ATNF ATUC MEMORANDUM

To: ATUC

From: Bob Sault

Date: 29 May 2004

Subject **Major projects at Mopra**

At its November 2003 meeting, ATUC requested the ATNF facilitate the development of some key scientific projects at Mopra. This is in part a reaction to the low productivity of Mopra. At its April meeting, the AT Steering Committee recommended that Mopra changes be planned with full community consultation. This memo sketches a different mode of operating Mopra that aims to improve its scientific productivity.

A brief review of Mopra

The Mopra Radiotelescope is a 22-m antenna located at the foot of Siding Spring Mountain, which currently specialises in 3mm spectroscopy (during the winter) and VLBI observations. The telescope also possesses receivers at 20, 13, 6, 3 cm and 12mm. The Mopra Observatory is generally unstaffed, and operated and maintained from Narrabri.

Currently most of the telescope usage is through a "national facility" approach. The UNSW however receives an allocation outside the normal TAC process as part of an agreement where they contributed funding to a dish surface and wideband correlator upgrade. In 2003, 59 days were allocated through the TAC for 3mm spectroscopy, 21 days for VLBI/VSOP, and 53 days were allocated to the UNSW. In addition to the science outputs, the UNSW has used Mopra as a "teaching facility" where students are able to get more hands-on experience than is possible with some other telescopes.In the past, some special programs (e.g. Project Phoenix and VSOP) have made large use of the telescope.

Since last winter season, there has been considerable work at Mopra. From the observers prospective, the most significant changes are

- the new antenna control system. This allows the cycle time of Mopra to be reduced from 10s to 2s, which leads to less latency in the observing system and greater observing efficiency.
- the implementation of an on-the-fly mapping mode.
- the installation of a preliminary version of the Mopra wideband correlator. This winter we are offering a 600 MHz, 1024 channel, dual polarisation system.
- the adjustment of the subreflector to improve the beamshape and antenna efficiency.

Considerable effort has also gone into resolving some significant technical problems that developed since last winter.

The 2004 Mopra season started on 23 May. This was after an introductory workshop at Mopra which attracted 27 attendees. Unfortunately more than a week in the first two weeks of observing were lost to a serious cryogenics failure and to poor weather.

Development plans after the end of the season include the installation of an ATCA-style millimetre receiver package, and the commissioning of the full wideband/multi-line correlator. The new receiver package will eliminate the need for manual tuning (a significant

bugbear of Mopra observers). It also means than the system will become a practical dual polarisation system (currently one polarisation is generally sacrificed to simplify pointing calibration– this sacrifice can be avoidedin the new system). However the new system is likely to have a poorer system temperature. There is also a plan to include improved subreflector control, which will improve the beamshape and gain some efficiency.

In the medium term there is also a proposal for CSIRO to fund a multi-gigabit/second link to Parkes and Narrabri, which would open the door to "e-VLBI" and potentially other innovative uses of the telescope. In the longer term, there are some prospects for installing a 7mm system.

Issues

The scientific productivity of Mopra is significantly lower than other ATNF facilities. Adjusting for the difference in cost of operating Mopra relative to the ATCA and Parkes, one might expect that Mopra would produce about eight refereed papers per year. However it typically produces one or two. Additionally the citation rate of Mopra papers is about a third the norm for ATNF publications.

The effort that is being expended on Mopra is not effective at producing good scientific results. The key question is what changes should be made to Mopra to make it more productive.

One approach to improving productivity is to focus Mopra on a small number of key, high-benefit projects where the telescope can be most productive. In this mode, we ask the ATNF Users Committee to be actively involved in fleshing out the major projects and in assisting in finding the resources (e.g. researchers and students) to move the projects forward. One of the largest challenges facing Mopra is the lack of a broad community that can exploit the instrument. Major projects will require people at a postdoc-level and higher to commit significant time to implement them.

To aid in developing such projects, this memo sketches the observing modes that could be used for major projects and the goals that they might aim for. A simple SWOT analysis helps to characterise areas where major projects may be most productive and areas requiring development before such projects could be initiated. Here we assume the completion of the wideband correlator upgrade and the installation of an ATCA-style millimetre receiver package. The possible installation of a high capacity network to Mopra may also influence the most appropriate major projects.

Mode of operation

As a strawman model, we could aim at the following mode of operation:

- Mopra will be scheduled April-November only (including VLBI)
- 75% of observing time over five years will be devoted to one or two high impact major projects. The remaining 25% will be allocated by normal TAC processes. Each major proposal would use approximately 3 months of observing time each winter.
- The major projects will be pursued in partnership with other research groups that are willing to commit resources to see these projects achieved.
- Seek additional funding via the partners (and the ARC) to support the major projects.
- During the major project observations, full remote operation of the telescope aimed to be achieved by winter 2005. Full automatic operation of the telescope aimed to be achieved by winter 2006.

The ATNF time assignment committee would need to sanction this use of Mopra, and would need to be involved in the process of selecting the major projects.

Advice sought

ATUC's advice is sought on the following issues:

- Does ATUC support placing significant focus on a few major proposals as a way to improving the scientific productivity of Mopra?
- What would ATUC see as the best way to develop the Mopra community, to engage the community over Mopra proposals, and to find scientific partners for proposals of major observing programs? What role would ATUC be willing to take in this process?

SWOT Analysis

Assuming the completion of the upgrades slated for late 2004, the strengths, weaknesses, opportunities and threats are as follows.

Strengths

- A robust 3mm observing system, which is unique in the southern hemisphere.
- Multi-line and broadband correlator
- High capacity network link (?).
- Frequency agility (both at 3mm and between wavelength bands)
- Strong technical expertise at Narrabri and Marsfield. Good local backup through AAO and other local people.
- Solid infrastructure, capable with modest work of remote operation (as it was during Project Phoenix).

Weaknesses

- Coma lobe (⇒ new receiver package with axial optics and subreflector actuation should eliminate this)
- Inefficient, tempremental, observing system (⇒ large, specialised projects; software upgrade)
- The atmosphere at the site is mediocre for 3mm operation (⇒ major projects in the lower part of the 3mm band or within the 12mm band?)
- No beam switching capability (⇒ on-the-fly mapping preferred observing mode).
- Primary and general monitoring system inadequate for remote operation (⇒ upgrade).
- Remote maintenance crew (⇒ breakdown call-outs limited to work hours)

Major project opportunities

- A pathfinding instrument in the pre-ALMA era.
- Major southern multi-line 3mm and 12mm spectroscopy surveys.
- VERA?
- Realtime VLBI – an SKA technology demonstrator (Mt Pleasant – Mopra via fibre)?

Threats

- Loss of community and inability to find science partners willing to commit to major projects.
- Funding limitations.
- Catastrophic failures, fire, weather and severe vandalism (mitigate by preventative maintenance, security and other appropriate measures).