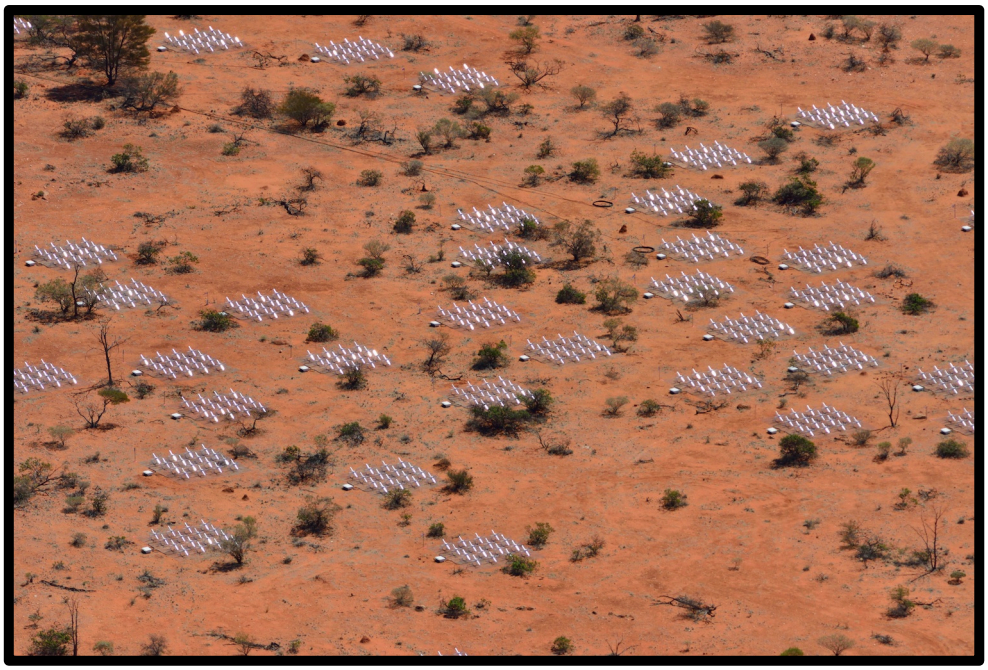
Allocation of observing time on the Murchison Widefield Array in its Early Operations phase: First Announcement of Opportunity and call for Expressions of Interest as steps toward first Call for Proposals



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Prof. Steven Tingay
MWA Director

Approved for release by MWA Board: **19th Dec 2012**

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Summary

This document is the first Announcement of Opportunity for observing time on the Murchison Widefield Array, a new low frequency radio telescope located on a radio quiet site in Western Australia. The MWA is currently nearing the end of its Science Commissioning phase and is expected to enter into its Early Operations phase in mid 2013.

This Announcement of Opportunity is the first stage in the allocation of observing time for the period July 2013 – June 2014. Potential users of the MWA are invited to submit Expressions of Interest (Appendix D of this document) to the MWA Director, outlining: their interest in particular areas of science with the MWA; the teams and resources they will assemble to undertake this science; the MWA observation modes required to undertake the science; the amount of observing time required; any other requirements.

Expressions of Interest will open on the 1st of January 2013 and the closing date for submissions will be the 1st of February 2013. The purpose of seeking Expressions of Interest is to allow the MWA Project Director to make a preliminary estimate of the likely demand across the different areas of science, the demand across different observation modes, and the prospects for undertaking observations that will satisfy multiple science programs.

It is expected that an informal meeting will be held for the Expression of Interest teams to discuss the status of the MWA and the timeline for operations with the MWA Director, Project Scientist and Management Team. Currently this meeting is scheduled for February 25/26, in Perth, Western Australia.

It is expected that a first Call for Proposals will be open from the 1st of March 2013 and will close on the 1st of May 2013. These proposals will be evaluated by the MWA Time Allocation Committee and an allocation of observing time will be made for the period July 2013 – December 2013. In this first observing period, time will only be allocated in the Guaranteed Time category, which is available only to teams led by Individual Members of the MWA project or by teams with more than 50% Individual Members.

This Announcement of Opportunity also covers the second observing period, which is expected to run from January 2014 to June 2014. During the second observing period, time will be allocated in both Guaranteed Time and Open Access categories. Open Access time is open to researchers who are not Members of the MWA project. The Call for Proposals for the second observing period is expected to open on the 1st of September 2013 and close on the 1st of November 2013.

Thus, this Announcement of Opportunity covers the first 12 months of MWA operations, split into two 6 month observing periods. The first observing period is open to MWA Members and the second period is open to Members and non-Members. The Expression of Interest process applies to both observing periods.

At this stage, it is expected that proposal teams will have to work closely with the MWA project to undertake their science programs during the first 12 months of operations. It is also expected that a Shared Risk approach will be taken during this period, as the MWA is a new style of radio telescope and the learning phase in terms of data processing and calibration will extend well into the Early

Operations period. It is therefore expected that proposal teams enter into MWA science programs with a relatively high level of experience and with the resources required to execute the programs.

