ASKAP update for August 2023

This month we report on maintenance activities and some of the interesting features found during data validation efforts.

Interesting features in ASKAP data

Survey operations continued for 6 of the 9 active Survey Science Teams this month. We also finalised plans to begin observations for GASKAP-HI, initially with a single field selected to assess data quality.

With the observatory now delivering a steady flow of data into the online archive CASDA, SST validation efforts are ramping up and several teams have held training sessions for new validators. The validation process has been revealing many interesting features in full survey data products, ranging from new perspectives on known sources to unexplained instrumental effects.

A recent EMU/POSSUM field contained one source with more pronounced imaging artefacts than any other. This turned out to be the bright millisecond pulsar J0437-4715, which scintillates on time and frequency scales sampled by ASKAP and therefore appears as a strongly variable source with associated calibration artefacts.

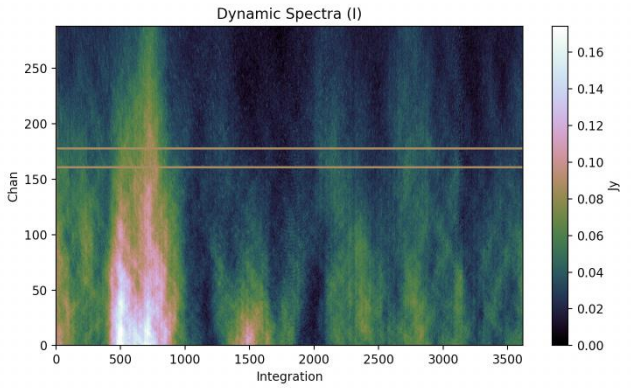

Figure 1: Dynamic spectrum of PSR J0437-4715 as observed in a recent 10-hr EMU observation spanning 800 to 1087 MHz, showing structure in both time and frequency. Image made by Emil Lenc.

We've also been searching for the cause of low-level calibration artefacts around ordinary sources. These include smoothly time-varying complex gain solutions, possibly due to temperature variations inside the Phased Array Feeds. The phase component of these gain variations should be removed during self-calibration, but the amplitude component is not (with the current pipeline calibration strategy).

In one unusual case we also observed degraded phase stability during the later part of an observation. The exact cause is not known, but the effect was strongest on the longer baselines and may have been related to weather conditions.

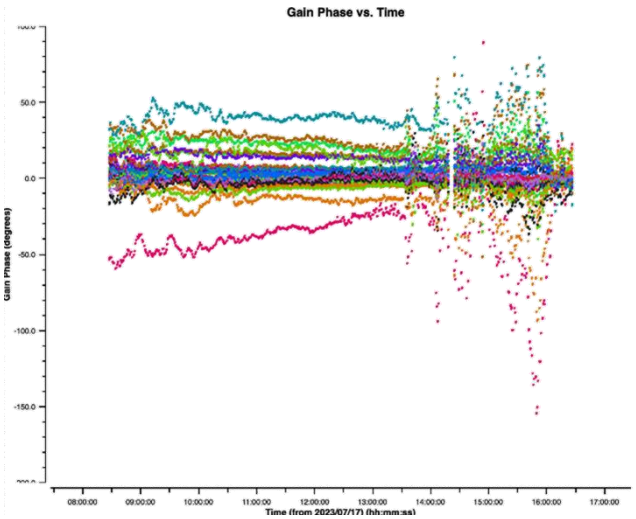

Figure 2: Phase of the complex gain derived from self-calibration as a function of time during a survey observation, showing degraded phase stability. Image made by Emil Lenc.

Some observations show evidence of small, position-dependent calibration errors that may result from pointing offsets. These could possibly be introduced during beam formation or arise from inaccuracies in the mechanical pointing model.

We continue to see a spread of astrometry errors arising from ASKAP's lack of phase referencing, but these are typically well within the image resolution element. Validation procedures catch the occasional field with astrometry errors above 2", which are usually rejected and re-observed.

