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Early science with ASKAP

Background

In May 2013, CASS announced its intention to develop an early science program for ASKAP (Appendix 1).

This document lays out a framework for an early science program for ASKAP and requests input from members of the astronomical community. It should be read in conjunction with Appendix 1.

What is ASKAP early science?

ASKAP early science is a program of observations designed to explore new scientific parameter-space with ASKAP before the construction of the array is complete. The early science program will consist of a series of science-focused observations, carried out by the ASKAP commissioning and early science team.

Early science will run side-by-side with ongoing commissioning, integration and verification. Completion of the ASKAP array will have the highest priority during the early science period.

How will it work?

The ASKAP Project Scientist, in consultation with the ASKAP science community, is developing a list of the scope and likely scientific utility of potential early science projects, ranging from short-duration observations in basic continuum and spectral line imaging modes, to more advanced projects such as wide-area surveys.

Community consultation on the scope of ASKAP early science will take place from May-August 2013.

An ASKAP early science workshop will take place on August 5th providing a key opportunity to discuss the goals and scope of ASKAP early science, and for community input to help design the early science program.

Following the early science workshop the ASKAP Project Scientist, with help from the ASKAP commissioning and system integration teams, will prepare a plan for early science observations including their broad scope, impact and comments on technical challenges. Options for commensal observing will be explored where possible. This list of project scope descriptions will be circulated to the ATNF Time Assignment Committee in September 2013. The TAC will review these descriptions and the associated technical comments and provide expert advice to the CASS Chief on the scientific impact. In all cases, observations are contingent on performance and resources. Priority will be given to completion of ASKAP.

The detailed design (bandwidth, observational frequency, integration time, etc.) of the first ASKAP early science programs will be carried out by the ASKAP commissioning and early science team following the completion of ASKAP Mk II PAF system performance verification. The community input, expert advice from ATUC and other advisory bodies such as the ATNF Steering Committee, resourcing and technical considerations will all play a role in the final program.

Likely constraints

Because ASKAP data processing, imaging and calibration techniques are all topics of ongoing research and development, we cannot yet predict which observing modes or sub-set of data products will demonstrate reliable performance when early science begins. Once an observing mode and the associated data products are demonstrably of an acceptable quality to carry out novel scientific research, the ASKAP commissioning and early science team will consider early science observations that utilise that observing mode.

Furthermore, the exact design of early science observations will depend ultimately on the performance of Mk II phased array feeds, the quality of the calibration that can be achieved and on the availability of suitable time to carry out observations.

Skilled operators will be required to set up the observations, which potentially involves manual setup, beamforming and calibration. Initially we expect a high[1] setup overhead on the observations.

ASKAP Science Workshop

We invite input from the scientific community on an early science program with ASKAP.

The ASKAP early science workshop on August 5th will provide a forum for community input into the ASKAP early science program.

We invite short (15 min) talks that address the following questions:

- What unique discovery space can be explored with ASKAP-12?
- What are the minimum requirements in your area of interest?
- What science topics could be tackled with a short amount of observing time (1 hour- 1 week)?
- Are there short observations that can tackle a number of different topics simultaneously?
- What could be achieved with a longer survey?

Speakers are encouraged to address the following questions:

- What is the potential for commensal science?
- How does ASKAP-12 compare with other existing telescopes?
- What is the likely scientific impact of the observations?
- Are observations 'high-risk' or 'low-risk' in terms of implementation?
- What are the likely minimum requirements with respect to observing time?
- Do the observations have advanced data processing, imaging or calibration requirements?
- Are there any requirements that are different from those of the ASKAP SSPs or the intended specifications or deliverables?

Abstract submissions are welcome from any interested astronomer. For reasons of time, existing ASKAP survey teams are encouraged to discuss and consolidate their ideas before the workshop, if possible.

Lisa Harvey-Smith
ASKAP Project Scientist
3 July 2013

[1] Using the current single-dish beamforming method for 36 beams, it would take several days to make all the beam weights. The current failure rate is approximately 20% of the total number of beams (one for each 1 MHz channel). With a single-pixel feed interferometer the reliability should improve, but significant R&D is required in this area.

Frequently Asked Questions

Q - Why not just have community-led projects?