Introduction and Background

The Murchison Widefield Array (MWA) is a low frequency interferometric radio telescope that operates between 80 and 300 MHz and consists of 128 aperture array "tiles" spread over an area of 3 km diameter. The MWA is located at CSIRO's Murchison Radio-astronomy Observatory (MRO), in the Murchison region of Western Australia, and is the only low frequency Square Kilometre Array (SKA) pathfinder on one of the two selected sites for the SKA. A full description of the capabilities of the MWA can be found in Tingay et al. (2012).

The MRO occupies a very sparsely populated area of Western Australia and is extraordinarily radio quiet, particularly in the FM band contained within the MWA frequency range. The instrument design and the radio-quiet location permit a number of areas of astronomical observation. A full description of the MWA science case is available on application to the MWA Project Scientist (Dr Judd Bowman, judd.bowman@asu.edu, to be available online in early 2013). Broadly speaking, the four main science themes for the MWA are:

- The search for radio emission from redshifted hydrogen corresponding to the Epoch of Reionisation (EoR);
- Studies of the solar heliosphere and the Sun – Earth connection (SHI);
- Galactic and extragalactic science, including large scale continuum and polarisation surveys, pulsar science, and galactic plane surveys (GEG);
- Studies of transient and variable radio sources (Transients).

The MWA has been constructed by a consortium of thirteen institutions[1] in four countries (Australia, India, New Zealand and the USA) and financed by funding organisations in these countries, plus the consortium partners. One of the obligations under funding for the MWA project is that a fraction of the observing time be made available, on a competitive "Open Skies" basis, to the international astronomy community.

The purpose of this document is to describe the process by which potential users of the MWA can be allocated observing time on the instrument, including a description of how the Early Operations phase of the MWA is expected to proceed, and restrictions on the accessible science and modes of operation. This document draws upon the MWA project documentation describing governance of the project and MWA policies, available publically from the following URL: http://mwatelescope.org.

Potential MWA users are encouraged to visit the MWA website to receive updates and further information on the MWA time allocation process, as this process proceeds. This information will appear at the following URL: http://mwatelescope.org.

[1] The MWA consortium institutions are listed in Appendix B

Appendix A contains a summary timeline of important dates, as described in this Announcement of Opportunity.

Period covered by this Announcement of Opportunity

This Announcement of Opportunity (AO) covers a 12 month period during which observations for scientific programs approved by the MWA Time Allocation Committee will be made.

This period is currently expected to commence from the start of July, 2013 and is expected to conclude at the end of June 2014. The period will be split into two six month periods, with the first six months available to Members of the MWA project and the second six months available to the entire international community, as well as MWA project Members.

Any deviation from these expectations will be communicated to potential users via the MWA website and via an email list that users will be able to register for, as the project moves through the final stages of commissioning in the lead-up to the commencement of Early Operations. To register for the distribution list, contact the MWA Project Scientist, Dr Judd Bowman (judd.bowman@asu.edu).

MWA Time Allocation Committee

The MWA Time Allocation Committee (TAC) is appointed by the MWA Board and is responsible for assessing and ranking proposals for MWA observing time. The MWA TAC is described in the MWA Time Allocation Policy, available at the URL provided in the introduction to this document.

The MWA TAC will not be involved in any assessment of the Expressions of Interest. The Expressions of Interest will be considered by the MWA Director, in order to make a preliminary assessment of the likely demand across the various areas of MWA science and also across the observation modes to be offered during Early Operations. This information will inform the subsequent Calls for Proposals, to open for the first six month period on the 1st March 2013 (for Guaranteed Time to MWA Members) and for the second six month period on the 1st September 2013 (for Guaranteed Time for MWA Members and Open Access time for non-Members).

No ranking or assessment of Expressions of Interest will be made, however the MWA Director will provide feedback on the Expressions of Interest and advice to the teams, to assist teams in preparing full proposals for the relevant deadlines. The MWA TAC will only assess and rank full proposals, which will be called for after consideration of the Expressions of Interest and consultation with the user community. It is currently expected that full proposals will be called for on the 1st of March, 2013, with a closing date of the 1st May, 2013.

Shared risk operations

Since the Early Operations phase of the MWA project will include the first scientific observations using the full instrument, data path and calibration and

imaging paths, it is likely that participation in the Early Operations phase will require the accumulation of considerable experience in operating the MWA hardware and software.

Furthermore, the MWA is a complex and non-traditional instrument (located in a very remote location) that poses new challenges in calibration and widefield imaging techniques, not least because of the vast dataset sizes produced.

As such, the MWA project operations team, and the MWA user community, will be on a significant learning curve and it is likely that full exploitation of the instrument and data will take time to realise.

