

# ASKAP Technical Update

CSIRO Astronomy and Space Science

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The ASKAP Technical Update contains a brief summary of recent science and technical developments and milestones related to the Australian SKA Pathfinder (ASKAP) project. Each issue also looks at an aspect of key ASKAP activity. Previous issues can be read online at [www.atnf.csiro.au/projects/askap](http://www.atnf.csiro.au/projects/askap).

## PAF's first 'look' at Virgo A

CSIRO is pleased to release an image from the Parkes Testbed Facility (PTF) which shows, for the first time, the raw on-sky port patterns from an ASKAP Phased Array Feed (PAF) installed at prime focus of the 12-m testbed antenna.

The image is a striking demonstration of recent PAF testing at the ASKAP testbed antenna installed at CSIRO's Parkes Observatory.

It matches the expected performance of the system, further validating chequerboard PAFs as rapid imaging devices for radio astronomy.

Following installation of the first full-sized prototype PAF on the Patriot

12-m antenna in July (see September's ASKAP Technical Update), tests were run during the September–November period, correlating each of the 188 ports on the testbed antenna with the central horn of the 20-cm multibeam receiver on CSIRO's Parkes 64-m radio telescope ('The Dish').

The Dish tracked the powerful radio galaxy Virgo A while the PTF executed a raster scan about the radio source to map out a 14 square degree patch of each PAF port pattern.

The two polarisations of the central beam of the 20cm multibeam receiver were connected to ports 189 and 190 of the beamformer, using an RF over fibre (RFoF) link.

Each of the 94 individual squares represent a port on the PAF, while another 94 ports with the orthogonal polarization (not shown), make up the total 188 ports. The central ports, close to the antenna bore-sight, show the source well-centred, while at the edges the source is radially offset, and shows larger and asymmetric side-lobes, just as expected.

The Parkes 64-m dish was an essential instrument for these measurements, providing a stable and powerful reference signal that accelerates the data collecting and calibration enormously.

This result and others in the pipeline have given the ASKAP team great confidence that the PAF and downstream signal processing electronics is reliable and robust, not just over hours but over days and weeks.

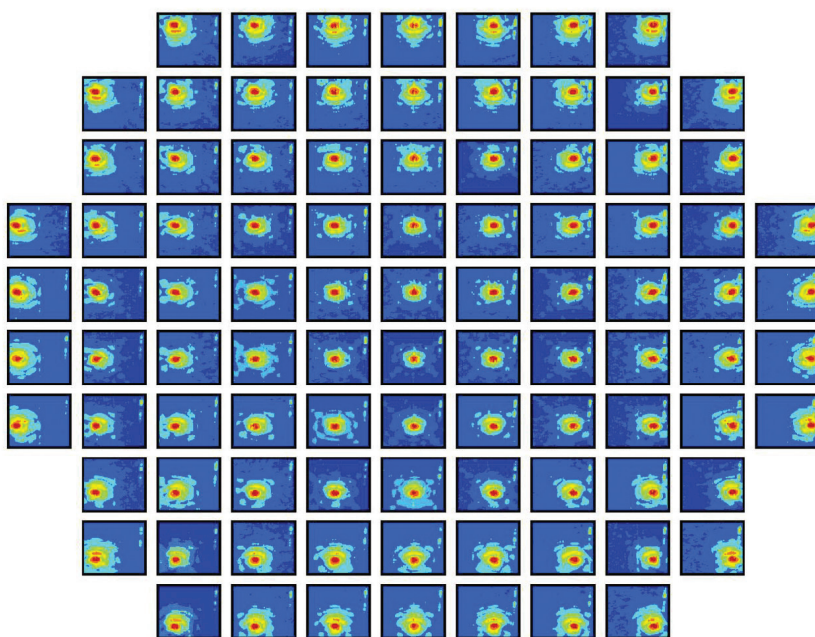
It is a culmination of over three years of cutting edge research and development by CSIRO staff and is a significant milestone towards demonstrating PAF technology for radio astronomy.

