ASKAP Update

May 2013

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 snaps multi-beam image

In recent commissioning tests on three ASKAP antennas at the Murchison Radio-astronomy Observatory (MRO), the ASKAP team successfully achieved a multi-beam image using three phased array feed (PAF) receivers.

In a demonstration of the wide field-of-view the ASKAP phased array feed receiver might offer, this is the first ever multi-beam image to be produced anywhere in the world by a multiple-PAF interferometer.

According to Chief of CSIRO Astronomy and Space Science, Lewis Ball, this is a landmark result for the team, "it is a striking visual demonstration that our PAF receivers and systems can actually do what they're built for, though there is of course still a long way to go."

The image was created with three ASKAP antennas installed with PAF receivers and hardware. Three separate beams were created for each PAF and lined up to track an elongated patch of sky over a 12 hour observation, showing the trio of Southern sources PKS 1547-795, 1549-790, 1610-771 (the three brightest spots in the image).

This field was specifically chosen to contain a trio of strong and well-known extragalactic sources, with suitable angular separations, including the three brightest points in the image (clockwise from the top-left) PKS 1610-771, PKS 1606-772, PKS 1549-790, and PKS 1610-771.

As before, the target field was observed, with data-capture running and on-the-fly correlation in software, with mage reduction performed in ASKAPsoft, the bespoke software designed by the Computing team.

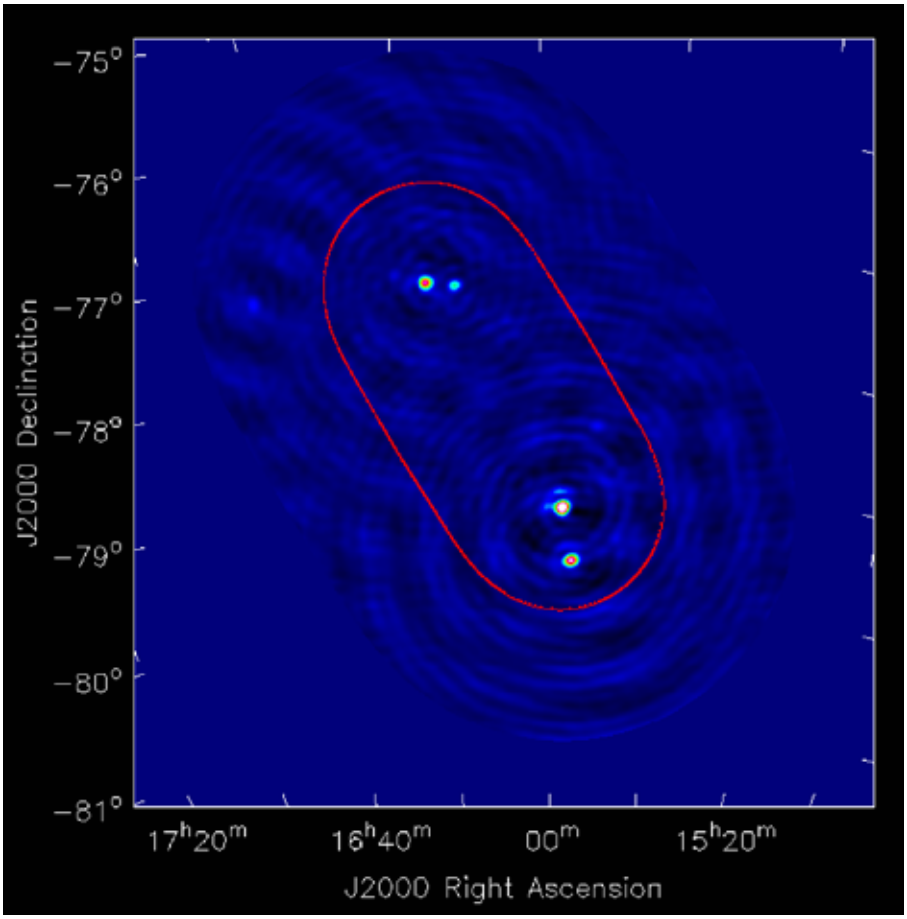
At least two additional 'serendipitous' sources also appeared in the results. These were found to be PKS 1606-772 and 1637-771. The region of 50% sensitivity, the envelope of the three overlapping PAF beams, is shown within the red contour.

This is very much a proof-of-concept result due to the level of artefacts in the image, is still some way before it is scientifically useful.