In recognition of this likely situation, as with most new instruments, the Early Operations phase of the MWA will be under "Shared Risk" conditions. [2] Shared Risk conditions are likely to apply for the full 12 month period covered by this AO.

During the Shared Risk Early Operations phase there is the possibility of reduced data quality and/or data collection efficiency compared with that advertised due to unanticipated requirements, poorer than anticipated performance and/or lower efficiency. This may even result in cancellation or rescheduling of some Shared Risk observations at short notice. Cancelled Shared Risk observations not executed during the period covered by this AO will not automatically be rescheduled at a later date.

Every effort will be made to provide a realistic assessment of the capabilities and performance of the MWA instrumentation. However, since some portion of the MWA science commissioning will not have been completed prior to the final Call for Proposals, some capabilities and aspects of performance may differ from those advertised.

Shared Risk conditions are expected to continue for the period covered in this first AO, although these conditions may be lifted early if the MWA project deems the instrument to be working at or above expected performance levels. A review of the need for a continuation of Shared Risk conditions for subsequent AOs will be held prior to the release of the second Call for Proposals (nominally expected for September 2013, as per the requirement for bi-annual calls for proposals stated in the MWA Time Allocation Policy).

Likely level of observing time available under this AO

The Early Operations phase of the MWA will proceed according to the MWA Operations Management Plan (OMP), which details the operational requirements of the MWA during this period in terms of the size and scope of the operational team. The scope of the OMP is bounded in practical terms by the level of operations funding available, as well as constraints in terms of the data flows that can be supported into the MWA data archive to be housed at the Pawsey

[2] The following paragraphs draw heavily from the description of "shared risks observing" for the Gemini Observatory at http://www.gemini.edu/?q=node/11012

Centre (a new $80m supercomputing facility that will be coming online in parallel to the MWA).

These practical considerations lead to an operational model with a defined ramping up of observational duty cycle (percentage of time devoted to executing scientific observations) over the Early Operations phase.

During Early Operations, commencing July 2013 for a 12 month period, an average duty cycle (ratio of observing time to calendar time) of approximately 20% is expected to be supported by the MWA operational team. This corresponds to 750 hours of observation in the period July – December 2013 and a further 1000 hours in the period January – June 2014, a total of 1750 hours over the period covered by this AO.

It should be noted that the duty cycle of observations is not likely to be constant throughout the AO period. For example, during the prime observing season for Epoch of Reionisation science (~November - ~March), long night-time observations of particular fields are likely to be proposed, lifting the duty cycle to 50% or higher (depending on the level of day-time observations) during that period.

It is also highly likely that day-time observing will be limited largely to solar observations, as night-time observations are likely to be significantly better for all other forms of observation, due to a generally more stable ionosphere. Exceptions to this are, of course, possible with suitable justification.

Categories of time allocation

The MWA Time Allocation Policy (referred to elsewhere in this document), outlines the different categories of time allocation available to MWA users.

In response to Calls for Proposals, the MWA TAC will allocate observing time in two categories, Guaranteed Time (GT) and Open Access (OA).

1. GT will be allocated to proposals led by Individual Members (defined in the MWA Membership Policy) of the MWA or submitted by teams comprising more than 50% Individual MWA Members. GT will comprise a target 60% of available observing time on the MWA and will be allocated over the four MWA Science Programs. A proposal seeking GT time must identify which of the four MWA Science Programs the proposal corresponds to, or make fractional assignments between the four MWA science Programs (see Expression of Interest template in later section of this document). GT proposals seeking time for EoR science in whole or in part must be accompanied by an explicit endorsement from the Chair of the MWA EoR consortium. *In utilising GT, the proposers will be bound by all MWA policies.*

2. OA will be allocated to proposals led by individuals who are not Individual Members of the MWA or by teams comprising less than 50% Individual Members (as long as the proposal is not led by an MWA Individual Member or is driven by MWA Individual Members). OA will comprise a target 20% of the available observing time on the MWA and

can be allocated to any area of science apart from studies of the Epoch of Reionisation. *Individuals and teams allocated time and data under OA are not bound by MWA Collaboration policies.*

Up to a further 20% of available observing time will be allocated to Director's Discretionary Time (DDT). During this first AO period, it is expected that DDT will be preferentially used to support commissioning for observation modes that will be made available in subsequent AO periods, as well as engineering test time. During the first AO period, DDT will be released to TAC-approved science programs at the discretion of the Director. The process for accessing DDT and data resulting from DDT will be further detailed in the first Call for Proposals.

Target of Opportunity observations and/or observations that require rapid rescheduling of the instrument at short notice will not be formally supported during this first AO period, although various tests of rapid reaction Target of Opportunity observations may be conducted internal to the MWA project, using DDT.

