

## ATNF ATUC Memorandum

**To:** ATUC  
**From:** Bob Sault  
**Date:** 22 November 2004  
**Subject:** 3mm systems on the ATCA

### Summary of 2004

The highlight of the year at the ATCA has been the installation of the 3mm systems on 5 antennas. The first 3 new systems were first used for observing on 10 September, and five systems being available on 20 September. This was appreciably later than the originally scheduled 6 July start to the 3mm season, and was caused by some substantial engineering challenges in the local oscillator system near the end of the project. The new systems were brought into operation as quickly as possible, with limited commissioning time. In some instances, the arrival of the hardware at Narrabri and first use in scheduled observations was on the same day. Scheduled 3-mm observing continued on the ATCA up until 15 October when the “3-mm season” was declared closed. This is dictated by weather: the summer weather pattern was already apparent by that stage. Almost all projects from the time of the installation up until the close of the season were 3mm ones. Scheduled 12-mm observing continued until 28 October.

Performance of the systems was generally good: system temperatures of 200-300K were readily attainable, and the system sensitivity was 22-25 Jy/K. With the limited time between delivery and the end of the season, commissioning tests were being performed in tandem with scheduled observing. Not surprisingly, there were a number of teething problems with the new systems, which were addressed as promptly as possible. A number of the lower priority or more long-term issues remain with us.

The late delivery of the 3mm systems required substantial rescheduling at short notice, which was a disruptive process for all concerned. We thank all those observers who graciously took the need to reschedule in their stride, and assisted us despite inconvenience to themselves.

Although most projects were rescheduled, this was less than optimal for some projects. Additionally only three or four antennas were available to the earliest projects to use the 3-mm system. Expressed as a fraction of total time in the term, 4.6% of projects originally scheduled needed to be cancelled and replaced with other projects, 1.2% observed with a three-antenna system, and 2.6% observed with a four-antenna system. The majority of projects that were cancelled were for 12-mm observations: the installation of the 3-mm system disabled the 12-mm system for a period.

### Prospects for 2005

There are many issues that will be addressed over the summer (where possible) with the aim of providing a polished system at the start of the 2005 millimetre season. An appendix to this paper lists some of these polishing tasks.

Some significant issues include:

- The antenna efficiency of CA01 is substantially less than other antennas, and the beam shape is poor. Although good progress has been made to understanding this problem, there is some way to go. We have contracted a photogrammetric survey of the subreflector and main dish of CA01 to be performed on 15-16 December. This should give a conclusive answer. Until this problem is better understood, the subreflector actuation project is on hold.
- The system temperature of CA04 Y polarisation in the band 86-90 GHz is significantly poorer than expected. This continues to be investigated.
- Above 102.3 GHz, system sensitivity abruptly degrades by about a factor of two. The cause is well understood, and options to resolve it are being assessed. It is unlikely that this will be resolved by the 2005 season.
- Although the polishing tasks are expected to give a better system, the “headline” capabilities of the system in 2005 will be the same as in 2004. In particular, the frequency range offered remains essentially unchanged (83.5-106 GHz), and noise diodes will not be installed on the antennas (note that polarimetric observations require the noise diodes). High frequency extension (106-115 GHz) and noise diode calibration will wait at least until their successful demonstration at Mopra.

One expected addition capability in 2005 is the provision of a second pair of 16 MHz filters. This will make dual spectral line observation possible for some set of projects.

At an operational level, we have removed the requirement that 3mm proposals must include a team member with 3mm ATCA experience. At the same time, proposals to use arrays more extended than H214 have been asked to provide a specific justification on technical feasibility and scientific value of using an “extended” array.

#### **Advice sought**

- ATUC is invited to consider the list of polishing tasks, and to give feedback on issues that will improve system performance and scientific usefulness of the 3mm systems. Prioritisation of items would be useful.
- More broadly, ATUC is invited to make suggestions on how to best exploit the 3mm systems and to maximise the quality of science produced by them.

## Appendix: 3mm polishing tasks

### Task

#### Antenna optics

CA01 subreflector  
CA02-CA05 subreflector  
Focus

#### Subreflector actuation

Project review

#### Receivers

Investigate possible compression problems

#### Correlator and IF Filters

2nd pair of 16 MHz filters  
New correlator configurations

#### System temperature and sensitivity

Upper sideband characterisation  
Hot/cold system temperature measurements, and assess discrepancy between Epping and on-sky system temperature values.  
Evaluate accuracy/consistency of paddle Tsys  
Characterise CA04-B, CA04-D performance near 88GHz  
Investigate "drop-outs" in "Gain" plot of 27-Sep  
Investigate oscillatory gain of CA05  
Gain/elevation curves  
Bandpass stability

#### System phase and baselines

Phase noise in LO system  
Investigate sharp amplitude drop-outs in poor weather  
Baseline calibration software  
Baseline calibration and frequency dependence

#### Pointing

Improved pointing model at 3mm  
Assess the accuracy of reference pointing as a function of distance to the pointing calibrator  
Comparison between 3mm, 12mm and 3cm pointing  
Evaluate pointing in windy conditions

#### On-line software

Pointing tracks planets  
"CACAL" table differentiation of settings includes L86 frequency  
Improved CATAG

#### Off-line software

Calibrator duty cycle tool (web)  
Velocity to frequency calculator (web)  
Miscellaneous improvements to atlod, uvsplit, gpboot, uvplt (Miriad)  
Improved algorithm for applying Tsys in atfix (Miriad)

Baseline-based calibration solutions to account for atmospheric decorrelation (Miriad)

**Atmospheric monitoring**

Evaluate seeing monitor data - compare models with measurements

Evaluate the WVR as an opacity meter

**Calibrators**

Improve calibrator grid

Improved characterisation of calibrators at 3mm

Flux monitoring

**Bigger questions**

Turret roller precision

Phase switching for sideband rejection

Subreflector actuation

Finer frequency setting

Front-end power equalisation