ASKAP Early Science Program

Dr. Lewis Ball, CASS Chief
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Prepared by: Dr. Lisa Harvey-Smith
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Document History
This document version 1.0 is the first public release of the ASKAP early science program outline.
This is a living document, which will be updated and/or amended as technical assessments are made and ASKAP commissioning process continues.
Comments are welcome and should be addressed to the ASKAP Project Scientist (lisa.harvey-smith@csiro.au).

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1 Introduction

ASKAP Early Science is an observing program aimed at producing scientifically useful data. It will commence when an array of twelve ASKAP antennas fitted with CSIRO's Mk II phased array feeds (the instrument known as ASKAP-12) has been commissioned and scientifically verified. Early science observations will be carried out in parallel with the deployment of the Mk II phased array feeds on further ASKAP antennas.

The priorities for ASKAP early science are:

1. Demonstrating the unique capabilities of ASKAP
2. Providing data sets to the astronomy community to facilitate the development of analysis and interpretation techniques
3. Providing a mechanism for feedback to CASS on the performance and characteristics of the system and opportunities for improvement
4. Achieving high scientific impact

Early science observations should address at least one, but preferably all of these aims.

Although early science is a high priority for CASS, the installation of the remaining phased array feeds and commissioning of ASKAP to full specification will remain the overarching goal.

CASS staff will design and implement the ASKAP early science observing program, taking account of input from ASKAP users and from its science advisory committees. CASS staff and the ASKAP user community will develop and optimise calibration, imaging and processing techniques for ASKAP-12 on a shared-risk collaborative basis. In all matters relating to ASKAP early science, the responsibility for arbitration will lie with the CASS Chief.

This document is related to the Announcement of ASKAP Early Science (issued May 2013) and the ASKAP Early Science Workshop announcement, which includes detailed information on the configuration of ASKAP's early science array.

The latest versions of these ASKAP project documents are available here: http://www.atnf.csiro.au/projects/mira/science.html.

This set of documents supersedes the BETA Science and User Commissioning Plan by Feain (2011).
During commissioning, the ASKAP system commissioning team will carry out a series of functionality tests of ASKAP hardware, firmware and science processing software that will seek to ensure that the data quality is appropriate for the early science program.

CASS staff will conduct the commissioning program, but contributions from ASKAP science teams are welcome.
3 Science demonstration data from BETA, ASKAP-6 and ASKAP-12

Prior to and during the ASKAP Early Science program, CASS will carry out science demonstrations with BETA, ASKAP-6 and ASKAP-12 in order to demonstrate capabilities and inform users.

Demonstration data may fulfill a number of purposes. They may be used for scientific or technical research, to demonstrate ASKAP’s capabilities or to test algorithms or pipelines. Demonstration data will be publicly released when they are deemed to be of appropriate quality by the ASKAP Project Scientist. The order of release will necessarily reflect the somewhat unpredictable nature of the commissioning process.

CASS intends to pursue the following demonstrations with BETA:

1. 1 MHz and 18.5 kHz observations of one or both of the ‘BETA Test Fields’, centred around Fornax and Circinus and other test fields at a range of frequencies between 700-1800 MHz. Data from the ATCA are in hand and have been analysed by members of the BETA test field science team. BETA data of these 30 square degree fields will provide a preliminary test of many facets of system performance.

2. Targeted observations of bright radio continuum sources for HI absorption in the redshift range $0.5 < z < 1.0$. These observations will demonstrate the unique capabilities of BETA in the 700-1000 MHz frequency range.

CASS is also developing plans for demonstration data from ASKAP-6 and ASKAP-12, which will use Mk II phased array feeds. These observations are likely to include a repeat of the BETA demonstration observations.

Suggestions for other demonstration observations should be addressed to the ASKAP project scientist.
4 Development of the ASKAP Early Science Program

4.1 Baseline design

As input to the development of the early science program, CASS invited presentations from the ASKAP user community at an open community workshop held on August 5th 2013.

It is clear that a coordinated observing program with two major streams has the potential to satisfy the four principle aims of ASKAP early science. These programs are:

1. A 1 MHz and 18.5 kHz survey in full Stokes, from 700-1800 MHz over a wide area of sky with 6-12 hours integration time per field and

2. An 18.5 kHz spectral line survey, over 1150-1450 MHz and targeted toward a small number of fields, with 50-60 hours integration time per field.

The first would provide a unique broadband data set, doubling the number of radio sources known and constraining the evolution of radio-loud active galactic nuclei. It would also allow us to study magnetic fields, density and turbulence at a range of redshifts. The high spectral resolution component could be used to probe the environments of HI absorbing systems at a range of intermediate redshifts that has never yet been studied.