In terms of the first AO period, and for the purposes of potential users preparing Expressions of Interest, the above can be summarised in the following expectations:

First six month period (July 2013 – December 2013):

1. A target 600 hours of GT will be available in the period July 2013 - December 2013;
2. No OA time will be available in the period July 2013 - December 2013;
3. Up to 150 hours of DDT will be available in the period July 2013 - December 2013.

Second six month period (January 2014 – June 2014):

4. A target 450 hours of GT will be available in the period January 2014 – June 2014;
5. A target 350 hours of OA will be available in the period January 2014 – June 2014;
6. Up to 200 hours of DDT will be allocated in the period January 2014 – June 2014.

Instrument capabilities and available modes of observation

The definitive description of the capabilities and expected performance of the MWA is contained in Tingay et al. (2012). For the purposes of preparing Expressions of Interest, it is envisaged that the information in Tingay et al. (2012) will be largely sufficient. If teams preparing Expressions of Interest require information beyond what is provided in Tingay et al. (2012), they should contact the MWA Project Scientist for advice, Dr Judd Bowman (judd.bowman@asu.edu).

One aspect of the MWA performance that is not extensively covered in Tingay et al. (2012), and may be of use in preparing Expressions of Interest, is the MWA uv plane coverage. Figures 1 and 2, below, provide an overview of what potential users can expect for different observation durations, bandwidths, and choices of

maximum baseline (for an example declination of -30 degrees). This is not an exhaustive exploration of parameter space, but should be sufficient to inform the preparation of Expressions of Interest.

Figure 7 of Tingay et al. (2012) is worthy of note, in particular the MWA tile beam shape near the high frequency end of the observing band, where the aperture array becomes sparse, causing significant grating lobes. Caution should be exercised when using the MWA above ~250 MHz for this reason, unless the target is the Sun.

As a radio telescope with a primary capability in very wide field surveys, the primary observational modes are naturally limited and widely applicable to a range of areas of science.

During the first AO period, two observational modes will be offered, Drift Scan Observations and Pointed and Tracked Observations.

Drift Scan Observations: Drift Scan Observations are observations during which the MWA primary beam is pointed at a fixed azimuth and elevation (corresponding to a fixed declination and usually corresponding to a point on the meridian). As the Earth rotates, data are produced covering a strip in right ascension at a fixed declination. The primary advantage of this observing mode is that the analog beamformer settings used to steer the primary beam are fixed, making calibration easier and more predictable. The disadvantage is that, while the confusion limit in Stokes I can be reached in this mode, it does not suit science that requires deep integrations for a given field.

Pointed and Tracked Observations: In contrast to Drift Scan Observations, Pointed and Tracked Observations involve tracking of a fixed right ascension and declination, involving periodic (timescale of minutes) changes to the analog beamformer settings to steer the primary beams in discrete steps. This is closer to how observations are made with a traditional radio telescope. The advantage of this mode of observation is that long and deep integrations are possible for a given field of interest (EoR field, for example). The disadvantage is that the discrete nature of the tracking introduces some potential complications into the calibration of the data.

