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ASKAP Commissioning Update, September 2018

In this issue, we report investigations into alternative beam-forming reference sources and ongoing efforts to release images from the first cosmology survey attempt.

Development of pilot survey plans

The final delivery of hardware required to complete ASKAP to its full specification is due to leave Sydney later this month. Given recent experience, we expect installation, commissioning and integration of the 8 remaining antennas to proceed swiftly.

This means that ASKAP should be hardware-complete by the end of 2018, allowing us to begin survey operations in early 2019. The next two years will be an intermediate phase; funding has been secured for a significant upgrade to the Pawsey supercomputing facilities that ASKAP relies on, but the new hardware will not be commissioned until the end of 2020.

In the meantime, we must make best use of existing resources and focus on learning how to efficiently survey the sky with ASKAP's full capabilities. This process will begin with limited-duration pilot surveys in early 2019 and progressively scale up once viable strategies have been demonstrated.

Detailed plans for the next two years will be released publicly before the end of the month.

Alternative beam-forming sources

ASKAP's digital beam-formers are highly flexible and configurable. However, they must be calibrated with new weights in response to any change in the phased array feed element gains or signal path delays.

Typically, we do this using an algorithm that maximises the signal to noise ratio of a reference source when compared to a blank patch of sky. This requires a strong reference source and in the past, we have used the Sun.

Under normal circumstances, this is a safe operation as each ASKAP antenna is painted with a compound called Goldstone-6, creating a surface that harmlessly scatters visible and infra-red wavelengths away from the focus. However, a recent incident revealed that this protection does not apply when the reflector surface is covered in a layer of water, which reflects roughly 2% of incident radiation in a specular manner at high angles of incidence.

When beam-forming on the Sun a few weeks ago, part of the array experienced a rain shower. One of the antennas received enough rain water to cause intense heating due to solar radiation at the focus – enough to burn out the central receiver elements. Fortunately, the damage was limited to the front layers of material and did not proceed to the ground plane or electronics, but significant work will be required to repair the chequerboard.

Since then, we have implemented new policies to ensure careful assessment of weather conditions before observing the Sun. We are also actively investigating alternative beamforming sources to minimise risk.

Reference source requirements

Presently, we form beams for each antenna and 1 MHz frequency channel independently. It is possible to use the combined sensitivity of the interferometer to form beams, but each PAF has many more elements than the number of beams we can simultaneously correlate. This means we would need at least three sets of observations, increasing operational overheads significantly.

For single-antenna beam-forming we have found that a reference source flux of about 1000 Jy is the minimum required and aside from the Sun, only the Moon and Taurus A (the Crab Nebula) could possibly be used.

Tests with these two alternative sources show that radio frequency interference is more likely to impact the beam weights, so we have been developing ways to use interpolation over multiple frequency channels to reconstruct valid weights for channels that fail.

Use of the On-Dish Calibration system

Ideally, we would make one measurement of a new beam footprint using a reference source. From then on, we would rely on ASKAP's ODC system to keep the weights up-to-date as parameters change over time.

We are testing this as an active operational model, but as there are still a few antennas without operational ODC hardware it cannot be used exclusively at the moment. Using the ODC to update beam-former weights is also much faster than re-determining the weights from scratch, which will greatly decrease operational overheads and allow more flexible scheduling (for example, switching between different bands more rapidly).

Processing of early science data

The plan for pilot surveys in 2019 involves temporarily storing visibility data and using batch processing. This allows iteration and investigation of image quality, but it makes disk space a major operational consideration.

To begin pilot surveys with a clean slate, we will be deleting all raw visibility data from early science phase one on the 6th of November 2018. In advance of this deadline, the ASKAP operations team is processing several existing data sets – the pilot cosmology survey and the four WALLABY spectral line test fields.

The cosmology survey

The original cosmology survey plan involved 68 fields. After observing the first 16 we paused to investigate data quality and determined that it was insufficient to meet the science goals originally specified.

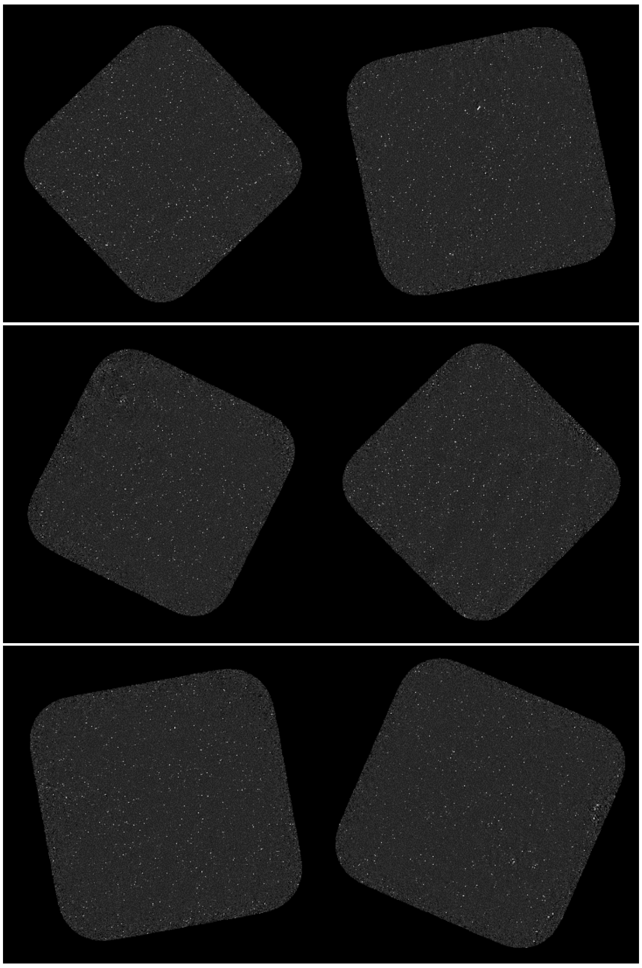
Although the survey has not resumed, the ASKAP operations team have been using the 16 observed fields as a case study to establish procedures for larger pilot surveys next year. Along the way, we have uncovered a few problems with the processing pipeline which are being addressed and should improve image quality for both continuum and spectral line observations in future.

One of the issues has to do with self-calibration. By default, ASKAP uses the output of a source-finding algorithm to generate model components for self-calibration, similar to what will eventually be obtained from a global sky model. The default configuration of this source finder was optimised for science, including a restriction on the goodness of fit required to register a component. In some cases, this was causing bright continuum sources to vanish from the model after one or two major cycles – leading to significant calibration errors.

This likely contributes to issues encountered during continuum subtraction of spectral line data, where in some cases obvious continuum sources were not being removed as expected – or side lobes were being removed.

The final set of cosmology images will be uploaded to CASDA shortly, along with full spectral resolution calibrated measurement sets for other science goals. Note that this will not be possible with future data sets as the visibility file sizes are now much too large.

We hope that this will be a science-capable demonstration of ASKAP's data archive (CASDA), which will become the primary point of access for users.



Images from the pilot cosmology survey observed in February 2018, made by ASKAP operations team members Susannah Keel, Robin Wark and Stacy Mader using the ASKAPsoft batch processing pipeline developed by Matthew Whiting

NGC7232 and WALLABY fields

After uploading the cosmology survey to CASDA, the operations team will switch focus to the four WALLABY early science target fields. The goal is to demonstrate CASDA's capability to support spectral line data and the pipeline's ability to provide outputs that can be used by science teams to create value-added products.

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