A- The early science program sits broadly under the period of 'commissioning and early science', during which a number of verification and construction activities will continue in parallel. During this time new observing modes will become available on a dynamic schedule. As such, it is not practical for CSIRO to advertise the emergence of a capability and then hold a formal time assignment process each time a new capability comes online. Early science observations will be designed in detail and executed when they are compatible with the progress of commissioning and other scheduling constraints.

Q- Why not allocate X hours (say) to each science team to use as they wish?

A – This method of time allocation has no scientific basis, as some experiments will take longer than others to break into new parameter space. Such an approach would also generate inflexibility in scheduling. For operational reasons, it is better to agree on an approach to early science, then to allow the expert ASKAP commissioning and early science team to design and schedule specific target fields in a flexible manner.

Q- Who will make the final decision on what is observed?

A- The CASS Chief has the ultimate responsibility for ASKAP early science. Scheduling of early science observations will be the carried out by the ASKAP commissioning and early science team. The actual early science program will take account of both the expert advice from the TAC and other sources, and practical constraints (e.g. readiness of observing modes, LST range, hardware/software performance) in scheduling observations.

Q- Why would SSTs help to design early science if they are not going to 'own' the data?

All ASKAP data taken for the purposes of conducting scientific research will be released publicly. There is no implied ownership of any ASKAP data.

Q- Will BETA antennas be incorporated into ASKAP-12?

The current plan is for ASKAP-12 to comprise only 'non-BETA' antennas. Subsequently, the Mk I PAFs on some or all BETA antennas may be retired and replaced with Mk II PAFs if this makes scientific sense, and if CSIRO has the resources to do this.

Appendix 1

CASS Statement on Early Science with ASKAP (May 2013)

CASS has stated its commitment to delivering ASKAP as fully scoped and is currently seeking additional funding to realise this goal. However, CASS also recognises the benefits of facilitating world-class early science while the construction, integration and testing of additional ASKAP Mk II receiver systems continues in parallel. This approach will not only provide early science data and training for future ASKAP users, but also enable a robust test of the science capabilities of the facility.

CASS therefore intends to support an early science program with an ASKAP platform, comprising at least 12 antennas with ADE systems and a hardware correlator with up to 300 MHz instantaneous bandwidth and 16,000 spectral channels.

Below we outline a proposed way forward. We invite feedback from the ASKAP survey teams and other members of the astronomy community.

Program development

CASS strongly supports a unified approach to the ASKAP early science program, resulting in data of broad scientific value. Given the limited observing time available on this facility, CASS suggests that a program of commensal continuum and spectral line observing is carried out. Rather than soliciting new proposals, CASS plans to develop a science program through a consultative process with SSTs. In specifying the evolving antenna configuration, frequency range and survey strategy, strongest consideration will be given to the science goals of the 'A' ranked science survey programs, EMU and WALLABY. However, input from the other SSTs will also be considered.

During May 2013, CASS will begin to develop a unified early scientific program in consultation with EMU, WALLABY and other survey science teams. In parallel, CASS will use the input it has received from the SSTs to formulate a proposed build order (configuration) of the antennas for the early science platform, taking into account relevant technical considerations and other project constraints, such as requirements relating to construction and commissioning activities.

This timing is determined by the fit-out schedule for the ASKAP antennas, which takes approximately one month per antenna. Since the antennas are already in place, and the first of the Mark-II PAFs are expected to be ready for deployment by the end of 2013, the fit-out sequence of early science antennas will need to be determined by mid-2013.

Timing and constraints

ASKAP early science will play an important role in the verification of the facility. However, the main priority during the construction and commissioning phase will remain completion of ASKAP construction and the delivery of the full ASKAP capability. Where the early science program is in direct conflict with the completion of ASKAP it should be assumed that the latter will take precedence.

The ASKAP early science platform will be validated through a program of commissioning tests and will operate on a shared risk/best efforts basis. It is expected that continued construction of ASKAP (i.e. installation and integration of further ADE systems) will continue during this period, meaning that science observing will most likely occur during the night. It is intended that the early science survey will undergo progressive sensitivity enhancement as additional Mk II receivers are taken into operation.

The total array time available for early science will be limited by other project priorities, the most pressing of these being commissioning. Under the current project plan, observations are expected to begin in early 2015 following the completion of approximately 6 months of basic commissioning on the 12-ADE array. From early 2015 onwards, the likely time available for scientific observations is two-thirds of the ~12 hour nights, including calibration and other observing overheads. Data from the program will be progressively released to the entire astronomy community once suitably verified. The early science program will continue until the complete ASKAP array is deemed ready to begin normal operations.