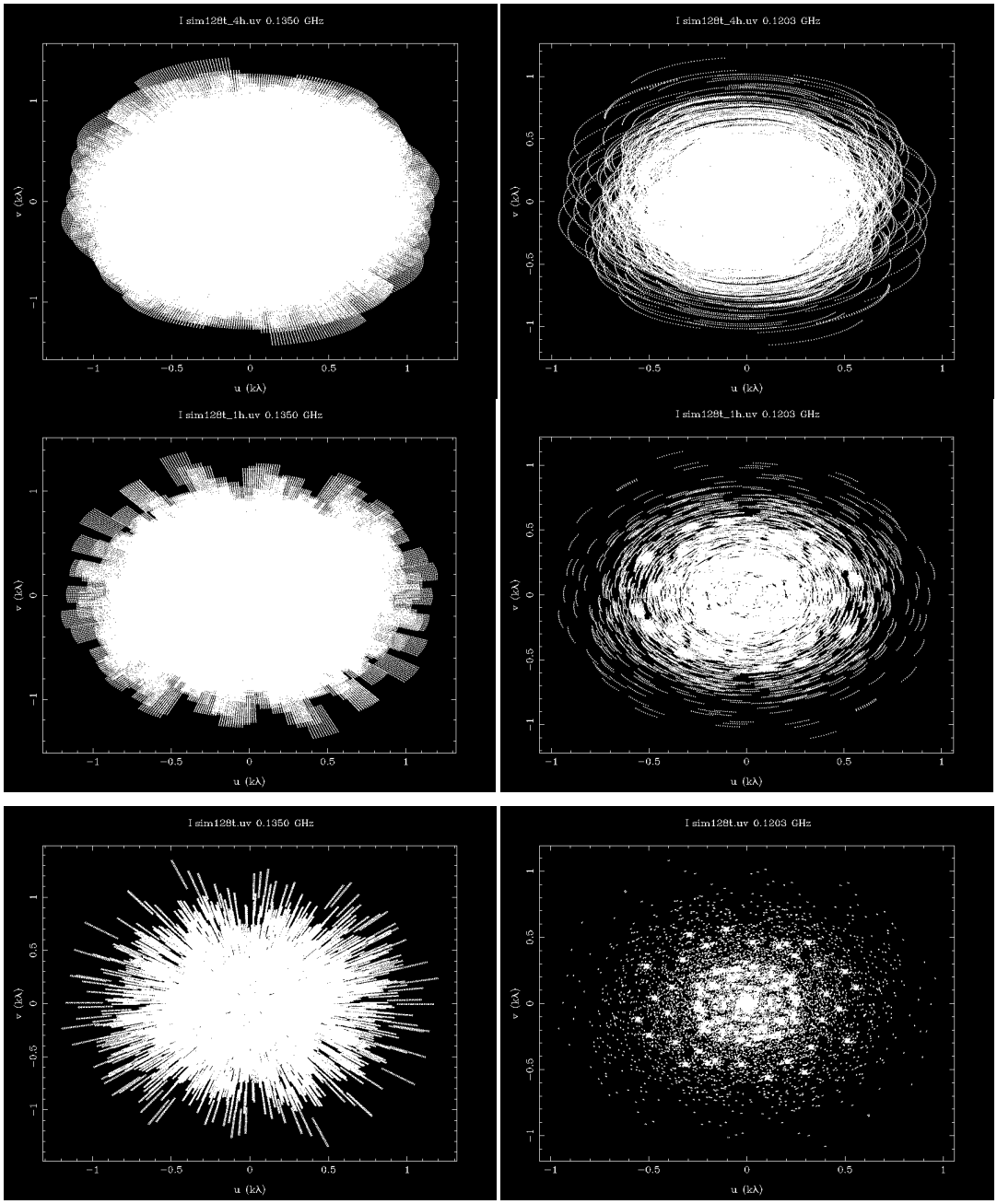

Figure 1: Example uv coverages at declination -30 degrees and observing frequency of 150 MHz for the full array. Left panels are full bandwidth (30 MHz) observations and right panels are single channel (40 kHz) observations. Top to bottom, the observation durations are 4 hours, 1 hour, and snapshot (~minute), respectively.

As noted above, Target of Opportunity observations will not be supported from the user community during the first AO period. Also, other observational modes described in Tingay et al. (2012), such as involving use of the voltage capture system, will not be available for this AO. These additional observational modes and capabilities will be commissioned and tested internal to the MWA project team during DDT and considered for availability for subsequent AO periods.

