ASKAP update for June 2022

In this issue we discuss plans for post-Pilot technical test observations, Setonix commissioning, and RACS.

Post-Pilot Technical Tests

Most of the Survey Science Teams have now received all the expected data from Pilot Surveys Phase II and are hard at work assessing whether its quality is sufficient for full surveys. In parallel, the Rapid ASKAP Continuum Survey (RACS) team has been conducting its own data quality checks across all three bands observed. Regular science working groups channel feedback from these sources into the ASKAP Operations team.

While data quality is in general much improved from Pilot Surveys Phase I, several outstanding issues remain.

For continuum and polarisation science, most concerns trace back to the need for accurate primary beam correction. We have found that ASKAP's digitally-formed beams have slight shape and position variations from one formation attempt to the next. This means that simulated beam patterns are insufficient for science data processing, and we must actively measure the beam shapes after each beamforming attempt, every few months.

Although it was possible to mosaic using measured primary beam shape information during Pilot Surveys Phase II, we did not always have measurements of the specific beams used for each science observation (only a representative sample of the footprints on offer). For full surveys in the future, we will routinely measure the shape of every newly-formed set of beams. The ASKAPsoft processing pipeline will be able to trace a beam weights ID to the matching holography data and use the correct beam shape files during linear mosaicking. This should ensure the best possible flux scale and off-axis polarisation leakage correction, with any residual errors being largely confined to the edge of the field.

The AKVET and RACS teams are working to verify that correctly-matched holography agrees with source-based measurements of the primary beam shape. They have found a small residual consisting of an array-wide shift of the footprint by about 2 arcminutes. The source of this shift is not yet understood but is likely a common pointing term that our existing model does not account for.

Alternative evidence for a pointing issue was documented by VAST when investigating the light curves of sources and noting a jump in flux on either side of transit during a long track. A sequence of test observations is planned to further investigate this effect, using fields covering a wide declination range. These observations will be done as part of consolidation work and made available on CASDA by the Observatory.

The POSSUM team have also requested additional tests to verify that off-axis polarisation leakage corrections based on holography meet science requirements. Due to the lack of matching holography during Phase II, existing data falls short. These tests will be conducted after the pointing investigation mentioned above has concluded, in the hope that we can further improve the correction that is applied.

We also plan to conduct repeated holography observations of the same set of beams, to quantify any (unexpected) changes that may occur between beamforming attempts.

For spectral line science, further improvements to ASKAPsoft's continuum subtraction are planned, along with final validation of wider beamforming intervals for FLASH. There are also some concerns over the presence of low-frequency sinusoidal ripples appearing in the image domain, most likely due to solar interference. Although ASKAP observations are scheduled to avoid known solar interference zones (close to the field centre, or within angles that directly illuminate the PAF), some residual impact remains. Flagging short baselines improves continuum image quality in these situations but has not been able to eliminate the effect and is detrimental to science cases involving diffuse emission. Investigation into alternative flagging strategies (including algorithms with knowledge of the Sun's position) is continuing. We also plan to increase the size of the exclusion zones by a few degrees to ensure that all beams fall outside the limits.

Setonix commissioning underway

Our initial timeline for the commencement of full surveys depended on receiving access to the new Setonix supercomputer in April/May. Unfortunately, this was delayed by several weeks. Members of the Science Data Processing team were granted access on the 13th of June and are working with Pawsey staff to configure the Operations environment. Initial work involves deploying and testing software containers and ensuring that we can run large-scale jobs using the batch queue system provided by Pawsey. Once basic functionality has been established, we will begin testing the performance, reliability, and correctness of individual tasks, followed by full pipeline runs.

Our timeline calls for 6 months of commissioning, which would push the start of full surveys into December. The current supercomputer Galaxy will remain operational for the next 6 months, but we hope to be running full-scale jobs on Setonix well before then. More information on the timeline for consolidation, Setonix commissioning and full survey commencement will be shared with the science community as it becomes available.

Second RACS-low epoch complete

Observations and initial processing of the second RACS-low epoch are now complete and we expect to start releasing data products from -mid, -high and -low2 over the next few months. The final RACS-low2 sky map shows significant improvements over the original RACS data release (see Figure 1) due to improvements in scheduling, processing, and overall telescope performance. The noise level is more uniform across the sky and has a median of 185 uJy/beam compared to the original 230 uJy/beam. RACS and the Pilot Surveys have been extremely valuable tests of ASKAP's capabilities, and it is excellent to see such significant improvements on the road to commencing the full survey projects.

Now that we have data from all three RACS frequency bands, we can take steps to assemble a global sky model that can be used by ASKAPsoft. The sky model service has been deployed and integrated with the pipeline and is undergoing tests with data from individual frequency bands. Compiling the global sky model will require some additional research and development to determine how we can best represent the frequency evolution of each source. We also need some additional tools to apply primary beam corrections to the output of the sky model service. Once these tasks are complete, we can investigate how best to use the sky model to improve imaging performance and quality. We hope to offer at least some of this functionality for the start of full surveys.

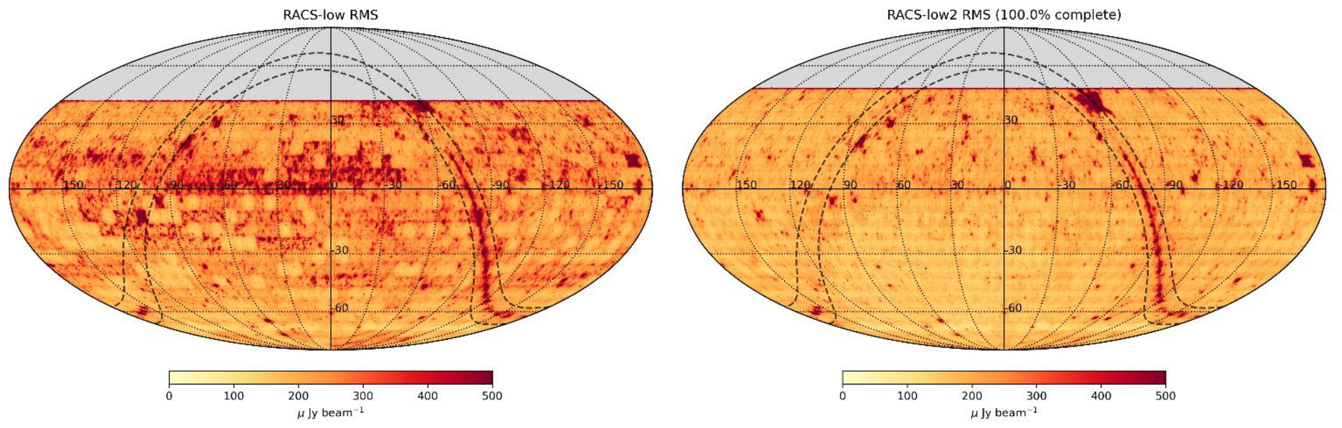

Figure 1: Comparison of the original RACS RMS map (left) with a new epoch done in the same frequency band (right). Observations and processing for RACS-low2 were completed in 1/3 the calendar time needed for the original RACS (with the same integration time per field), demonstrating improved observing and processing workflows. The second epoch covers 1500 additional square degrees in the North and is 25% more sensitive, with a median of 185 uJy/beam. The improvements are due to a combination of enhanced scheduling and adjustments to the telescope and processing software. Image made by Emil Lenc.

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