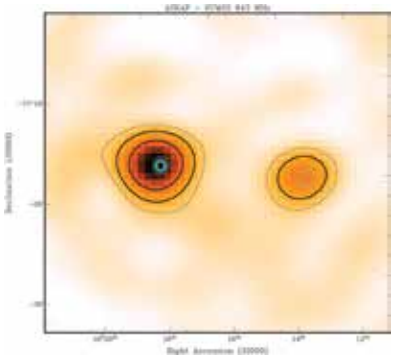
Nevertheless, Lewis Ball was pleased with the results, saying "this is very encouraging progress. The entire ASKAP team, including the BETA and SEIC teams and our staff in Geraldton, have put in a big effort over the last 12-18 months to make this commissioning step possible."

Importantly, these sources are too far apart to be observed simultaneously using a conventional radio telescope feed without significant movement of the antennas and multiple integrations, a much slower process.

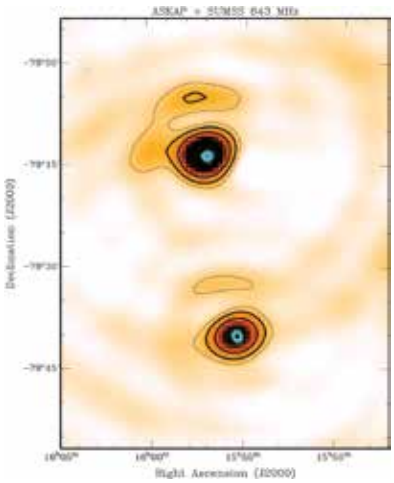
This is a striking demonstration of the potential of PAF imaging, despite the very limited u-v coverage that can be achieved with just three antennas.



The red contour shows the effective field-of-view where sensitivity is greater than 50%, elongated due to the use of three beams in a line (using a SPF would result in a circular region). The ripples are a result of incomplete uv-coverage, but will reduce as more antennas are added to the interferometer – this will also allow weaker sources to be studied.



The two strong sources from the top region of the 'BETA image' overlayed with data from the SUMSS catalogue.



The two strong sources from the bottom region of the 'BETA image' overlayed with data from the SUMSS catalogue.

Quick as a FLASH

Already, the ASKAP Survey Science Teams have shown interest in the multibeam results, and are keen to investigate further. Elaine Sadler, Principal Investigator of FLASH (The First Large Absorption Survey in HI), conducted an interesting comparison of the multi-beam image with the SUMSS catalogue* catalogue.

By zooming into the plots, the data reveals the astrometry of the ASKAP data to be quite good. The peak flux densities measured for the four strongest sources also agree well with the values in the SUMSS catalogue. The resulting plots (above) show two regions of the BETA image overlaid with contours from both BETA (black) and SUMSS (cyan).

That the two nicely showed a correlation is testament that the first generation of the ASKAP PAF receivers are "doing their job".

From a distance

CSIRO's ASKAP team has successfully controlled its pathfinder telescope in Western Australia, from its Sydney based Science Operations Centre (SOC) – a distance in excess of 3,400km.

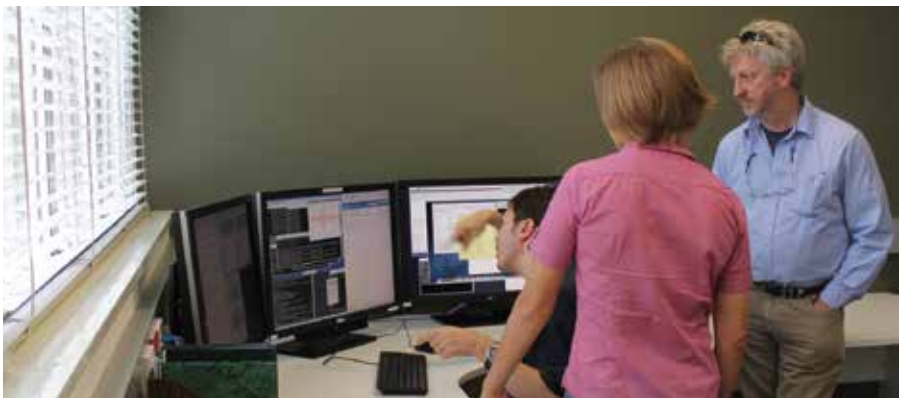
The remote connection, between the CSIRO Astronomy and Space Science headquarters in Sydney and the Murchison Radio-astronomy Observatory (MRO) in Western Australia where ASKAP is sited, was part of continuing commissioning activities to test the stability of the ASKAP system.

Not only do the tests mark the first time the antennas have been operated fully from outside the MRO or nearby Boolardy Homestead, but they provide insight into the remote science operations and observations that will take place with ASKAP and a national and international research community. Benefits of remote access at this, the commissioning stage, include increased staff safety and efficiency as workers need to spend less time in the remote desert environment.

"Initial fringes were successfully obtained from the new observing space recently built in the SOC and marks a significant step forward in the commissioning process," said ASKAP Project Scientist Lisa Harvey-Smith, "The SOC facilities will continue to provide an invaluable remote platform as commissioning begins to ramp up in earnest."