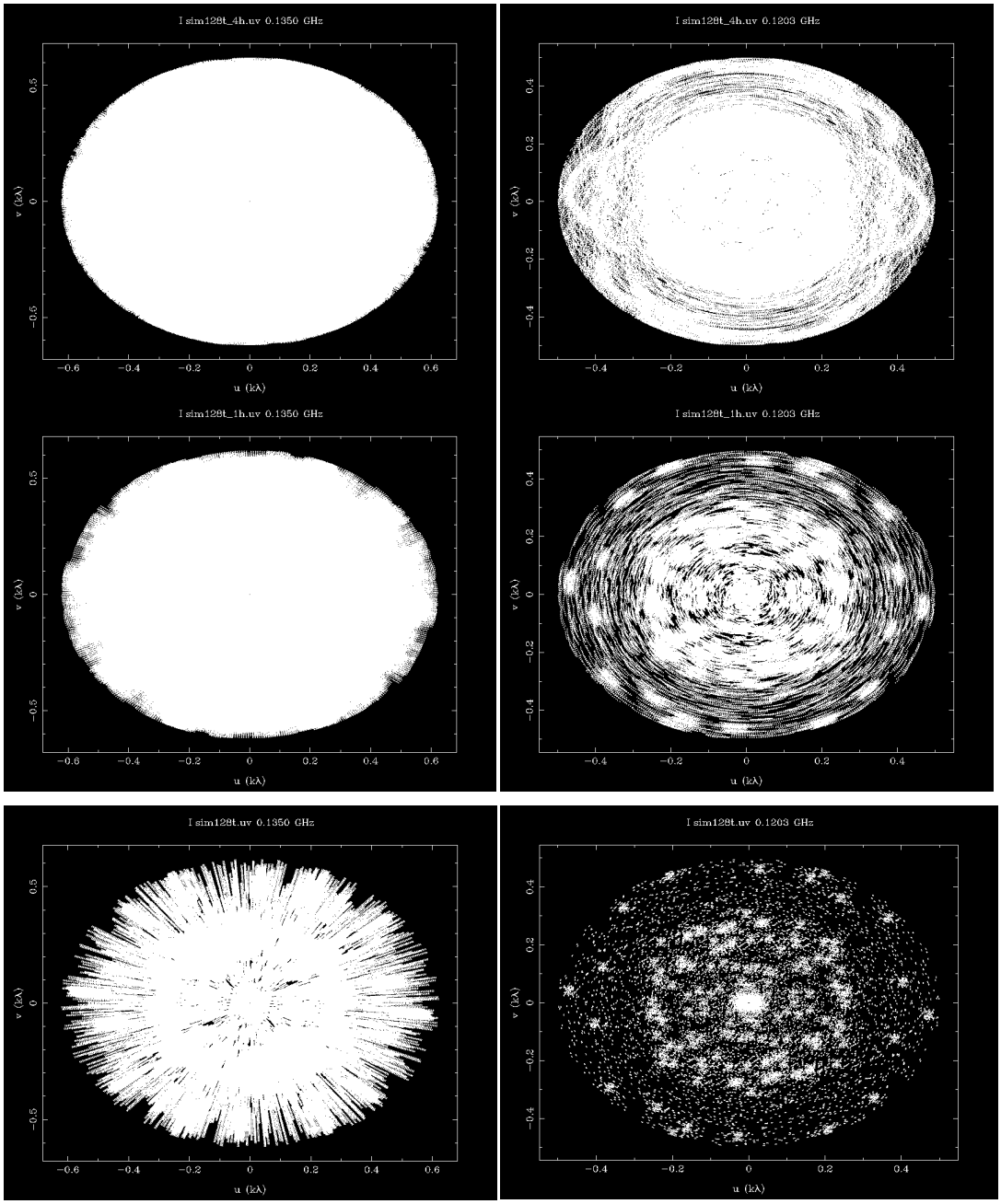

Figure 2: Example uv coverages as for Figure 1, but with maximum baseline restricted to 1 km.

Restrictions on Epoch of Reionisation science

The use of the MWA for studies of the Epoch of Reionisation is restricted to members of the MWA EoR Collaboration, which is made up of a subset of the Individual Members of the MWA project team. Thus, observing time for EoR science can only be proposed as part of the GT allocation, by the MWA EoR Collaboration, under the conditions stated in the MWA Time Allocation Policy, available on the MWA website.

Observations proposed for EoR science will be reviewed by the MWA TAC and judged against other proposals received in the GT category.

Further enquires regarding EoR science with the MWA can be directed to the leader of the MWA EoR Collaboration, currently Prof. Jackie Hewitt at MIT Kavli (jhewitt@mit.edu).

Data products, data access and data processing

The MWA will produce various levels of data product. The two primary data products relevant to the Early Operations period and the first AO period covered in this document are uv data and images from the real-time imaging and calibration system. Access to MWA data is governed by the MWA Data Access Policy, available on the MWA website.

As described by Tingay et al. (2012), the observational modes described above (observations for imaging purposes) will produce visibility data at an approximate maximum rate of 3.2 Gbps. These data will be automatically transferred on a dedicated 10 Gbps network to the Pawsey HPC Centre for SKA Science in Perth, where 15 PB of storage has been allocated, ramping up over a 5 year period starting in the second half of 2013. These visibility data will be available to MWA users via an archive interface in the standard UVFITS format.

In addition, an experimental real-time imaging and calibration system (Real-Time System: RTS) will be in operation, alongside the MWA correlator, also described by Tingay et al. (2012). The RTS is a highly sophisticated software suite and, while it is expected to produce the best possible images using MWA data, the RTS will likely take significant time to settle into robust and routine operations. However, the image output of the RTS (when running) will also be transferred to the MWA archive at the Pawsey Centre (at approximately 1.2 Gbps) and made available to users via the archive interface.

Therefore, users will have options to retrieve visibility and/or RTS imaging data from the MWA archive, for their observations. As described by Tingay et al. (2012), it is expected that the two observational modes described here will produce visibility data with a spectral resolution of 40 kHz and a time integration of 0.5 seconds, while it is expected that the RTS will produce images at an 8 second cadence (and perhaps averaged up over several minutes). It is expected that these correlator and RTS parameters will be fixed for the majority of MWA users.

It should be noted, however, that if users have any requirement to retrieve large volumes of data (visibilities or images) from the MWA archive, they will be required to be responsible for organising a suitable destination for these data, as well as appropriate processing resources. MWA users requiring such large data volumes may be interested in the prospect of applying for storage and compute resources on the Pawsey Centre, via a number of merit-based allocation processes. Users interested in this possibility should familiarise themselves with the allocation processes (http://www.ivec.org and queries to george.beckett@ivec.org).

