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.

Infrastructure Construction Approaches Completion

Significant progress continues at the Murchison Radio-astronomy Observatory (MRO), home of ASKAP, with infrastructure construction approaching completion.

With 34 ASKAP antennas also now on site (the final two are due by early May 2012), the MRO has been a constant hive of activity.

High-speed internet connections now link the MRO Support Facility (MSF) in Geraldton with the MRO and iVEC's Pawsey Centre in Perth.

The optical fibre connection between Geraldton and the MRO (370 km) was installed by CSIRO as an integral part of MRO development, and the Geraldton–Perth (450 km) link is part of the National Broadband Network.

The link currently operates at 1 Gb/s, but will progressively increase during 2012 to 40 Gb/s.

Support infrastructure works at the MRO are approaching the final phases of commissioning and testing, and include the construction of 36 kilometres of access roads and tracks, power and data infrastructure, as well as a central Control Building and antenna foundations.

The Control Building houses the complex digital systems of ASKAP and other international projects at the MRO within two layers of welded steel shielding. This including the ASKAP beamformers and correlator, as well as termination points for approximately 7600 fibre links coming in from the ASKAP antennas, the Murchison Widefield Array and the link to Geraldton.

The Control Building will also act as a base for MRO support staff and visitors with office space, laboratories (electronics repair), an operations control room, a small mechanical workshop, stores and general amenities.

Designed to stringent requirements, the Control Building requires innovative energy efficiency solutions and building techniques to preserve the pristine radio-quiet environment of the MRO.

Final phases of the Control Building construction are now underway, and formal testing of various facility characteristics are required over the coming weeks before the official handover to CSIRO can take place.

The 31st and 32nd sets of ASKAP antenna components arrive on road trains at the Murchison Radio-astronomy Observatory in Western Australia. The Control Building can be seen toward the upper middle of the photo.

Credit: Barry Turner, CSIRO.

The Path to ASKAP Commissioning

The substantial commissioning required to prepare BETA, and ultimately ASKAP, for scientific observation can be broken down into three partially overlapping phases:

1. Engineering, Integration and Functionality: the engineering and integration plan executed by the System Commissioning Team, SCOM-1, and driven by ASKAP's Systems Engineering, Integration and Commissioning (SEIC) project team.

2. Science and User Readiness: when BETA is capable of producing useful observations, commissioning will be executed by SCOM-2, the Science Commissioning Team, driven by ASKAP's Science and User Policy (SUP) team.

3. SST-Specific Readiness: once BETA is able to provide scientifically useful data, the ASKAP team will work closely with the ten ASKAP Survey Science Teams (SSTs) to test and debug BETA for science survey readiness.

End-to-end Systems Tests with the First ASKAP PAF

The ASKAP Systems Commissioning and Computing teams have developed a software correlator able to process signals from multiple ASKAP antenna receivers in real-time.

This allows end-to-end system tests onsite with the first Phased Array Feed (PAF) receiver installed on an ASKAP antenna at the MRO.

The system uses 'raw data capture' from memory on beamformer cards, capable of handling data from 16 bands, each 1 MHz, spanning 300 MHz bandwidth to produce measurement sets just like a full correlator.

The interim measure is a vital diagnostic verification tool for full system implementation.

The first on-sky commissioning session in December 2011 achieved first fringes of Virgo A using an ASKAP PAF and a high performance L-band single pixel feed (SPF) receiver installed on ASKAP antennas at the MRO.

Using an RF-over-fibre (RFoF) link the team was able to capture baseband data from the two antennas simultaneously through the same beamformer, then able to verify fringes with the software correlator.

The test process was conceptually similar to that used at the Parkes Testbed Facility late last year – with interferometry between the first full-sized PAF prototype installed on the 12-m testbed and the central horn of the multibeam receiver on CSIRO's Parkes 64-m 'Dish' telescope.

Now in 2012, the next step will be to install two additional PAFs forming a real-time three-baseline system.

The software correlator is crucial for the end-to-end system testing in this configuration.

Once PAFs are installed on six ASKAP antennas, the Commissioning Teams will use this engineering testbed known as BETA (Boolardy Engineering Test Array) to prepare for the full fit-out of the 36 antenna ASKAP radio telescope.

New Commissioning Taskforce Guides SCOM-2

In parallel to Systems Engineering Commissioning, preparation for Science Commissioning activities (SCOM-2) is underway in 2012, driven by the ASKAP Science team with input from the Systems Commissioning and ASKAP Computing teams.

In March, a detailed Science Commissioning Plan was presented to an ASKAP Commissioning Taskforce, a team of senior CASS staff with decades of experience gained from commissioning CSIRO's Australia Telescope Compact Array as well as many other international facilities.

ASKAP's SCOM-2 team will draw on the deep experience within this Taskforce to guide ASKAP science commissioning activities and maximise the strategy for BETA science verification planning.

The eventual goal of the science commissioning team is to run full end-to-end tests of BETA as a software telescope in preparation for science observations.

To ensure that the scientific requirements of the instrument are met, the team will observe astronomical objects with available pre-existing data to make direct quantitative comparisons for all aspects of the data cubes.

Both Galactic and Extragalactic objects will be considered, to test instrument requirements including (among others) field of view sensitivity and stability, frequency response, imaging fidelity, calibration accuracy and dynamic range.

ASKAP antenna fibres prior to installation.

Credit: Department of Innovation, Industry, Science, Research and Tertiary Education.

Towards the end of the second phase, when BETA is at a point at which it is ready to perform scientifically useful observations on a 'shared risk' basis, the ASKAP team will work closely with the Survey Science Teams (SSTs) to ensure a science and user ready BETA instrument capable of accomplishing the Survey Science Projects themselves.

