ASKAP Commissioning Update, May 2018

In this issue, we report the successful validation of ASKAP's new fringe tracking system and describe the remaining work required to integrate it into the telescope. We also report on the progress of commissioning the on-dish calibration system and additions to the beam weights service.

Fringe tracking system validation

The latest implementation of ASKAP's fringe tracking system provides several important benefits, including reduced flagging on long baselines, independent phase tracking per beam and a reduction of computational load at the point of data ingest.

Since fringe tracking is a core component of the telescope, we must ensure that the new control method produces data that is consistent with earlier implementations before we use it for science observations.

Side-by-side tests on astronomical sources began last month and highlighted some problems with the new system. These were isolated to an issue with the timing of parameter updates and an offset of the frequency axis in the metadata used to compute fringe rotator parameters. After fixing these issues, we now obtain comparable levels of phase stability on long tracks of a bright calibrator source compared to the previous ingest-based system.

Although this means we are almost ready to begin tests on science targets, there are still some low-level issues that need to be investigated. We have observed per-antenna delay terms of order 100 microseconds that can occasionally change when the system is reset. There is still a frequency offset in the phase tracking parameters at the level of one fine channel (18.5 kHz). Both are present in the ingest-based system, although the frequency offset was previously half a fine channel. These issues will be investigated in parallel with science validation tests as the level of impact on image quality is expected to be small.

Integration and deployment of new features

The new fringe tracking system alters the source of key metadata such as UVW coordinates. These were previously computed by the ingest pipeline but are now passed down from the control software. We must verify that the required metadata arrives at the same time as the visibilities when writing the measurement set.

As part of these changes we will also implement support for the 1400-1800 MHz observing band (which is inverted with respect to the others) and the simplest form of zoom modes, where bandwidth is traded for frequency resolution. Workshop tests suggest that inverted bands should function normally once the necessary configuration parameters can be sent to the ingest pipeline prior to the start of an observation. The compatibility of zoom modes with the fringe rotator has yet to be verified, but these tests will begin soon.

It is important for mode switching to be transparent to the operator, to avoid the potential for human error in configuring the telescope.

Fringe tracking with multiple beams

With the new fringe tracking system, we will be able to independently phase track each of ASKAP's 36 beams.

Combining phase tracking per beam with ASKAP's unique 3-axis antenna mount requires some consideration, as we need to make sure that metadata is captured in such a way that each beam can be correctly imaged in all possible modes of operation. When the phase tracking centre is the same as the antenna pointing centre, we can consider an ASKAP antenna to have either an equatorial mount when the roll axis is tracking, or an Az-El mount when it is not. When each beam is independently phase-tracked, and most are offset from the pointing direction, we need additional metadata to describe the situation.

To support non-standard observations that require a stationary roll axis (like holography), we must still allow each beam to track a common phase centre. This mode is also used for bandpass calibration during early science. Since this collective phase tracking approach most closely resembles the previous control system, we will trial it first before moving on to support fully independent phase tracking per beam.

On-dish calibration service integration

Work on the beam weights database service has reached a point where we are ready to implement support for the on-dish calibration system.

This system injects a low-power reference signal into the phased array feed from the vertex of each antenna, providing a way to measure gain changes on each of the 188 active elements. If any change is detected, an appropriate adjustment can be made to the beam-former weights to ensure that the beam shape remains fixed.

All 16 antennas in the main array now have on-dish calibration systems installed and the code required to automate the weight correction and upload procedure is ready for testing. In the short term, this update procedure will be triggered by the telescope operator, but it is hoped that we will eventually be able to automatically determine when the corrections should be applied using diagnostic information obtained alongside normal observations.

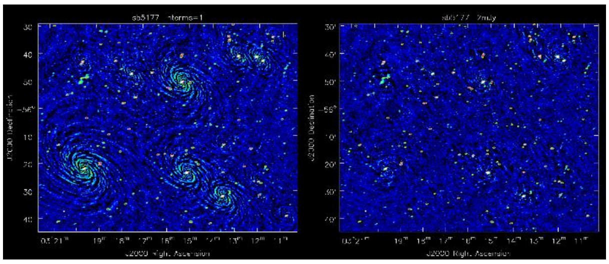
Data challenges and busy weeks

During commissioning, ASKAP's configuration can change from one set of observations to the next (as we integrate additional components and features). This means that the optimal image processing parameters may differ significantly from one observation to another. ASKAPsoft has many parameters that can be tuned to adjust its algorithms, and these must be matched to a data set to achieve the best results.

Recent cosmology survey observations used 16 antennas and 240 MHz of bandwidth – quite an improvement over the 12 antennas and 48 MHz we had when the current continuum pipeline parameter defaults were defined.

Although having more antennas provides additional sensitivity and UV coverage, the extra bandwidth means that de-convolution algorithms must account for steep-spectrum sources. ASKAPsoft was designed to handle this using Taylor term imaging, in which the spectral characteristics of each pixel are modelled using a small number of parameters. The cosmology survey is one of the first large-scale tests of this method on real data.

The cosmology survey is also one of the first projects to be observed after fixing the astrometry errors that had impacted previous data sets. The imaging process is therefore less reliant on self-calibration and we are now free to explore other options. Therefore, the continuum and polarisation working group has issued a new "data challenge" to its members, with the goal of producing the best possible image of one 200 minute, 36-beam field. More details are available on the science team confluence pages for anyone wishing to participate.



An example of the improvement provided by Taylor term imaging (right) when compared to the current default parameters (left). Images created by J. Marvil.

In addition to the cosmology survey data challenge, the spectral line working group are hosting a busy week at CASS headquarters in Marsfield during the week of May 21st. One of the goals will be to establish a standard set of processing parameters for each of the four WALLABY early science fields, so that individual scheduling blocks can be imaged and uploaded to the science data archive.

Operations support of science processing

One of the reasons to establish standard processing parameters is to allow the ASKAP operations team to assist with processing the backlog of early science data. Once satisfactory parameters have been established, the operations team will begin routine processing of existing early science observations with the goal of producing images for upload to the ASKAP science data archive.

Operations-based processing has the benefit of allowing a small group to manage our finite disk storage resources and ensures that any platform-specific processing problems are logged for future investigation.

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