It is expected that some users will require visibilities to pursue their science requirements, while it is possible that some users will be satisfied with the RTS image outputs. Users who wish to work with visibilities will be responsible for the data processing themselves, once data have been retrieved from the MWA

archive. The MWA project team have developed data processing pipelines to transform visibility data into images, but it is not expected that these pipelines will be officially supported as tools for the general user community (due to constraints on the resources available to the MWA operational team). However, access to these pipelines will be possible, in informal collaboration with MWA project team members (see following section).

As an MWA sub-system that will remain experimental for some period into the Early Operations period, RTS images will be provided on a best effort basis to users. Therefore, the responsibility will be on users to employ RTS images for science, although it is noted that the RTS performance to date has been shown to be good.

The MWA is the first of the three SKA precursors to be operational, entering the age of significant data rates, vast data sets, automated and large-scale processing, and huge archives. This archive is currently being implemented and commissioned at the Pawsey Centre, which itself is currently under construction. Therefore, it is expected that the MWA archive will be the sub-system that will evolve most strongly during the Early Operations phase of the MWA, in response to experience gained with respect to usage patterns for the archive (number and frequency of database queries, frequencies and volumes of datasets retrieved from archive, and ratio of visibility to image requests). These usage patterns are virtually impossible to predict in advance. The operational form of the archive will therefore evolve strongly and will require significant communications between the MWA operational team and the MWA users during the Early Operations phase.

As the final stages of MWA and Pawsey commissioning proceed and further aspects of archive operations become concrete, users will be informed. It is expected that an update on archive operations will be a significant portion of the planned informal meeting between the MWA operational team and the Expression of Interest teams in February 2013.

Collaboration with members of the MWA project

As noted above, significant software resources have been developed to image and calibrate MWA data. These have been developed to process data from the MWA 32 tile prototype (e.g. Williams et al. 2012) and, more recently, for the purposes of MWA Science Commissioning.

These software resources have proven themselves capable of producing MWA images of scientific quality, but have been developed for internal MWA project purposes. Currently, the release of the software to the general user community is under discussion within the MWA project. It is possible that the software may be made available to users, but without formal support from the MWA operational team, due to resource limitations within that team.

However, for users not familiar with the MWA or indeed with interferometry or radio astronomy, informal collaborations with MWA team members will be possible. In fact, it is strongly encouraged that teams developing Expressions of Interest include at least one member deeply familiar with the MWA and MWA data processing.

Due to their recent and deep experience in commissioning the MWA for science, including use of data processing pipelines, members of the MWA Science Commissioning Team are best placed to be approached for such collaborations. The names, areas of expertise and contact email addresses for the MWA Science Commissioning Team (SCT) members are included in Appendix C.

It will be a personal choice of SCT members to collaborate or not, based on approaches from Expression of Interest teams. If required, Expression of Interest teams can seek further advice on collaboration with MWA team members from the MWA Director (s.tingay@curtin.edu.au), MWA Project Scientist (judd.bowman@asu.edu) or MWA Commissioning Scientist (r.wayth@curtin.edu.au).

Call for Expressions of Interest, user consultation, and Call for Proposals process

The information provided in this AO, and contained in the references cited, is intended to assist teams in preparing Expressions of Interest in science observations with the MWA. The Expressions of Interest lead into user community consultation and the Calls for Proposals.

The Expressions of Interest will not be evaluated or assessed by the MWA TAC for scientific worthiness, but will be considered by the MWA Director in order to estimate the demand for MWA observing time across the different areas of science and, importantly, across different observing modes. This information will be used to prepare for a user consultation meeting and then a formal Call for Proposals. The MWA Director will provide written feedback and advice to the Expression of Interest teams, ahead of the user consultation meeting, to assist in the preparation of full proposals. These proposals will be evaluated by the MWA TAC, as a basis for scheduling available MWA observing time and operational resources.

The Expression of Interest template can be found in Appendix D. Expression of Interest teams should complete the template and submit it to the MWA Director. The Expression of Interest submission period opens on 1st January, 2013, and closes on 1st February, 2013.

Following this deadline, it is expected that a user consultation meeting will be called for February 25/26, 2013, at Curtin University, Perth, Western Australia.

Following the user consultation meeting, it is expected that a Call for Proposals will be made with a submission period running from 1st March, 2013, to 1st May, 2013.

If further information or assistance is required to complete the Expression of Interest template, the MWA Project Scientist can be contacted (judd.bowman@asu.edu).

Acknowledgements

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Foundation (grants AST CAREER-0847753, AST-0457585, AST-0908884 and PHY-0835713), the Australian Research Council (LIEF grants LE0775621 and LE0882938), the U.S. Air Force Office of Scientic Research (grant FA9550-0510247), the Centre for All-sky Astrophysics (an Australian Research Council Centre of Excellence funded by grant CE110001020), New Zealand Ministry of Economic Development (grant MED-E1799), an IBM Shared University Research Grant (via VUW \& Curtin), the Smithsonian Astrophysical Observatory, the MIT School of Science, the Raman Research Institute, the Australian National University, the Victoria University of Wellington, the Australian Federal government via the National Collaborative Research Infrastructure Strategy, Education Investment Fund and the Australia India Strategic Research Fund and Astronomy Australia Limited, under contract to Curtin University, the iVEC Petabyte Data Store, the Initiative in Innovative Computing and NVIDIA sponsored CUDA Center for Excellence at Harvard, and the International Centre for Radio Astronomy Research, a Joint Venture of Curtin University and The University of Western Australia, funded by the Western Australian State government.

