ASKAP update for June 2021

In this issue we report on work to improve ASKAP's digital firmware, Pilot Survey Phase II quality gate processing, CASDA updates due this month, and finally highlight the latest work on holography primary beam correction.

Digital firmware development campaign

Efforts to improve ASKAP's digital firmware intensified this month, with work on several areas including data stream alignment, corner-turn stalls, and multicast ethernet packet support. This work is designed to address the reliability of the digital system in various ways.

Work on the alignment and robustness of internal data streams may reduce or remove the underlying causes of correlator "dropouts", where some of the high-resolution frequency channels cease to provide data.

Improvements to the way high-volume data are transmitted over the network should reduce the likelihood of packet flooding events that occasionally disrupt normal operations.

As part of these ongoing investigations, we observed that the fringe rotator continues to track a nominated phase centre even after the source has set (unless a new command is given). This can result in the CALC prediction software tracking a source across the physical horizon, where the atmospheric delay component becomes large. This causes a spread of delays across the antennas and beams, using a large fraction of the delay compensation FIFO buffers. There was some concern this could lead to data stream alignment problems, but closer inspection shows no relation to dropout events. We will investigate disabling CALC updates at the end of a scheduling block to avoid this scenario.

Continued improvements to the firmware allow us to take advantage of operational experience, improving data quality and overall efficiency. The current period of intensive firmware work is scheduled to continue for another week, after which we plan to resume Pilot Survey Phase II observations. Ongoing tests will still be possible on a weekly basis as part of scheduled development time.

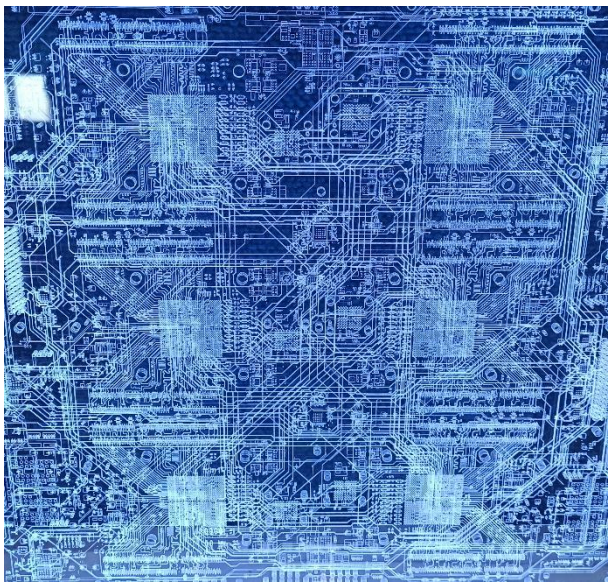

Figure 1: Signal paths in the Bullant digital signal processing board used extensively by ASKAP. Backlit etched crystal panel made for display by John Tuthill, Lou Puls and James Hannah

Pilot Surveys Phase II

EMU and WALLABY quality gates were observed recently and have now been through a first processing pass.

WALLABY quality gate processing has demonstrated the need for improved matching of calibrator observations to science targets. Calibrator matching is now done using an ID number identifying the beamformer weights. This ID is a new metadata component added with the weights archive service, which provides full tracking of the origin and application of a given set of beamformer weights. The processing pipeline will soon be updated to read this

information from a scheduling block and check that the calibrator used the same weights as the science field.

Continuum subtraction of WALLABY data also needs further tuning, especially the fitting parameters used for image-based subtraction. An alternative would be to use more Taylor terms in the imaging itself, to better account for spectral curvature.

EMU quality gate fields have also been imaged, initially using the same circular Gaussian primary beam correction as for Pilot Surveys Phase I, and more recently using primary beam shapes measured by holography. Our intention is to offer holography-based primary beam correction as a standard option for Phase II and beyond. Tests on RACS data have shown that it significantly improves the flux scale, and further improvements are under investigation (see below).

Technical test progress

Work continues to address issues arising from Pilot Surveys Phase I, with activity focussed on GASKAP-OH zoom mode data quality (after an issue with the fringe rotator was fixed) and ensuring that broad absorption lines of interest to FLASH are not removed by the beam forming and calibration process.

The latest GASKP-OH test observation has been examined in detail and shows no sign of the fringe rotator problem, though some refinement of the processing strategy may sill improve the final cube quality. At least one more round of FLASH tests will be necessary to explore all permutations of fixing amplitude and phase of the beamformer weights over larger frequency intervals.

Observatory project progress

The Rapid ASKAP Continuum Survey (RACS) processing pipeline is currently being tuned for mid-band data, with full-scale processing likely to begin soon. Roughly half the total integration time of SWAG-X has been uploaded to CASDA and we are currently determining the best way to validate and release these data to the community. The remaining SWAG-X observations are on tape storage and do not conflict with ongoing operations, so they will be processed at a lower priority during Pilot Surveys Phase II.

CASDA development in June

A new release of the ASKAP science data archive, CASDA, is due at the end of June and development of several important features is underway. This sprint will focus on addressing issues that arose during Pilot Surveys Phase I and preparing for new expectations in Phase II.

The next version of CASDA will allow partial release of a data deposit. This requirement arose from experience with polarisation data, where Stokes I products might be suitable for release but others not.

CASDA will also provide support for associated commensal project codes to improve the discovery of data products. Phase II includes a dedicated test of commensality between several of the ASKAP survey science projects, so this update will ensure all teams can quickly find data of interest even if the originating scheduling blocks was nominally observed for a different project.

Holography primary beam correction

Preparation for processing mid-band RACS data prompted further investigation into the accuracy of holographic primary beam measurements. This technique was used to improve the flux scale for RACS low-band data, but with residual effects that needed to be corrected in the image plane after mosaicking.

For the mid-band data, we have closely examined these flux scale residuals and have identified two small sources of error in the holography maps. Our holography procedure corrects the measurement grid for sky curvature, but the method used was only strictly valid in the small angle approximation, leaving a slight distortion at the outer edges. This has been corrected in the control system and verified with new observations.

The second issue has been much more difficult to track down. This problem manifests as a slight asymmetry in the measured field of view (which we expect to be square, for a regular grid of beams). We have investigated many avenues including the validity of corrections to the roll axis that compensate for polarisation angle tracking.

Our best current theory is that wide-field corrections may be needed when gridding the holography data, since our grid coordinates are only computed with respect to the antenna pointing direction. Further experiments will be done to test this theory.

Holography maps are already an improvement over the symmetric beam models used by default and this investigation will ensure they provide the best possible flux scale for RACS and other observations, with no need for additional direction-dependent scale factors.

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