

## ASKAP Commissioning Update #3 July 2013

Welcome to the third ASKAP Commissioning Update. This is a regular informal e-mail report on the progress of ASKAP commissioning including new results and challenges, bugs, releases of new software and availability of test data files.

If this edition has been forwarded to you, please sign up to the exploder by sending an e-mail to '[askap-commissioning-request@atnf.csiro.au](mailto:askap-commissioning-request@atnf.csiro.au)' with the message text: 'subscribe'. We hope you enjoy receiving this regular update on the progress of ASKAP commissioning. Do not hesitate to contact us if you have any questions about the project.

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ASKAP Project Director

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### **A survey of the Galactic Centre using an ASKAP phased array feed**

The ASKAP commissioning and early science team and University of Queensland student Sarah Hegarty have been working on code to calibrate and image multibeam data taken with a single PAF-equipped antenna.

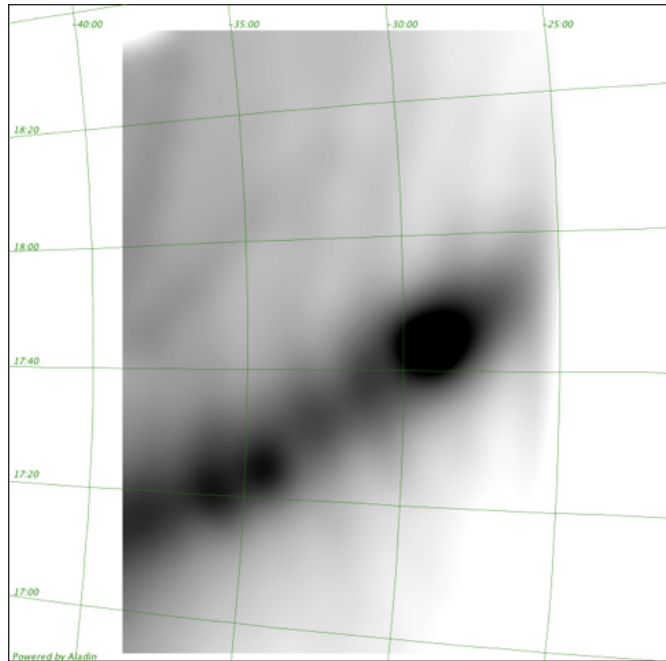
Since January, the team led by Aidan Hotan has been observing and analysing test data sets with the Parkes Testbed Facility – a PAF-equipped 12 m antenna about 400 m away from the 64 m Parkes dish. The close proximity allows the 64 m antenna to be used as a reference source to improve the quality of beam weights formed using the maximum signal-to-noise ratio beamforming method.

After constructing an arrangement of seven beams in a hexagonal pattern, areas of the sky can be surveyed using tessellated observations on a regular grid. Power levels from each beam are extracted from disk, normalised, calibrated and gridded onto a map. Targets include bright point-source calibrators (to gain confidence with the system) and more extended objects such as the region around the galactic centre.

The ongoing project assists in developing understanding of multi-beam imaging with phased array feeds and once perfected, will enable studies of the optimal arrangement of beams on the sky for various imaging targets.

The preliminary image below demonstrates the progress made thus far. It was created from an (unfinished) 20x20 degree observation around the Galactic Centre.

The data were first gridded onto a regular array of points and then smoothed to match the beam pattern and resolution of the 12m antenna.



*Image of the Galactic centre made using a phased array feed on a single 12-m dish at Parkes by Sarah Hegarty & Aidan Hotan. The image is made from a single 1 MHz channel at an observing frequency of approximately 1.3 GHz. Total integration time is 1.5 hours, comprising 87 x 2 minute pointings.*

### **Phase Closure with the ASKAP Correlator**

The team has this week made a great step forward in commissioning by achieving phase closure with three ASKAP antenna systems and the hardware correlator at Marsfield.

This was quickly followed by successfully repeating the test on the hardware correlator and ASKAP Mk I PAFs at the MRO using the radio source Virgo A.

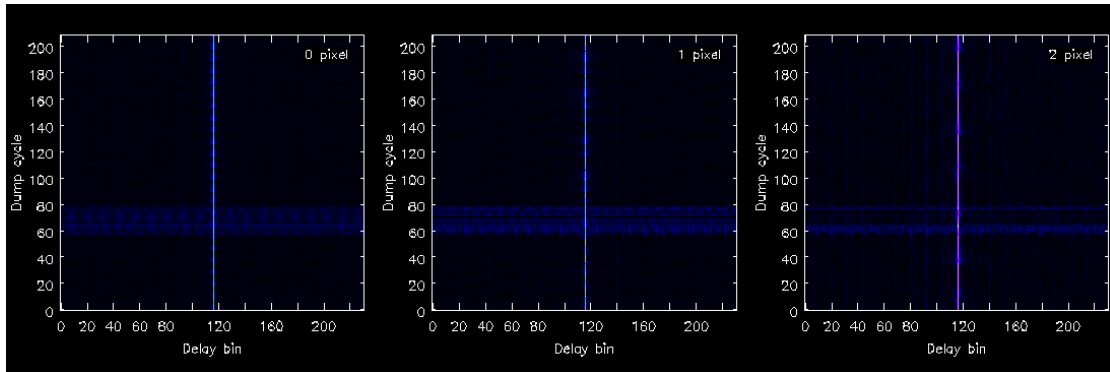
The result is an important milestone because the hardware correlator offers much higher sensitivity, bandwidth and spectral resolution than the interim data-capture and software correlator scheme used in previous commissioning tests at the MRO that produced the first multi-beam image with multiple PAF receivers.

