ASKAP Commissioning Update, June 2018

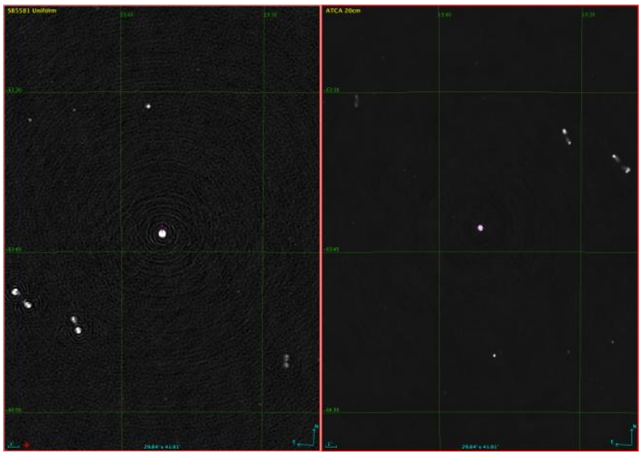
In this issue, we present the first image of a calibrator source in the highest ASKAP frequency band. We also demonstrate improved holography measurements of primary beam shapes following a productive ACES busy week.

Imaging with ASKAP's new fringe tracker

Although we are still testing full integration of UVW and phase centre metadata from the new fringe tracking system, we have been able to conduct simple imaging tests with a hybrid system that exercises most of the new components. This first test involved making images of the field surrounding B1934-638 with a single beam in all three of the ASKAP frequency bands.

The test showed that the image in the uppermost band (taken at a centre frequency of 1632 MHz) was a mirror image of the expected field (see figure below), which could be explained by a conjugation of the visibilities or negation of the predicted UVW coordinates.

Further investigation revealed that although the fringe tracking software was accounting for the inverted nature of the upper band, the visibilities themselves needed to be corrected as well.



First ASKAP image at 1632 MHz (left) compared with an ATCA image of the same field, showing other sources in the field mirrored about B1934-638 in the centre

Commissioning the 1400-1800 MHz band

ASKAP uses a direct sampling system to digitise 300 MHz of bandwidth. Given the large fractional bandwidth requirement (full coverage from 700-1800 MHz with 300 MHz instantaneously) the digitiser firmware was designed to operate at one of two different sampling rates, with the band of interest appearing in one of two possible Nyquist zones. The two Nyquist zones produce spectra that are inverted with respect to one another, which must be accounted for downstream.

Since the firmware has knowledge of the Nyquist zone, the easiest solution is to have it take the complex conjugate of the inverted Nyquist zone and re-order the frequencies presented to the correlator so that the visibility data appears to have the same spectral characteristics anywhere inside the ASKAP band.

Although the channel re-ordering was being done, the conjugation had not been implemented. The required change was a very simple addition to the firmware logic which has now been completed and will be tested in the coming week.

The road to Array Release 3

Once the final fringe tracker integration tasks have been completed, the commissioning team will run an extensive series of test observations. These include making measurements of the System Equivalent Flux Density (SEFD) across all bands, verifying that the imaging and mosaicking software supports independent phase centres for each of the 36 beams, validating the astrometry of known sources (which could be impacted by errors in the timing of the fringe tracking parameters) and finally, making images of early science target fields to compare overall quality metrics with previous results.

The 6th correlator block has now been installed at the MRO and is being commissioned. Once its network links are in place, we will be able to test ingest of 288 MHz of bandwidth, very close to the full ASKAP specification. The remaining 12 MHz requires only a partial correlator block, which will be configured later for Array Release 4.

The final stage of preparation for Array Release 3 is the integration of at least two more antennas to bring the array size up to 18, ideally with several spares and at least two of the outer 6 antennas to test our longest baselines.

