ASKAP Update, June 2020

In this issue, we report development activities during the first month of post-Pilot consolidation time, provide an update on processing of Pilot Survey Phase I data and the Rapid ASKAP Continuum Survey.

Post-pilot consolidation underway

The conclusion of Pilot Survey Phase I has shifted the focus of activities, but not their intensity. ASKAP's engineering teams have been testing and releasing many improvements to the system, including a new software build scheme for the ingest pipeline applications, automated activation of phased array feed monitoring while antennas are stowed and incorporation of additional weather prediction data into the automatic stow system. The most significant feature to be released is the beam weights service, which will automate the process of creating, managing, and applying the beam weights required to provide ASKAP's wide field of view.

Beam weights service commissioning

This new software package consists of a database and tools for managing Phased Array Feed (PAF) beam weights. Each ASKAP antenna needs a unique set of complex weights that are applied prior to summation of the voltage signals from every individual PAF receptor, forming a set of primary beams that fill the field of view. These weights are created from observations of an astronomical reference source using an algorithm that optimises the signal to noise ratio between the reference and a background field. Each arrangement of beams at a given observing frequency needs its own set of weights. Weight solutions last until the system is disturbed in some way, either by resetting the digital receiver (which introduces small random delays into the signal from each element) or changing hardware components in the PAF. Since we often need to reset the digital receiver (e.g. when changing observing bands), we also need to update the weight solutions regularly. Updates can be done using our on-dish calibration system in a minute or two, compared to about an hour for a new solution.

The beam weights service was designed to automate the entire life cycle of beam weights, from formation through to updates and eventual retirement when hardware is changed in the phased array feed. It also automates the selection of the best available weights from the database, based on a query that matches the requested observing mode. This should ensure that the correct beam weights are always loaded and remove the possibility of human error. It will also allow greater scheduling flexibility.

The initial software release provides command line tools to interact with the database and merges the calculation and update of beam weights into the scheduling block system. The observing procedure can still load specific weights on request but now also provides an automatic mode which queries the database instead of looking for specific weights files. These new features are being tested and commissioned this month.

Pilot survey data processing update

Consolidation is also a busy time for the Galaxy supercomputer as we work through the backlog of Pilot Survey Phase I data. Recent highlights include the release of updates to the science data processing pipeline that allow upload of POSSUM data into CASDA. We are currently working on the first GASKAP pilot survey fields.

Tests of a newly available continuum subtraction tool have been done by several survey science teams, with feedback from FLASH, WALLABY and DINGO helping to tune the fitting parameters.

Rapid ASKAP Continuum Survey update

Processing of ASKAP's first all-sky survey, the Rapid ASKAP Continuum Survey (RACS) is nearing completion (see Figure 1). The first observations were done in April 2019 and the RACS team has been rigorously testing data quality since then. Two main issues were discovered during quality control, the first being a large amount of variation in the Point Spread Function (PSF) from one field to another (and sometimes within a single field) and the second being a systematic flux offset in sources towards the edge of each field.

The PSF variations were primarily due to groups of fields being observed at different hour angles. This presents difficulties when mosaicking or source-finding across multiple fields because the same source observed in two different fields can have a different PSF. An updated scheduling algorithm was developed to minimise hour angle variations across fields and the worst-impacted areas of sky were re-observed earlier this year. This will allow the creation of a global catalogue with a common resolution of 25” across nearly all of the sky between +40 and -90 declination.

The second issue relates to our knowledge of the primary beam shape away from the optical axis of the antennas. ASKAPsoft’s mosaicking tool assumes circular Gaussian beams, which is reasonable across most of the field of view. However, the outermost beams experience coma distortion. This results in a degree of elongation in the radial direction, but also shifts the most sensitive part of the beam away from the geometric centre. The elongation means that our primary beam correction is not accurate at the edge of the field and the coma distortion means that our bandpass calibration observations do not place the reference source PKS B1934-638 in the correct position within the beam. These compounding effects result in flux errors of up to 15% towards the edge of the field when compared to previous surveys.

Careful investigation revealed that the required correction is a smooth function across the image plane. This can be applied as an addition to the final stages of the processing pipeline, which will be done prior to releasing the first RACS images.