While continuum image quality generally meets the required standard, spectral line data products are more sensitive to the kinds of issues described above, leading to significant rejection rates.

As we build up our knowledge of these issues, we can search for patterns and learn more about their cause. This in turn helps prioritise mitigation efforts. Aside from solar interference that generates relatively long-period but unpredictable ripples in time and frequency, there does not appear to be a single dominant issue. Instead, we have a variety of effects that can appear in any observation to a greater or lesser extent.

Improving image quality

Although many of the issues described above will take time to investigate and address, we know of a few systematic issues that can be solved by modifying ASKAP's processing pipeline. The highest priority item is peeling bright sources from outside of a beam, so they do not introduce artefacts within the beam being imaged due to lack of deconvolution.

We are also investigating reports of excessive polarisation leakage in the polar cap survey region, which may be related to tracking a wider range of position angles than we have used closer to the equator. We plan to conduct dedicated observations that may help find the cause.

Improving pipeline performance

Another high priority is ensuring that ASKAP's processing pipeline can keep up with incoming survey data. The next software release will include support for parallel measurement set access, which should speed up several components of the workflow. We are also reducing the number of jobs required by grouping tasks together. This should improve the reliability of spectral line processing and reduce the chance of overloading the queuing system on the supercomputer.

Solar interference

Investigation continues into imaging artefacts introduced by the Sun, being a powerful radio source far from the field centre. We have been experimenting with various mitigation methods including flagging and subtraction of visibilities dominated by solar emission, but these methods have so far all had some impact on the underlying science data.

As solar activity increases, we are also noticing time-dependent emission from hot spots within the solar disk, offset from its centre. These bright outbursts are much stronger than the Sun's quiescent emission and are difficult to characterise for mitigation purposes due to their variable nature. They are also more compact and spread the Sun's influence over a wider range of spatial scales.

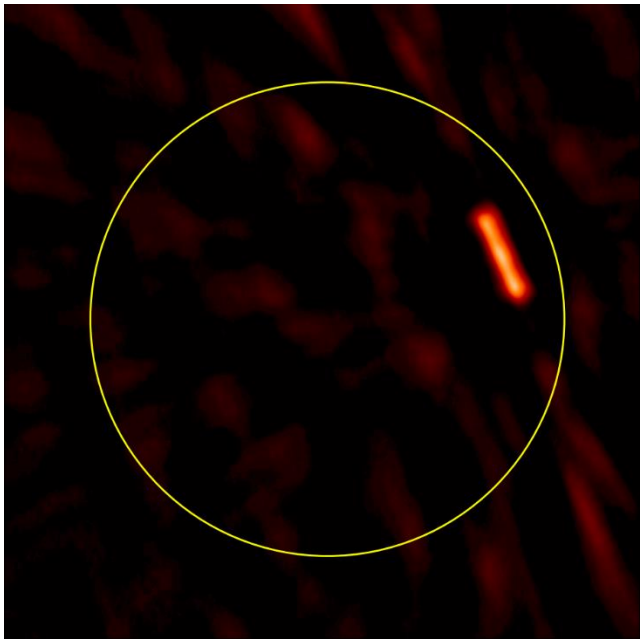

Figure 3: Data from a recent science observation re-phased in the direction of the Sun showing a bright hot spot with significant bandwidth smearing due to its distance from the phase tracking centre. The solar disk is outlined in yellow. Image made by Emil Lenc.

Maintenance activities

The Pawsey Supercomputing Research Centre is conducting a major upgrade of its new Setonix platform this month. The supercomputer will be unavailable from August 9th through to an estimated completion date of August 21st. The ASKAP intermediate data storage disks and ingest cluster are expected to remain online, but without Setonix to process data we will be unable to observe in disk-intensive modes and will have reduced capacity to promptly assess data quality. CASDA should remain accessible for download of previously archived data, but new deposits, data validation and release tasks will be unavailable.

During the Setonix upgrade we will be conducting mechanical maintenance on several of the inner and outer antennas in the array, which should maximise the availability of key baselines during future science observations.

For further information

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