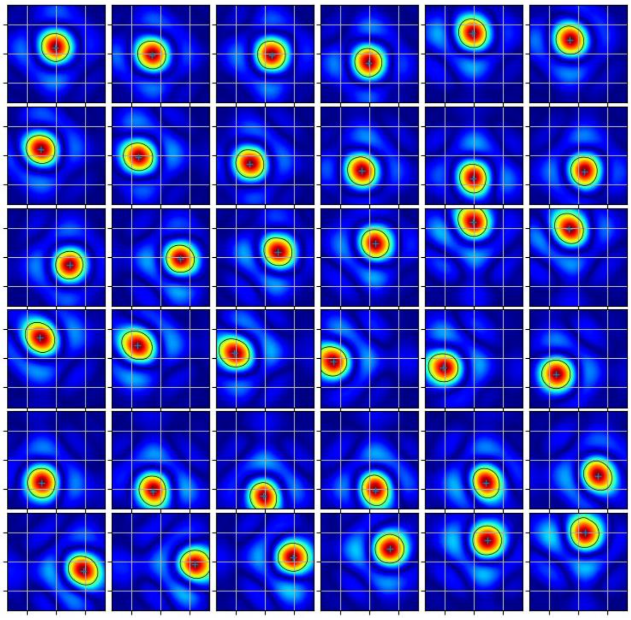
If possible, we will use any available time between these activities to finish observations associated with the early science cosmology survey. Future observations with Array

Release 3 will be planned as part of the pilot survey program, details of which are currently being discussed with the survey science team principal investigators.

Improvements to holography

During the ASKAP commissioning and early science busy week held in May, we fixed a long-standing bug in the software that extracts and grids visibilities to the reference antenna for holography observations. The normalisation for total observing time on each grid point was not being done correctly and variations in the number of cycles flagged were causing "holes" to appear in the raster image. Fixing this problem has dramatically improved the quality of our beam shape measurements.

At the same time, we implemented the ability to correct holography visibilities for source structure by dividing out a model of the reference field. Although not as good as performing a full self-calibration, this approach has shown that on baselines of ~2 km, the structure of Virgo A was dominating our holography measurements. We will now begin to investigate using other reference sources when measuring the beam shapes of more distant antennas.



New holography measurements of ASKAP's 36 beams in a standard "Square 6x6" footprint, showing that in general, the main lobe could be well approximated by an elliptical Gaussian

With greater confidence in our beam shape measurements, we can begin to test more realistic primary beam models in the mosaicking stage of the imaging pipeline. The first such improvement will be to allow use of an elliptical Gaussian model instead of a circular Gaussian, which we have seen is a better approximation to the outer beams (where Coma distortion is present) and to the individual polarisations.

We can also begin to assess the consistency of beam shapes and pointing directions across all antennas, and the frequency evolution of beam size.

Science data processing sprint update

The first SDP sprint cycle has concluded, with the successful completion of 24 individual tickets, covering a wide range of issues. Some of the primary tasks included investigating the memory requirements of joint deconvolution over multiple beams, improving documentation, providing some additional user tools for bandpass plotting and smoothing, fixing a file access bug in the imager and improving its kernel caching abilities, and incorporating several requested features (such as AOflagger and the ability to compute spectral indices from continuum cubes) into the imaging pipeline scripts.

The theme of optimisation and improvement of existing tools will continue into the next sprint, in anticipation of testing AR3 with the same observing strategies and pipeline processing methods used for early science thus far. When the most recent changes have been packaged and released, we will distribute detailed patch notes.

SDP development priorities and feedback

As previously mentioned, ASKAPsoft development priorities are now set on a month-by-month basis through consultation with the ASKAP lead scientist, using an agile sprint methodology.

Science team members who wish to request specific changes or additions to the software should do so via the weekly ACES meetings (through their team's representative) or the monthly early science forum. Alternatively, please feel free to email the lead scientist directly. Short term priorities will be aligned with the impending array releases, with the eventual goal of streaming real-time processing being pushed back until further validation of the core software components has been completed as part of the early science program.

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