

ATNF ATUC Memorandum

To: ATUC
From: Warwick Wilson
Date: 25 November 2004
Subject **Current Project - Technology Development Report**

5.1 Current projects

MNRF1997 – 3/12mm systems

Following the successful installation of the new 3mm receivers on the ATCA, one outstanding major deliverable remains to complete the MNRF1997 project; the installation of a similar 3/12mm receiver at Mopra. The current plan is that the Mopra receiver will be a copy of the ATCA receivers, but with an extended 3mm frequency coverage up to 115GHz. This will require the development of new LNAs and a modified LO chain. It should be noted that both of these developments, in particular the LO chain, represent a significant extrapolation from our current state and so have significant risks associated with them. The current goal is to have the receiver installed at Mopra in time for the 2005 millimeter season. When completed, the Mopra receiver will become the prototype for an eventual 115GHz upgrade of the ATCA receivers. Successful commission of the Mopra receiver will mark the end of the MNRF1997 project

3/12mm system: Outstanding issues

Commissioning tests and initial observations with the new 3mm receivers on the ATCA have revealed some outstanding technical issues that need to be considered. The cause of excessive noise produced by the local oscillator chain, particularly at the higher frequencies, has recently been identified. A modified LO chain will be developed for the Mopra receiver and could be available for retrofitting to the ATCA, but not before 2006. The problem of inadequate sideband rejection at the higher frequencies, due to falling frontend gain, will be difficult to remedy with the existing LNAs, but will be addressed in the design of the Mopra receiver. It is likely that retrofitting will take significant resources and ATUC are asked to provide advice on the relative priority of this new activity when considered against other projects on which it is likely to impact.

Other potential work planned for the existing ATCA mm receivers include:

- The provision of spares for 12 and 3mm sub-assemblies. This should allow the replacement of some currently under-performing parts.
- Replacement of the 4-12GHz IF amplifiers to reduce gain and possible compression problems.
- Development of a calibration signal injection system – not before 2006.

MNRF2001 – ATCA Broadband Upgrade (CABB)

A decision has been made to adopt digital data transfer between the antennas and the central site, with nominal 8-bit data paths. The alternative analogue transmission system, while offering advantages in simplifying the antenna electronics, and thereby reducing self-generated RFI, is not able to provide the high dynamic range required when operating in the presence of strong external RFI. The implications of this

decision are now being worked through in developing conceptual designs of the conversion and data transmission systems. Design of the prototype samplers, using two interleaved 2GSample/sec 8-bit digitisers, is nearing completion, with testing expected to begin in January.

The digital filter bank (DFB) development has been slower than expected, with a 512MHz bandwidth demonstrator DFB now completed, but almost three months behind schedule. A significant fraction of this delay resulted from the fact that the design process did not include the simulation of all parts of the system. This resulted in having to resort to debugging firmware in the final hardware, with the attendant long turn-around times. An effort will now be made to introduce new design tools to improve this situation. Firmware design effort will then shift to the 2GHz DFB to be implemented in the prototype CABB hardware. Fabrication of this very complex custom designed printed circuit board, containing 16 large FPGAs, is expected to begin in January. The next step in the development will be a modification to the board to use the latest Xilinx FPGAs. The increased processing power should provide a greatly increased scope to implement features requested in the recent workshop.

The prototype hardware will be used in the Mopra 8GHz Spectrometer. The current goal is to have the first 2GHz sub-band of the spectrometer operating at Mopra by June 05, with the remaining units to be installed before September 2005.

MNRF2001 – MMIC Development

InP MMICs

The final InP fabrication run in the EU Faraday project collaboration is now planned for April 2005. Circuits to be included on this run include production quantities of the 7mm LNAs and mixers and 1-3GHz and 4-12GHz LNAs for the ATCA. A major effort is under way to test packaged prototype MMICs of these designs before the next run. A new goal is to include an InP LNA design for the NTD project on this run.

Integrated Receivers

The initial fabrication run for the RF-CMOS integrated receiver MMIC, containing RF test structures, was planned for December 2004. This has now been deferred until February 2005 to allow a re-appraisal of project aims in the light of recent developments in the NTD project. The delay will also allow additional digital test structures to be added, resulting in a more efficient use of available area on the silicon.

6GHz Multibeam Receiver for Parkes

Preliminary mechanical design of the dewar and dewar internals – i.e. feeds, thermal isolation, cal injection, polariser – is complete. Now awaiting final design information on the feed structure from CSIRO ICT.

Jodrell Bank is in agreement with the proposed October 2005 installation at Parkes and they are confident that they can meet their commitments, i.e. LNAs, first conversion system.

A proposal has been made to double the maximum available bandwidth from the receiver, to about 600MHz, particularly for pulsar observations. The major item of hardware required is an additional first conversion system, which would be provided by Jodrell Bank. Some modifications to the mechanical design may be needed to accommodate the extra hardware, but this will not delay in any way the installation of the receiver as originally specified. ATUC is invited to comment on this proposal.

SKA Site Testing

Activities have proceeded towards SKA site selection in Australia in the following areas.

RFI Long-term test Program.

Funding was obtained from the WA government in July 04 towards the construction of a mobile RFI data collection system. The system consists of a suite of antennas positioned on 6m masts covering the frequency range 50MHz to 24.5GHz. The system is powered from a continuous 24hr demand 200W solar power system with a backup diesel generating system. The use of renewable energy supply for this system will provide valuable experience for the NTD and the SKA.

The system is now 80% complete, and will be need to be deployed prior to Christmas 2004 in order to accumulate 12months of RFI data from Mileura station for the SKA 31 Dec 2005, RFP Australian site submission. Given the tight timeline, final testing and system retrofits will need to be done in the field. At present both hardware calibration and software testing are proceeding in the laboratory.

The SKA International Project Office expects to conduct RFI measurements at Mileura in April 2005, with equipment developed by ASTRON. These measurements will be cross checked with the Australian measurements.

Site Selection

The International SKA Project Office released the Request for Proposal document on 1 Sept 2004. A single Australian candidate site was to be selected.

The Australian SKA Site Working Group (CSIRO/Swinburne team) was formed to provide ASKAC with the necessary technical information and analysis needed to enable a choice between the WA Mileura site and NSW Reola site. WA was eventually selected by ASKAC as the preferred candidate Australian SKA core site. The SA Murnpeowie site was eliminated somewhat earlier due to the inability to meet the 3000km baseline criteria as outlined in the RFP document.

There are currently 5 prospective locations for the SKA core at Mileura station. The long-term RFI measurements must be conducted at the proposed core location, down-selection of a site within Mileura will need to be done quickly.