The SOC comprises four control rooms that can be linked to CSIRO's four telescopes – the Australia Telescope Compact Array, the Parkes 64-m, Mopra, and most recently, ASKAP.

The ASKAP commissioning team will initially use one of the larger observing rooms, with a smart board linked to a similar unit at the MRO site to ensure there is a single source of current information available to engineers and commissioning teams. The two larger rooms can be joined into one large space for group observing sessions such as LBA observing, ASKAP commissioning activities and outreach activities such as CSIRO's 'PULSE@Parkes' outreach project.



Members of the ASKAP team testing out remote access to the MRO from the Sydney headquarters

*SUMSS: Sydney University Molonglo Sky Survey, a wide-field radio imaging survey of the southern sky at 843 MHz.

Remote access aids commissioning

The next vital step in commissioning is the installation of the ASKAP hardware correlator, which will provide valuable data output for testing of the ASKAP Science Processing Pipeline. This will allow the ASKAP team to begin early evaluation of high-level functionality of the telescope.

The hardware correlator has been under development at the headquarters of CASS in Sydney and now the Digital Systems team will head to the MRO for remote testing of the new hardware. Though previous PAF test runs have already produced initial valuable results (see page 1), the custom-made software correlator that was used to process the raw data captured directly from the beamformer is limited to 16 MHz of instantaneous bandwidth.

Once online, the hardware correlator is expected to offer the full 304 MHz of instantaneous bandwidth at 18 kHz resolution.

'One of the important early outcomes of the hardware correlator delivery will be the further refinement of beamforming algorithms for calibration of the ASKAP receiver systems, enabled by the significant increase in processing bandwidth and sensitivity.'

The shift towards optimising remote accessibility of ASKAP from the CSIRO Astronomy and Space Science (CASS) headquarters in Sydney will allow for ongoing commissioning activities at the remote site to be more effectively carried out.

Meanwhile, out at the Murchison Radio-astronomy Observatory, members of the ASKAP team stayed busy over the summer, with a number of trips out to the MRO to continue commissioning tests.

Space junk at summer school

Each year, CSIRO Astronomy and Space Science hosts a number of undergraduate students as part of its summer vacation scholarship program. This year, Charles Li was one of those students. His investigation into the likely signals that may be detected by ASKAP and the SKA other than those originating from space made for an interesting project.

Charles conducted an investigation to characterise the likely signal that would be detected by ASKAP and the SKA from satellites and aeroplanes, as well as from reflections off space junk and other near-earth objects.

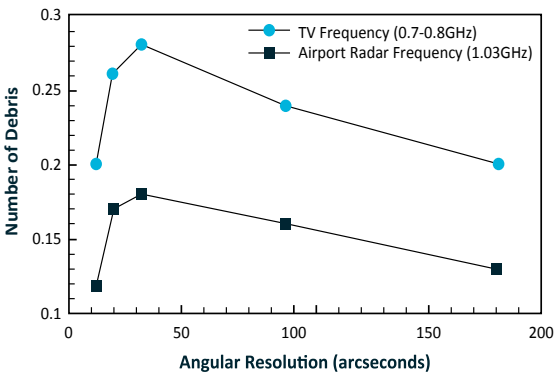
Using Space Debris Catalogue from the Space Surveillance Network and the Australian Radio Transmitters Database from the Australian Communication and Media Authority (ACMA), two strong RFI sources within the ASKAP frequency range were identified. These were found to be airport radars and TV broadcasting signals.

After calculating the strength of the signals reflected off space debris of various sizes, it was found that approximately one in five scans performed by ASKAP would be likely to have a piece of visible space debris in it.

The motivation for this project originated from suggestions that the reflection of terrestrial RFI might cause space debris to appear to be transient sources during large surveys. Consideration of these signals is vital in the planning for large-scale projects that survey the sky for transient radio sources, such as ASKAP Survey Science Projects VAST (ASKAP survey for Variables and Slow Transients) and CRAFT (Commensal Real-time ASKAP Fast Transients survey).

However, Charles does note that these sources should be easily differentiable from real transient sources as they have very narrow emission lines while natural sources tend to have a continuum emission.

Average Number of Detectable Debris in each Field of View



This plot shows the number of debris pieces detected in the time the LEO objects sweeps across one pixel. Different resolutions available for the ASKAP are based on the specifications from Johnston et al. 2009, arXiv:0903.401.

Charles Li, one of the students involved in CSIRO's Summer Vacation programme, who investigated the likely signal that would be detected by ASKAP from satellites and aeroplanes, and other near-earth objects.
Photo: courtesy of Charles Li.

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