References

Tingay, S.J. et al. 2012, PASA accepted (arXiv:1206.6945)
Williams, C.L. et al. 2012, ApJ, 755, 47

Appendix A: Summary of key dates described in this Announcement of Opportunity

1st January 2013	This Announcement of Opportunity released. Expressions of Interest open.
1st February 2013	Expressions of Interest close.
25/26 February 2013	Expression of Interest team meeting and consultation with MWA Project Office, feedback on Expressions of Interest.
1st March 2013	First Call for Proposals opens (GT allocation only).
1st May 2013	First Call for Proposals closes.
July 2013	MWA operations commence for first 6 month period.
1st September 2013	Second Call for Proposals opens (GT and OA allocations).
1 November 2013	Second Call for Proposals closes.
December 2013	MWA operations conclude for first 6 month period.
January 2014	MWA operations commence for second 6 month period.
June 2014	MWA operations conclude for second 6 month period.

Appendix B: MWA Consortium institutions

Curtin University (MWA Lead and Managing Organisation):	Australia
Australian National University:	Australia
CSIRO:	Australia
Harvard-Smithsonian Center for Astrophysics:	USA
Massachusetts Institute of Technology, Haystack Observatory:	USA
Massachusetts Institute of Technology, Kavli Institute:	USA
Raman Research Institute:	India
Swinburne University of Technology:	Australia
The University of Melbourne:	Australia
The University of Sydney:	Australia
University of Tasmania:	Australia
The University of Western Australia:	Australia
Victoria University of Wellington:	New Zealand

Appendix C: Contact list for MWA Science Commissioning Team

NAME CONTACT	ROLE/EXPERTISE/SCIENCE INTEREST
Randall Wayth r.wayth@curtin.edu.au	Commissioning Scientist Sky Survey
Natasha Hurley-Walker nhw@icrar.org	Co-leader of imaging-calibration pipeline Sky Survey/GEG
Martin Bell mebell@physics.usyd.edu.au	Co-leader of imaging-calibration pipeline transients
Frank Briggs fbriggs@mso.anu.edu.au	EoR/Calibration
Gianni Bernardi gbernard@cfa.harvard.edu	Sky Survey/RTS
Daniel Mitchell daniel.mitchell@unimelb.edu.au	Sky Survey/EoR/RTS
Stephen Ord Stephen.Ord@curtin.edu.au	Pulsars and high time resolution/RTS/Correlator
Divya Oberoi div@ncra.tifr.res.in	SHI
Danny Jacobs daniel.c.jacobs@asu.edu	Sky Survey/EoR
Ben McKinley ben@mso.anu.edu.au	GEG/Grad student
Nadia Kudryavtseva Nadia.Kudryavtseva@curtin.edu.au	Transients
Emil Lenc e.lenc@physics.usyd.edu.au	Polarisation
Avinash Deshpande desh@rri.res.in	Pulsars

Ramesh Bhat Ramesh.Bhat@curtin.edu.au	Pulsars
Bryna Hazelton brynah@phys.washington.edu	EoR/M&C
Lu Feng lufeng@mit.edu	Grad student.
Aaron Ewall-Wice aaronew@mit.edu	Grad student
Jennifer Riding j.thompson10@student.unimelb.edu.au	Grad student
Pietro Procopio pietro.procopio@unimelb.edu.au	RTS

Appendix D: Expression of Interest template

To: MWA Director
Prof. Steven Tingay, Curtin University
S.Tingay@curtin.edu.au

From: **[INSERT EoI LEAD INVESTIGATOR NAME HERE]**

RE: MWA Expression of Interest in response to first Announcement of Opportunity

Title of EoI:

Area(s) of MWA science (EoR; GEG; Transients; SHI):

Does this EoI pertain to the GT or OA category of time allocation:

Members of EoI team (list names, titles and institutions):

Provide a scientific description of the project (maximum of 1 page):

Which of the available MWA observation modes will be required? (mark all modes applicable):
Drift scan:
Pointed and tracked:

Provide an estimate of the observing time required, broken down against the observing modes indicated above, required observing frequencies or other relevant parameters (maximum of 0.5 pages):

Are there any requirements that have not been adequately described above (polarisation, spectral resolution, correlator integration time, particular dates or times of year)? Note that some requirements may be deemed to be not supportable (maximum of 0.5 pages):