Correcting these discrepancies will be important for all future ASKAP observations. The ASKAPsoft team have already implemented the ability to use elliptical Gaussian primary beam models, but this will not account for the centroid offset introduced by coma distortion. We will also be investigating the use of holography data as a direct input to the mosaicking process.

Our holography measurements of the beam shapes have coarse angular resolution due to the time required to observe a grid of positions covering ASKAP’s wide field of view. Provided these measurements meet the Nyquist sampling criterion, it should be possible to interpolate in both frequency and spatial dimensions to derive a beam shape that is more accurate than simple geometric models. We are investigating the possibility of repeating holographic measurements on a regular cadence to build up both an average measured beam shape and further assess the stability of individual shape measurements compared to the global average over antennas and time.

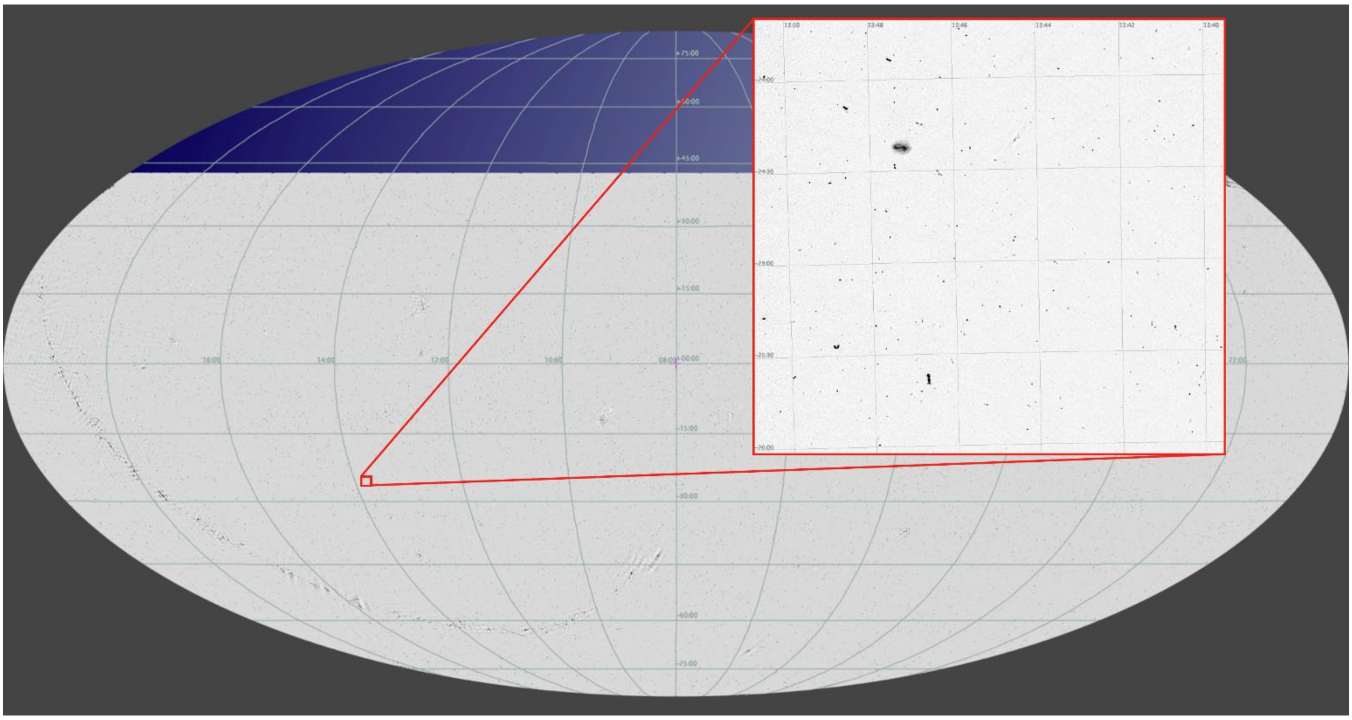

Figure 1: Full mosaic of the most recent RACS processing run, with inset showing a representative field. Image made by Emil Lenc.

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