CASS will seek advice on the proposed ASKAP early science program from its advisory committees. This will include the ATNF Steering Committee (ATSC), the Australia Telescope User Committee (ATUC) and the ATNF Time Assignment Committee (TAC - augmented by experts on ASKAP science). CASS will consider the advice of the ATSC, ATUC and TAC and will aim to finalise the plans for the early science program by August 2013.

Lewis Ball
CASS Chief
3 May 2013

Updated consultation Schedule for ASKAP early science (all dates 2013)

May 6th	A configuration for ASKAP-6, ASKAP-12, ASKAP-18 is proposed by CASS.
May 7th	The early science plan, consultation schedule and proposed configuration sent to SST PIs.
May 9th (ASKAP SST C&M Meeting)	CSIRO and SSTs discuss the early science plan and configuration. Fix a date for early science workshop.
May 15th	ASKAP early science plan, configuration and consultation schedule sent to AAL, ANZSCC, ATSC, ATUC. Invite comments.
End May	Positions of the first six ADE antennas finalised and communicated to SEIC and ASKAP team. Work begins on antenna pedestals. ASKAP-12 and ASKAP-18 configurations remain as 'draft' until early science program is decided.
May 31st	CAASTRO strategy meeting
May-July	Advertise and discuss early science plan with Australian astronomy community via visits to universities and institutes.
5th August	One-day workshop at CASS to develop a unified early scientific program in consultation with EMU, WALLABY and other survey science teams. Considerable leadership input by EMU and WALLABY PIs in this process will be encouraged. Follow-up meetings also encouraged as required.
August	Workshop report produced by ASKAP Project Scientist and EMU/WALLABY PIs, suggesting a unified early science plan.
August	Workshop report presented to Astronomy community and to AAL, ANZSCC, ATSC, ATUC. Feedback requested. Amendments as required.
August - September	ASKAP early science plan finalised. Signed off by CASS Chief

Appendix 2

Configuration of ASKAP for Early Science

Following a broad community consultation, the identification of antenna locations for ASKAP's first twelve Mk II phased array feeds has been planned as follows.

Geometry

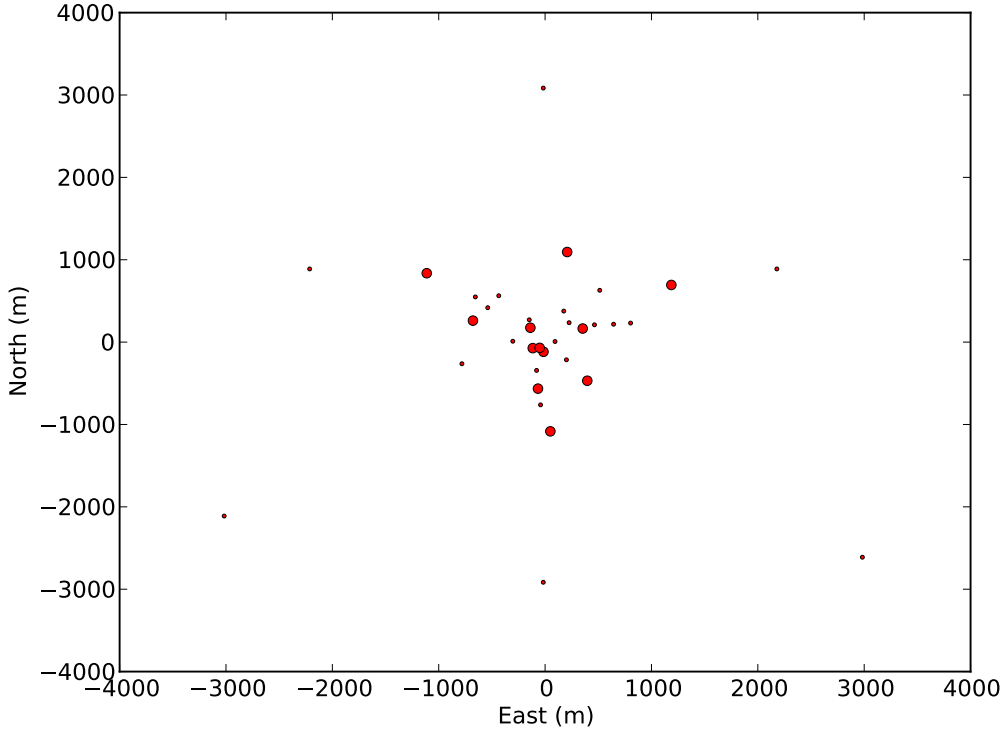
The first twelve antennas to host Mk II phased array feeds and the approximate geographical position of each is listed in Table 1.

