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ASKAP Commissioning Update, April 2018

In this issue, we report on recent tests of ASKAP's new fringe tracking system using astronomical observations. We also describe several changes to the structure of the ASKAP commissioning team and how our operations staff will soon be more actively involved in early science.

ASKAP's fringe tracking system

As described in previous issues of this newsletter, ASKAP is designed to use an autonomous real-time fringe tracking system. The telescope's digital signal processing firmware incorporates modules that can adjust coarse and fine delay steps for each antenna and set the phase and rate of each frequency channel. The parameters given to these modules are updated on the edge of each correlator integration cycle. Updates are driven by the telescope control system, based on knowledge of the antenna positions and the phase tracking centre.

It has taken some time to fully implement this system and up until now we have been using a temporary alternative. This allowed early science observations to commence, but the asynchronous updates we currently use require several cycles of data to be flagged around the time each update occurs. Predicted parameters are currently computed by the ingest pipeline instead of the telescope control system, increasing the amount of computational load in a part of the system that is performance critical.

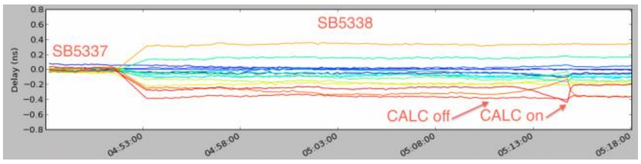
Workshop testing concludes successfully

The new system has now completed extensive workshop tests using a small subset of the ASKAP hardware. During these tests we established that the system could correctly compensate for known delays and was stable over long periods of time, with no phase glitches or other undesirable characteristics.

However, as we have seen before, there is a real chance that new issues will arise as we scale the system up from a few hardware components to the full array. Ultimately, the true test of the system is whether or not it can accurately predict the corrections required to track an astronomical source as the Earth rotates, for multiple antennas and the full ASKAP bandwidth. Therefore, we have progressed to tests at the MRO.

Initially, we observed known calibrator sources with a single beam. The first tests in this mode revealed a sign error in the delay compensation, but this was quickly rectified. Subsequent tests have shown that the system works well, but is not completely consistent with the previous ingest-based implementation. Since we are using a different model (based on NASA's CALC program), it is important to understand the differences between the two methods before proceeding to imaging tests.

After several rise-to-set tracks of B1934-638 and other calibrator sources, we saw that the differences between the two systems could be separated into two components – a small frequency offset that was quickly tracked to the difference between the centre and edge of the reference channel, and a time offset of roughly 7.7 seconds. This time offset is proving more elusive to understand as it is not a neat multiple or fraction of the correlator cycle time and the most recent observations suggest that it may not always be present on all antennas.



Delay tracking with CALC predictions turned on and off

Preparations for imaging tests

Once the basic correctness of the new system has been validated, there is still some work to do to complete its integration with the data processing pipeline. We must ensure that key metadata (such as the UVW coordinates) are correctly merged with the visibilities and recorded to disk. We also intend to track the phase centre of each of ASKAP's 36 beams independently and must take care to ensure that this information is captured in the CASA measurement set so that imaging is done correctly.

Once these last few tasks are complete, we will begin imaging tests as a final stage of verification. This will include re-observing some of the early science fields and comparing source positions with existing catalogues, which has been a useful indicator of problems with the fringe tracking system in the past.

Changes to ACES team structure

The ASKAP Commissioning and Early Science (ACES) team has been the main interface between CASS and the Survey Science Teams (SSTs) for several years. Initially, its focus was on commissioning fundamental aspects of the telescope such as beam-forming and antenna pointing corrections. Since commencement of the formal early science program with an array of 12 antennas, ACES has had a large influx of members and its focus has shifted more towards operational issues and understanding the Science Data Processing (SDP) pipeline. To better support the amount of activity required and the large number of people involved, the SSTs independently created several science working groups, which now meet weekly to discuss similar issues.

In order to avoid duplication of reporting and allow the core ACES team to address low-level commissioning tasks, we have decided to shrink the ACES team and instead support the science working groups in their role as the main forum for discussion of science data processing.

In order to maintain effective lines of communication, the new ACES team will consist of a core group of CASS staff and one representative from each of the SSTs. In addition, several of the core ACES members will attend the science working group meetings to receive feedback and offer assistance.

Software development planning and priority

Alongside this re-organisation, the SDP development team is adopting a new system to prioritise its activities. Early science operations have been a rigorous test of the SDP software and it has become clear that the project needs a formal way to adjust its development priorities based on the needs of the users.

In particular, there is a desire to focus more on improving image quality and processing reliability before making the pipeline run in real time. Although this will likely mean we cannot operate at 100% duty cycle for the first generation or two of pilot survey projects, we will be able to better understand the optimal processing strategies as a result.

We are therefore adopting an agile scrum approach with the ASKAP lead scientist identified as the product owner. Priorities will be set on a 4-6 week development sprint cycle, with feedback from the SSTs and the requirements for upcoming array releases driving the decisions.

Changes to early science operations

The ASKAP early science program has generated a large amount of data that our science teams have been eagerly processing. Initial efforts used various pre-existing software packages such as CASA and Miriad, but in recent months the focus has shifted to a scripted pipeline based on the custom tools provided as part of the ASKAPsoft package developed by CASS. ASKAPsoft was designed to efficiently cope with wide-field imaging on a highly parallel processing platform and supports modern techniques such as multi-scale, multi-frequency synthesis.

It was always envisioned that ASKAP's high data rates would make traditional offline processing prohibitive. However, the overheads of operating a complex imaging pipeline in a supercomputing environment have been a challenge for our science teams during the commissioning and early science phase, requiring expert knowledge in batch queue processing and careful management of finite disk space. This impacts the amount of time spent on investigating data quality and extracting scientific results.

Transitioning to a new operations model

In the long term, ASKAP's imaging pipeline will be operated by CASS as a service to the community. However, during early science it has been important to involve our science teams directly in the data processing to make best use of their extensive experience.

As we work towards completing the first phase of early science, we intend to ramp up the involvement of the operations team. This should address some of the inefficiencies in the current system, especially those associated with multiple users processing the same data.

Our first goal is to handle the initial bandpass calibration stage, as well as provide a curated flagging table and associations between calibration and science observations to avoid some of the guesswork in the current system. This should allow the science teams to focus on perfecting the imaging stage. As time progresses and the pipeline parameters mature, more of the process will be handed over to the operations team until we reach a point where images can be routinely uploaded to the science data archive upon completion of each scheduling block.

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