It also means all the last of the BETA hardware and firmware is now ready to be deployed at the MRO for integration and commissioning. Most critically, this is a demonstration of the full "end to end" signal chain for BETA, validating the full system design and construction.

The team will now prepare the remaining systems for shipment to the MRO. The full six-antenna BETA array, including the MkI PAFs, beamformer and correlator, will be deployed at the MRO in August.

The commissioning team is now on site at the MRO to continue commissioning work using the correlator. This week they attempt to observe a close pair of compact sources or double source with two beams, one on boresight, the other positioned at

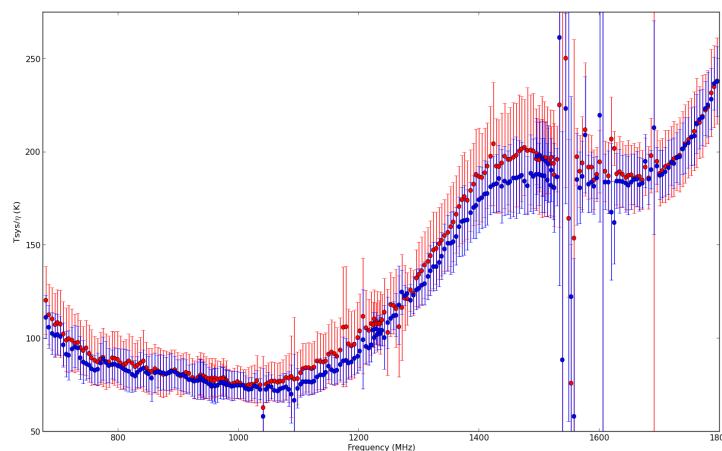
the correct angular separation. They will track the source for several hours, parallactifying all antennas at the correct position angle. Once done, they will extend this work to add further beams until they can produce the first full field-of-view mosaic.



*Correlations between three antennas at the MRO using the ASKAP hardware correlator. Each of the three panels shows a single baseline, with delay ('lag') running along the horizontal axis and time in five-second increments running upwards. Each system was fed with the signal from the PAF from each of the three antennas whilst tracking Virgo A. This is expected to produce a 'white light fringe' at a specific delay on each baseline, and this is precisely what is seen in the figure: a single bright vertical line.*

### **On-dish Tsys/efficiency measurement for Mk I Phased Array Feed**

Aidan Hotan and other members of the commissioning team have measured the Tsys/efficiency for the Mk I phased array feed mounted on antenna #6 at the MRO. The plot below is the result of 4 trials, taken over two days, using the Sun as a beamforming reference and then pointing the formed beams at either Virgo A or Taurus A. Red and blue lines denote the two polarisations. There is no correction for the finite size of the Sun or elevation effects, but these are not expected to be significant above the measurement noise. Beamforming was carried out using the single dish maximum signal/noise beamforming method.



*This figure shows a typical Tsys/efficiency of ~75 K in the good part of the band, which is precisely what we expect for Mk I PAFs. It may be possible to improve this with a better understanding of the beamforming process – this will be a topic for future research.*

## **ASKAP (Mk II) Phased Array Feeds**

There was plenty of good progress again on Mk II PAFs this month. Effort was split between system validation and pre-production of the first 8 ADE systems.

The performance of first Mk II PAF (5x4) was tested in the EMC chamber. The PAF input signal was provided by a hot load (microwave absorber) and a radiator.

Initial tests showed that the PAF signal levels were correct and there was no measurable self-generated RFI.

The team then demonstrated the full Mk II receiver chain from the PAF to the digital receiver system and the beamformer system. This high level test shows that the whole system works.

Finally, testing of the Mk II PAF ground-plane was completed. The final test demonstrated thermal performance that closely matches previous simulated results and meets our overall specifications.

This great progress sees:

- The few outstanding technical risks further mitigated.
- ADE Integration activities stay on track for completion late this year.
- Production readiness of components and subsystems being demonstrated

The next steps are to repeat these tests with a full-sized Mk II PAF in the EMC chamber and then to carry out characterization testing of the full-sized Mk II systems at the MRO.

## **Science Meetings**

Last month, CASS (Marsfield) hosted a workshop on 'RFI and its impact on the new generation of HI spectral-line surveys'.

Around 60 international scientists and engineers attended the meeting. Participants discussed a diverse range of topics from spectrum management, EMC/RFI monitoring methods, flagging algorithms to active mitigation using PAFs.

The participants were treated to a tour of some of the engineering laboratories on site, as well as a bushwalk in the local Lane Cove National Park.

Recommendations from the workshop included:

- An international data challenge for RFI flagging software
- Systematic monitoring programs should be standard at all observatories
- User documentation is a priority – existing knowledge must get to the user!

- SKA Pathfinders will deal with RFI in front-end, software and active techniques.
- During design phase we (SKA representatives) must keep watching brief on pathfinder techniques and their effectiveness.
- Keep RFI on the agenda through presentations at international conferences, SKA engineering meeting, representation in work packages etc.
- Hold regular international workshops alongside targeted science meetings



*SKA Pathfinders HI Survey Coordination Committee (PHISCC)*

A number of ASKAP scientists took part in the 2013 PHISCC meeting, hosted by CAASTRO at the University of Sydney. PHISCC holds regular international conferences to discuss scientific issues relevant to future large HI surveys and technical and other issues where collaboration between the SKA pathfinder teams can be mutually beneficial. As well as providing a general update on progress and plans for upcoming HI surveys on the various SKA Pathfinder and Precursor telescopes, the 2013 PHISCC workshop focused on techniques, tools and plans for studies of galaxy velocity fields with large optical and radio surveys.