Antenna Pad Number	Estimated Latitude	Estimated Longitude	Antenna Name
2	-26.6971188993	116.6316950935	Birliya
4	-26.6966844076	116.6313350455	Bimba
5	-26.6967143551	116.6306814286	Gagurla
10	-26.6944746931	116.6304642494	Bardi
12	-26.6945779527	116.6354119050	Yalibirri
13	-26.7002986290	116.6358238913	Jabi
14	-26.7011533985	116.6311610162	Gagu
16	-26.6936844977	116.6250408025	Jindi-Jindi
24	-26.7058376461	116.6321847199	Janimaarnu
27	-26.6884765151	116.6206916288	Yamaljingga
28	-26.6861860961	116.6339695192	Ngurlubarndi
30	-26.6898230389	116.6438012947	Nyarluwarri

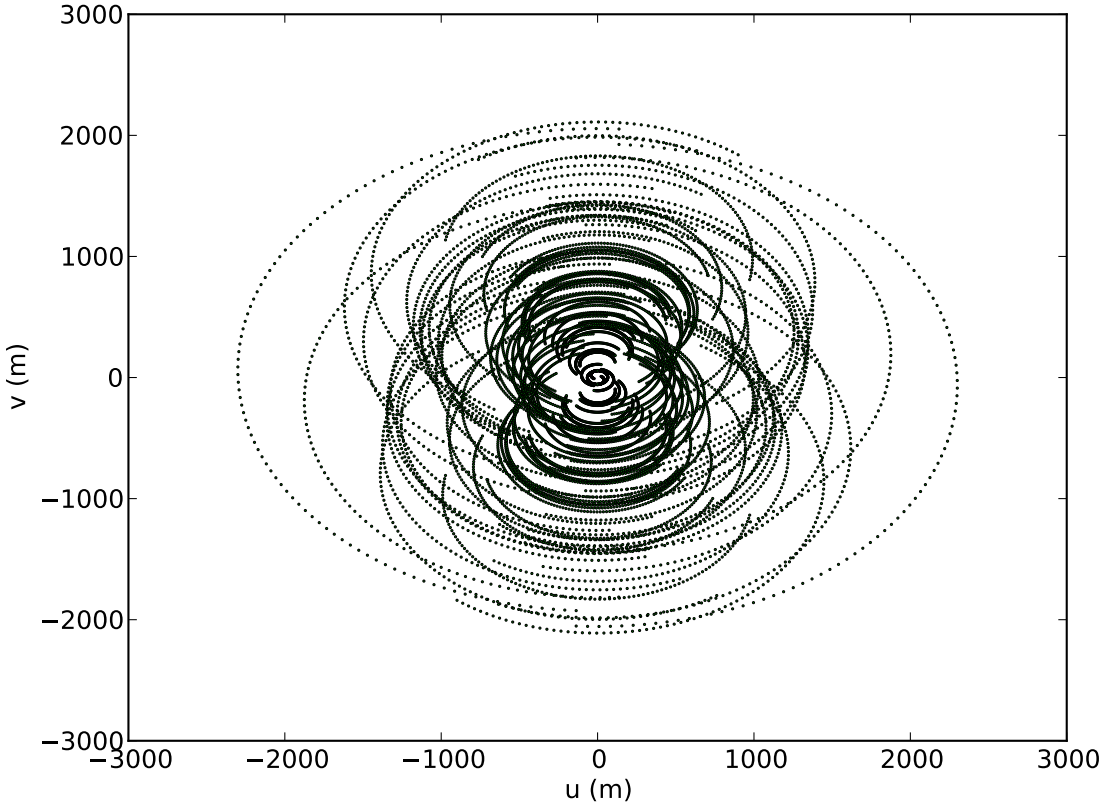
Table 1: Antenna positions and names for the planned ASKAP Early Science platform.