Planning is underway for 'Busy Weeks' in which SCOM-1, SCOM-2 and ASKAP Engineers (including the software and computing group) will work with the SSTs to test and debug BETA for science survey readiness.

These sessions will allow experience gathered during engineering verification activities to propagate through to the science commissioning phase.

Next Six Configuration Proposed

Beyond BETA, an important science commissioning step is to determine a twelve-antenna configuration. Two possible configurations for the first 12 antennas have been proposed, based on various requirements of the SSTs.

The locations of the 36 actual antenna are of course already fixed at this point – the current configuration discussion focuses on the selection of which antennas will be fitted with the second set of six PAFs.

A configuration for BETA plus these additional six antennas offers some 600,000 possible options. Simulation tools have been developed to study the synthesised beam of an observation with any specified configuration, allowing investigations of sidelobe levels and exploration of how the beam changes with declinations, frequencies and observation time.

Though the configuration is not yet finalised, a distribution with the most uniform uv coverage has been proposed.

The Science team will work closely with the SSTs over the coming months to refine the configuration and to ensure the best possible science can be achieved with the 12 PAF array, while the remaining PAF systems are then installed.

Data Challenge to Simulate BETA Data Flow

Having been accepted as 'early adopters' of the iVEC Pawsey Centre 'Epic' supercomputer, the Pawsey Centre 1A machine, ASKAP's Computing team have been using the system since July 2011 to test the processing pipeline software.

The team was granted one million CPU hours on Epic in the second half of 2011, and eight million CPU hours in the first half of 2012.

In preparation for BETA observations, the computing group is instituting a 'Data Challenge', a simulated BETA observation to test science processing code and simulate the flow of data from the BETA instrument (at the MRO) to the MRO Support Facility (Geraldton) and then to iVEC's Pawsey Centre (Perth) where it will pass through calibration, imaging and source finding software.

The Data Challenge aims to construct a data reduction pipeline capable of processing data from BETA.

It produces measurement sets and a sky model (derived from a model sky based on that used for the large science simulations generated in 2011).

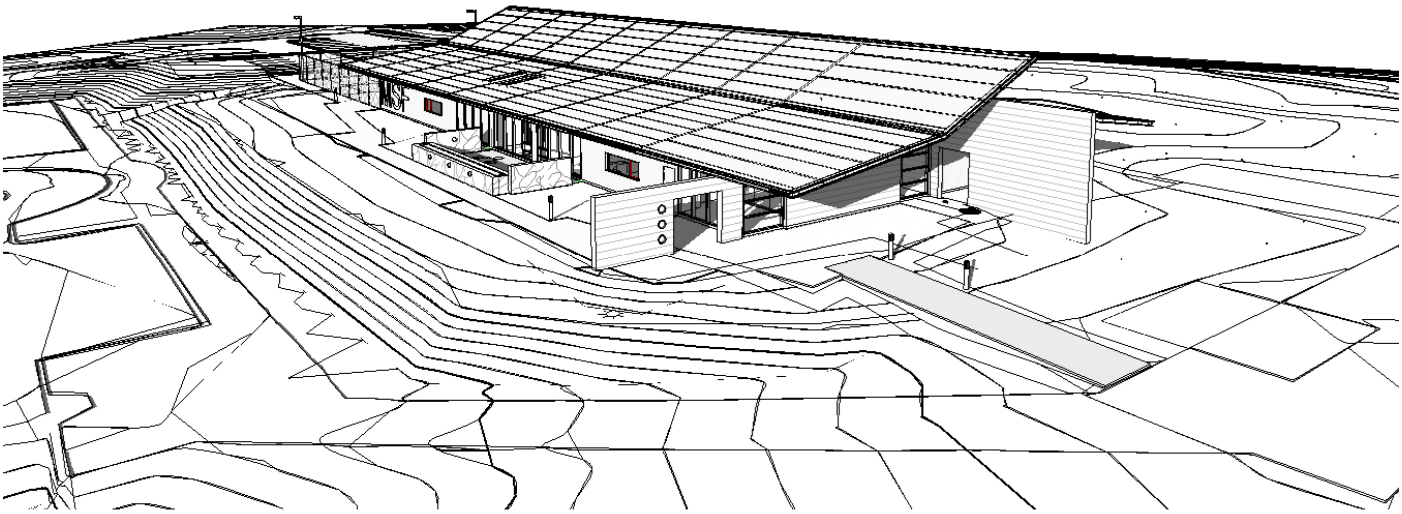
It then runs the calibration and imaging pipeline, and performs source finding and quality measurements.

It will be used to drive improvements in the imaging software, in particular to test reliability, robustness and track performance improvements as they are introduced.

Ultimately, when BETA is ready for observing, the experience and developments from the Data Challenge will allow a smooth switch-over to the processing of real BETA data.

ASKAP Antenna 3 was the first to be installed with a Phased Array Feed (PAF) receiver.

Credit: Barry Turner, CSIRO.



Construction of the MRO Support Facility (MSF) began earlier in 2012. The MSF will be located within the Geraldton University Centre in Geraldton and provide remote operations services for CSIRO's ASKAP telescope and other projects under construction at the MRO.

It will also feature a dedicated room for Geraldton-based researchers who have been awarded computing time on iVEC's Pawsey Centre supercomputers. Completion of the Support Facility is expected before year's end.

Credit: (Photos) Priscilla Clayton and Gemma Whiting, CSIRO. (Building Diagram) CSIRO.

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