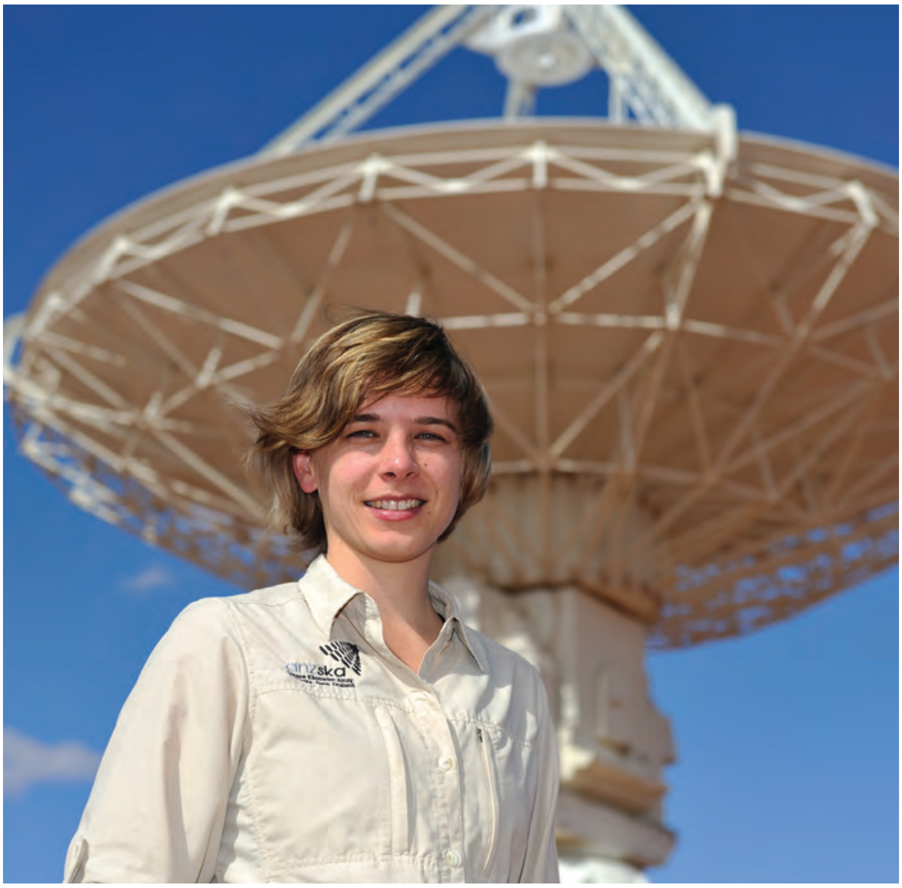
New Project Scientist for ASKAP

Dr Lisa Harvey-Smith has recently been appointed ASKAP Project Scientist. In this role, Lisa will provide critical input and leadership in the areas of ASKAP performance, Science Survey Team management, commissioning, and international SKA developments.

In her previous role of CSIRO Project Scientist for the SKA, Lisa worked closely within the international SKA project and the wider astronomical community to refine the science case for the SKA with a particular emphasis on keeping technology developments aligned with science goals. Lisa also played a major scientific role in Australia-New Zealand's response to the 'Request for Information' on siting for the SKA.

She remains an active member of the SKA Science Working Group, which involves working with an international team on science-engineering studies in preparation for a detailed design phase of the SKA.

Aside from concentrating on the SKA and ASKAP science, Lisa's research interests include the origin and evolution of cosmic magnetism, supernova remnants, the interstellar medium, massive star formation and astrophysical masers.



Lisa Harvey-Smith, CSIRO ASKAP Project Scientist, is looking forward to being a part of the 'technological revolution' of developing ASKAP for the astronomy community. Credit: Dragonfly Media.

> "For me, one of the most exciting scientific outcomes from ASKAP will be the all-sky catalogue of polarised radio sources. Studying the properties of this polarised emission will allow us to make significant advances in our understanding of cosmic magnetic fields".

"Two key aspects of Australia's preparation for the SKA were building ASKAP at the Murchison Radio-astronomy Observatory in Western Australia and developing innovative (phased array) receivers for radio astronomy," says Lisa. "Being a part of this technological revolution makes the role as ASKAP Project Scientist all the more attractive".

Lisa is also a member of the continuum (EMU) and polarisation (POSSUM) Survey Science Teams for ASKAP, playing a leading role in the design and verification of data catalogues. Lisa is now looking forward to working more closely with all ten Survey Science Teams.

"I am delighted to be rolling up my sleeves in the science commissioning effort for ASKAP. With such a motivated and capable group the project has come leaps and bounds. I look forward to continuing that success and delivering a world-class survey telescope to our Survey Science Teams."

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