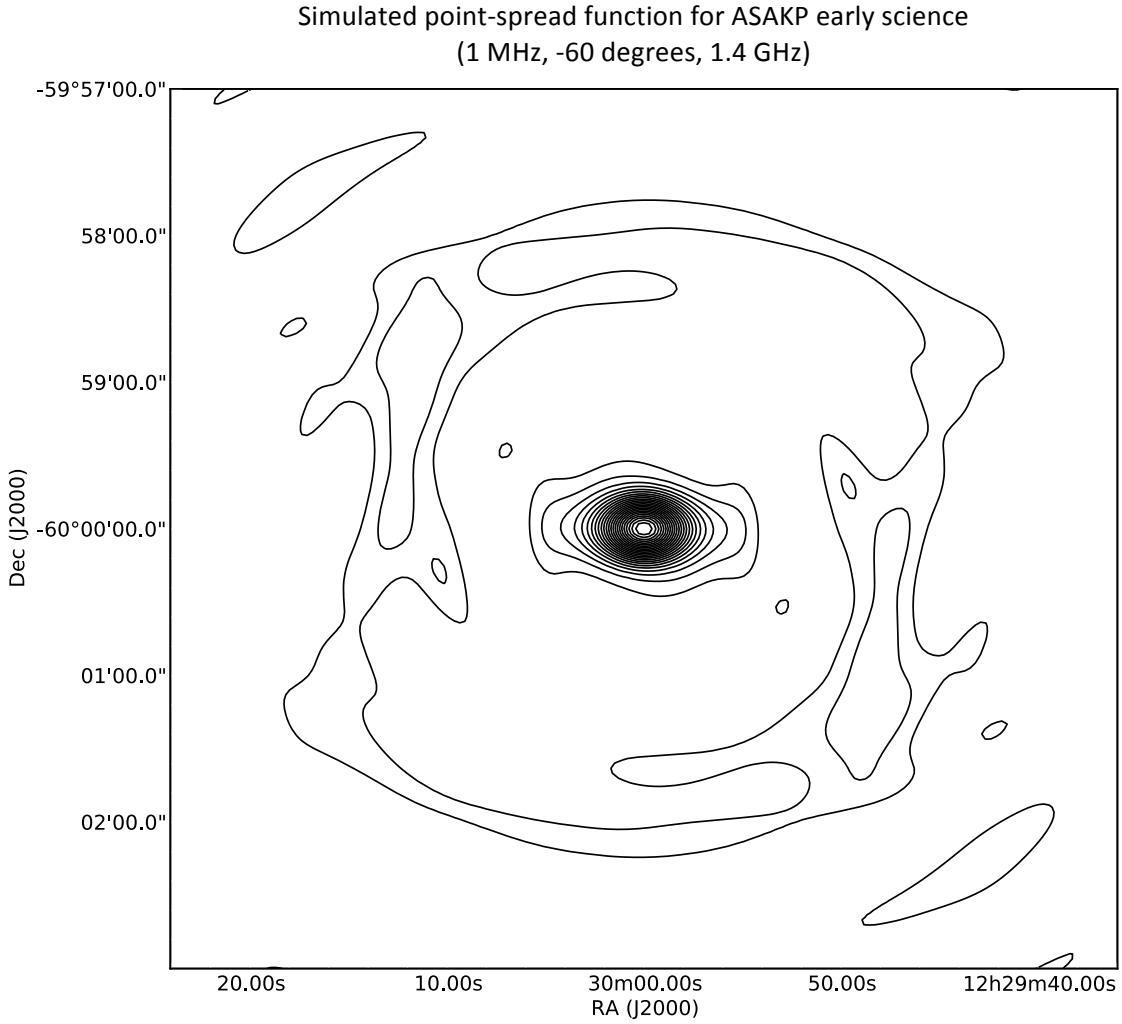
The resulting configuration and an indicative simulated u-v coverage and point-spread function are illustrated below. Simulations were generated by Tim Shimwell.

Planned antenna positions for ASKAP early science
(large filled circles)



Simulated u-v coverage for ASAKP early science
(1 MHz, -60 degrees, 12 hrs)




Simulated point-spread function for ASAKP early science
(1 MHz, -60 degrees, 1.4 GHz)
-59°57'00.0"
58'00.0"
59'00.0"
-60°00'00.0"
01'00.0"
02'00.0"
Dec (J2000)
20.00s
10.00s
30m00.00s
50.00s
12h29m40.00s
RA (J2000)