Ant Schinckel, CSIRO ASKAP Project Director, was quick to praise the ASKAP team for the excellence of their work.

"This represents a group effort – the entire ASKAP team, from the PAF designers and builders, through the data transport group to the digital backend team and software group. This is a great result for the team!" he said.

## BETA installation in full swing

The installation of the first three PAF receivers on ASKAP antennas at the MRO was a major milestone recently achieved by the ASKAP team.



> The coloured image within each square represents the power received at each PAF port. The colour scale in each image represents logarithmic intensity over approximately 55 dB in range and comprises 40 x 1 MHz summed channels, spanning frequency range 1.2–1.5 GHz. Each image is normalised to its peak value. Credit: Aidan Hotan, CSIRO.

These are the second, third and fourth complete PAFs built to the ASKAP design (the prototype PAF is installed on the testbed antenna at Parkes), but the first to be deployed to the ASKAP site.

The ASKAP team is working to have all three receivers and associated electronics functioning at the MRO by the year's end. This instrument will represent the first half of engineering and scientific commissioning instrument, the Boolardy Engineering Test Array (BETA).

BETA will provide an invaluable testbed instrument for the ASKAP team to learn how to 'drive' the PAF receivers and achieve the best possible performance.

While the central ASKAP Control Building is assembled and fitted-out on site, the correlator and beam-former electronics for the first half of BETA have been temporarily accommodated at the MRO in a modified shipping container, known as the 'BETA Box'.

The fibre link between the MRO and Perth (used in July 2011 for a live 'e-VLBI demonstration) is currently awaiting final sign-off before becoming fully operational and achieving full bandwidth.

### BETA commissioning gears up

The ASKAP System Commissioning Team (SCOM) has been busy over the last several months working with the first PAF receiver at Parkes and producing images such as the montage on the front page.

SCOM forms part of the wider System Engineering, Integration and Commissioning (SEIC) team and takes specific responsibility for executing

>ASKAP antennas installed with PAFs at the MRO. When fitted with associated electronics, they will represent the first half of BETA. Credit: Barry Turner, CSIRO.



### Boolardy Engineering Test Array (BETA)

BETA will comprise six ASKAP antennas at the MRO with PAFs and a correlator - complete with full 300 MHz ASKAP bandwidth and 36 formed beams covering six 30 square degree fields.

While primarily an engineering testbed, BETA will also be an entry point for the ten ASKAP Survey Science Teams to become actively involved in preliminary scientific observations, analysing data in preparation for delivery of the full 36 antenna array.

Although BETA is not a science instrument, it is more than likely some real 'early science' will be undertaken, to assist the SCOM team with the full fit-out of the ASKAP radio telescope.

commissioning plans, particularly on BETA and the MRO.

Guided by the very positive outcomes on the 12-m testbed at Parkes, main objectives of commissioning at the MRO in the coming months are single dish PAF and beamformer testing and phase closure demonstration.

### Single Dish Testing

Using software and firmware validated at Parkes, the team will undertake scans with ASKAP antennas at the MRO on bright calibrators such as Virgo A in single-dish mode.

In the low-RFI environment at the MRO the team expects to achieve enough sensitivity to determine first-order beam-weights, investigate a range of PAF and beamforming questions and continue to confirm basic functionality of the system.

Several high-performance and well-characterised feedhorn (single pixel) receivers are also available to provide reference signals using exactly the same proven techniques demonstrated at Parkes.

### Phase Closure Demonstration

Once reliable beam-weights have been obtained and the basic single-dish mode of operation has been validated, the next objective is to obtain correlation first on a single baseline (between two PAF antennas) and then on three baselines (three PAF antennas). The latter should yield 'phase closure'.

In the first instance signal correlation will use a relatively low bandwidth (16 MHz) capturing baseband data for a single formed-beam on a point-source calibrator and correlating in software. Once validated, additional beams will be added and more complex fields observed.

These measurements will move to multiple beam imaging of simple astronomical fields during early 2012, paving the way for more complex imaging observations as we acquire additional antennas and the full-bandwidth, real-time correlator.

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