The second data set would enable the study of galaxy evolution as a function of environment as well as the morphology of (and interactions between) HI clouds and filaments between nearby galaxies. It could potentially incorporate a search for variable or transient sources.

CASS is now assessing these two surveys, based on simulations of the expected imaging performance and dynamic range of ASKAP-12. This will enable an informed assessment of the likely success of these two proposed surveys.

Three additional observations are also under consideration.

The first is a deep observation of a small region of the sky to investigate the possibility of a galaxy evolution study using HI stacking. This would require approximately 50 hours integration each on 2-4 fields, recorded in 18.5 kHz mode between 1000-1300 MHz. CASS will investigate the viability of such a survey using simulated data and possibly (if early indications are positive and the observing time is available), a pilot observation of a single ASKAP field of view.

The second is a search for variables and slow transient radio sources. This could potentially probe unexplored parameter space, although the international capability in this field of research is developing rapidly. This aim may be achievable through repeated observations a single ASKAP field of view which could possibly be accommodated by piggybacking on either regular calibration source observations and/or a multi-field spectral line survey. The observing strategies for the primary surveys will be designed with searches for variable and transient sources in mind.

Thirdly, a strong science case has been made for ASKAP Early Science observations in a fast transient mode. The current ASKAP project plan does not include a fast transient mode implemented at the time of ASKAP Early Science observations. However, given the potential for very significant scientific impact, CASS is now investigating the additional resources in terms of firmware and other effort that would be required to facilitate such a program. If this can be accommodated during the Early Science program, CASS will prioritise the development of this capability above the implementation of zoom and tied array modes.
ASKAP early science data are non-proprietary and will be publicly released when they are deemed to be of appropriate quality by the ASKAP Project Scientist.

4.2 Pilot observations

Following the results of the assessments outlined above, the appropriate observational programs will be carried forward to the ‘pilot’ stage. Pilot observations will be short (a few hours) proof-of-concept observations using ASKAP-12 to establish whether gathering larger amounts of data in that mode is warranted. CASS will work with science teams over the coming months to design short pilot observations that will demonstrate the quality of data products that are required for the proposed early science goals to be achieved.

Data from the pilot observations will be publicly released. Science teams will have the opportunity to study the data and present results at a second ASKAP Early Science community workshop. Following this workshop and taking account of scientific advice, CASS will decide which of the pilot observations warrant the initiation of a full early science survey with ASKAP-12.

4.3 Accommodating new ideas

CASS will welcome new ideas for early science observations throughout the period of ASKAP Early Science. Suggestions should be addressed to the ASKAP Project Scientist.

4.4 The intended sequence

CASS will complete a technical assessment of the feasibility of the early science observations described in this document and communicate the results of this assessment by the end of 2013.

CASS will continue to review the early science program as information on the performance of Mk II phased array feeds and data quality is gathered during ASKAP commissioning. Once the science verification results from ASKAP-12 are in hand, CASS will decide the early science observations that will be supported to the pilot stage. CASS will then work with ASKAP science teams to plan and carry out these pilot observations.

Results from the pilot observations will be presented at a community workshop, following which CASS will (based on the scientific advice received) decide which early science observations warrant further time. CASS will then work with the relevant ASKAP science survey teams to design and carry out the approved early science observations as soon as practicable. We currently anticipate Early Science observing starting around early to mid-2015.

4.5 Data processing and communication

Early science observations and demonstration observations will not be processed automatically through the ASKAP data processing pipeline. These early observations will likely require extensive interaction, from setting up the observations to manually reducing the data into useable data products.

While the ASKAP Early Science program is being carried out, the ASKAP commissioning and early science team in Marsfield will develop expertise to process ASKAP-12 data in the supercomputing environment. Data, once verified, will be publicly released. Busy weeks, aimed at bringing together the CASS team and members of the relevant science survey teams and facilitating the rapid processing of data and sharing of results will be organised when the need arises.
In addition to training a group of expert users, CASS will interact regularly with ASKAP science teams via written updates and videoconference meetings, as required. The first point of contact for science teams on all ASKAP commissioning and early science matters is the ASKAP Project Scientist.
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FOR FURTHER INFORMATION
CSIRO Astronomy and Space Science
Lisa Harvey-Smith
t +61 2 9372 4653
e lisa.harvey-smith@csiro.au
w www.csiro.au/cass
w http://www.atnf.csiro.au/projects/askap/