ASKAP update for November 2023

This month we report on survey progress, the latest ASKAPsoft pipeline software release and plans to improve ASKAP's astrometry.

Survey progress report

After a workaround for the degraded performance of /scratch was implemented at the end of October, we have been progressing steadily through the data backlog. Some further Setonix downtime is planned before the end of the year, when a patch for the underlying software issue is made available by the platform vendor. We have now cleared enough data to resume limited spectral line observing. Our goal is to get the remaining three Survey Science Projects up and running as soon as possible.

SST	Deposited	Awaiting Validation	Released	Rejected
EMU	130	7	105	18
WALLABY	48	1	19	28
POSSUM	177	13	126	39
VAST	2077	0	2042	36
FLASH	82	24	25	33
GASKAP-HI	1	1	0	0

Table 1: Survey progress as of 13-11-2023

Table 1 (above) shows progress since the beginning of full survey operations. We also have 33 EMU blocks in various stages of processing and 28 yet to start. We have made improvements to the management of validation files so that a larger number of scheduling blocks can run in parallel while we get through the backlog. These changes reduce the total number of files stored at the conclusion of a processing run, though there is still a limit to the total number of jobs that can be queued simultaneously.

We are also trialling changes to the field prioritisation system that is designed to preferentially fill EMUCAT tiles. After observing almost 200 fields, the existing system had become overwhelmed with tiles to choose from, resulting in almost uniform field priority across the survey. We now weight each field's priority by the number of observed fields in its associated tile and treat the overall score as a floating-point number rather than an integer. This should allow for more subtle priority variations and hopefully ensure that tile completion remains prioritised throughout the survey.

New pipeline software features

The ASKAPsoft pipeline scripts were recently updated with a suite of new features aimed at improving processing efficiency and bringing the remaining Survey Science Projects online:

Release highlights

- Spectral-line joint imaging of all beams is now available, through a new scienceCalim workflow, triggered by setting DO_JOINT_IMAGING_SPECTRAL=true.
- Full-stokes imaging is now possible for the spectral-line datasets. This includes on-axis leakage calibration by adapting the coarse-resolution leakage table to full spectral resolution.
- Doppler correction can be done in mssplit (the job used to make a spectral MS to be imaged), with the option of interpolation to improve accuracy.
- The MPIWProject gridder may be used in all gridding stages that are run as parallel jobs.
- Improvements to ccontsubtract, allowing use of uvlin.
- Providing the option of copying the spectral-line MSs (pre- or post-contsub) to a defined place on disk.
- Ensuring the tarred-up extracted spectra created by selavy are deleted once the tarring has completed.
- Archiving the diagnostics directory (tarred up) as an evaluation file in CASDA, alongside the usual calibration-metadata-processing-logs file.
- Use of check parameters with validation scripts to prevent unnecessary re-runs.

With these updates, there should be no remaining technical barriers for GASKAP-OH, GASKAP-HI or DINGO. We are now conducting the first survey observations in these modes. If the results meet quality requirements, we should have all Survey Science Projects in the observing pool next year.

Astrometry and phase calibration

The growing history of ASKAP observations is providing a detailed picture of the telescope's astrometry scale. It has long been known that individual observations can exhibit larger than usual astrometry errors of up 6" in extreme cases, but usually better than 2". ASKAP is susceptible to astrometry offsets because we do not conduct any phase referencing during an observation due to the large field of view. We had initially planned to conduct phase referencing against a global sky model, but no suitable model exists. We therefore need an intermediate phase referencing scheme that can be used as a stepping stone to create a global sky model.

Extensive internal discussion has converged on a theory that the dominant cause of astrometry offsets in ASKAP is the fact that our bandpass calibration observations (which provide the fundamental phase reference) are spread out sequentially for each beam over a time span of more than 2 hours. The ionosphere and other environmental factors do not remain fixed during this time, so the astrometry of each beam can be inconsistent. When combined into a linear mosaic, this can have a complicated effect that is difficult to correct without the per-beam images.

Our plan is to test this theory using a local sky model of a specifically chosen field to phase calibrate all beams simultaneously. This would use much less observing time than bandpass calibration and could therefore be done more often (though still without interrupting long science observations). Extracting the phase adjustments from these additional calibration observations should be possible with the existing ASKAPsoft tools, though some changes to the calibration workflow will be needed to incorporate the corrections.

Our first task is to select a suitable standard field using a combination of RACS and other surveys, then construct a model of it in a format compatible with ASKAPsoft. We will then observe this field along with a typical bandpass and science test field, then image the science test field with and without updated phase solutions derived from the standard field. If our understanding of the issue is correct, this should improve the astrometry of the science field, or at least make it self-consistent.

If the new step has the desired effect, we can incorporate it into the standard survey workflow and use it for all science observations and future passes of RACS, which should assist in the formation of a global sky model with good astrometry.

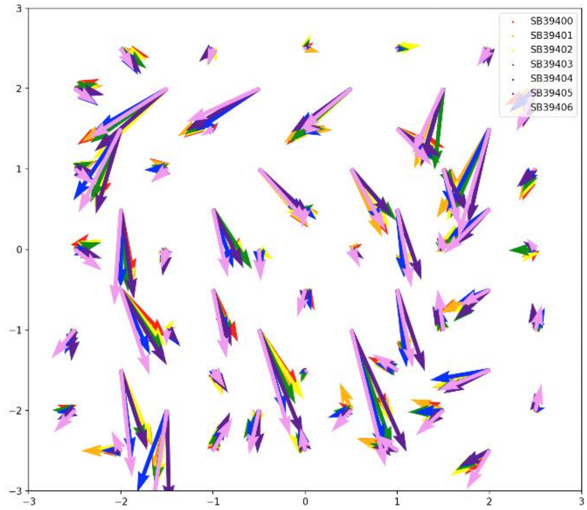

Figure 1: Astrometry offsets measured in RACS-low2 fields by comparing the positions of sources visible in two beams simultaneously where they overlap. Different colours represent different survey fields, and the vector origins are placed between the beams from which they were derived, on a plane representing the beam footprint. This shows that neighbouring beams can have different astrometry, and that there are trends following the sequential pattern in which the bandpass calibration is performed. The fact that the pattern is similar for different fields suggests that the initial phase calibration derived from the bandpass observation is more significant than the contents of the science field itself. Plot made by Emil Lenc.

RACS-low version 3 planning

The RACS team is developing plans for another RACS epoch in the low frequency band, this time using a beam footprint matched to the one used in the mid- and high-frequency bands. This should make it easier to construct a global sky model across all frequencies accessible to ASKAP.

Guest science project preparation

Successful guest science PIs from the current semester should have received an email describing the next steps. Please reach out to the operations team to discuss the details of your observing and processing parameters so we can activate these projects as soon as possible.

For further information

CSIRO Space & Astronomy
Aidan Hotan
+61 8 6436 8543
aidan.hotan@csiro.au
csiro.au/astronomy