ATNF ATUC Memorandum

To: ATUC
From: Tasso Tzioumis
Date: 25 November 2004
Subject: **VLBI report - LBA Operations & eVLBI**

1) Observing

No VLBI session was scheduled during the winter term, to maximise the time available to mm observations at the ATCA and Mopra. The main VLBI session in the last 6 months was Nov 15-21, and there were no major problems reported from any observatory.

The main VLBI system remains the S2 tape-based recording system and the LBA correlator at ATNF. However, about 15% of the time was allocated to the new eVLBI disk-based systems, both for technical tests and test observations. Correlation is done in software at Swinburne.

2) Correlation and data checking

The backlog of correlations has been minimised and only a few old observations that require special provisions at the correlator remain unprocessed. However, there is a substantial backlog of tapes that PIs have not yet released.

Most observations are now correlated by the "correlator operator" in consultation with the PI, mainly via email. The operator has been appointed to a 3-day per week term position.

The correlator operator has been trained to do some preliminary data analysis in AIPS, similar to the VLBA's "data quality analysts". Thus we can now offer preliminary data processing and checking and the results are made available to the PIs on our ftp site. This has facilitated much faster turnaround of the tapes and better service to observers.

The next step is to progress the analysis further into fringe-fitting and calibration. The aim is to provide the PIs with a dataset that they can then process further without any special VLBI tools. This will be possible for most continuum observations but limited for spectral-line and pulsar observations.

3) VLBI webpages

ATUC requested an upgrade of the VLBI web pages, especially of the most critical pages for observing. An upgrade is in progress. The pages of telescope parameters have been updated and the status of active proposals is available. A list of "standard" observing modes is being compiled and standard setup files for SCHED are available, For special observations, PIs are encouraged to contact the VLBI group for assistance. A more extensive webpage update is planned.

4) eVLBI - Fast network connections

The network connections to the telescopes are planned as part of the AARNET3 Regional Network. Progress in this area has been slower than originally suggested by AARNET and CSIRO IT. The last mile connections were to be completed before the end of 2004 but have been delayed into 2005

with no guaranteed timelines.

AARNET3 has issued a Request-for-Tenders for the fibre connections to all AARNET3 sites including the ATNF antennas. The tender closes at the end of November 2004 and the estimated completion time is 3-6 months, but with no guarantees.

It has been decided that 10 Gbps connections will be provided but the tender for the network equipment has not been finalised yet.

ATNF is also lobbying within CSIRO to give the network connectivity higher priority.

The University of Tasmania has gained an ARC grant to upgrade the connections to the Hobart telescope using optical fibres, which will greatly improve connectivity.

5) ATNF eVLBI project

The first part of the eVLBI project has been approved within ATNF, aiming to provide 500 Mbps operation by mid-2005. The full eVLBI proposal was presented to ATUC at its last meeting. As suggested by ATUC, phase C (LBA real-time correlation) has been dropped.

The focus of the eVLBI project up to this stage has been to equip the LBA antennas for direct network connections. The first step is to develop and implement the data interfaces from the telescope to the network.

In the absence of fast network connections, the interfaces have been developed for writing directly to disks. The disk systems provide a buffer for the slow networks and a tool for the development of the necessary hardware and software.

Progress to date:

- All LBA antennas have been equipped with VSIC/VSIB interfaces. These were developed in Finland for the EVN and enable direct writing to disks at 512 Mbps. Higher rates may be achieved by using multiple interfaces. These systems are relatively inexpensive (~$2k + cost of computer).
- All LBA antennas have been tested at 256 Mbps using the current LBA DAS as the interface to the telescope systems.
- The ATNF antennas have been equipped with 2 DAS systems each and have been tested successfully at 512 Mbps.
- Tests have been initiated to achieve 512 Mbps for a single DAS. This will enable 512 Mbps operation at all LBA antennas and 1 Gbps operation at the ATNF antennas.

A review of the eVLBI project will be conducted in mid-2005 before implementing any further plans.

6) Software correlators

Swinburne University of Technology has led the software correlator part of eVLBI. The Swinburne computer cluster has been used to correlate the disk VLBI data. Correlation of 6-stations (15 baselines) has been achieved and

development continues.

The software correlator is a critical part of the eVLBI effort and will be the only VLBI correlator for the disk-based system. It will also be the LBA correlator for high data rates until the new correlator at Narrabri comes online in about 3 years.

It should be noted that software correlators are currently much slower than real time. Only limited observations can be supported. The storage of the raw data on disks would also be a significant cost.

A collaboration is underway between Swinburne, UWA & ATNF to develop much faster software correlators. Grants have been obtained from the WA government and Cray computing and the project has commenced.

7) Real-time fringe testing

The disk eVLBI capabilities and the software correlator have made possible for the first time the "near real-time" detection of fringes from all VLBI antennas. Using the present systems in the November 2004 VLBI session, fringes were detected to all LBA antennas within minutes.

Data is recorded on disk and a small amount (~0.1 sec) is transferred via the (slow) ftp connections to Swinburne, correlated and posted on the web. The main bottleneck is the very slow connections to many telescopes such as Hobart (modem) and Mopra.

The current LBA record stands at 31 seconds from photon to fringe!

The plan for the LBA is to further automate this process and operate it as part of the routine observational checks for all LBA observations. It will become much easier when the fast network connections become available. However, it is considered an indispensable tool to increase VLBI network reliability.

8) VLBI tracking of the Huygen's probe

A proposal has been approved to use the LBA antennas to track the descent of the Huygen's probe into Titan. The probe will be launched from the Cassini spacecraft and the descent will take place on 14 January 2005. The VLBI tracking will enable the precise determination of the probe's position. Coupled with Doppler tracking, it will provide a precise 3-D position of the probe in Titan's atmosphere and greatly enhance the science return.

This tracking will utilise telescopes in the USA, Asia and Australia and it will be entirely recorded on disks. It has become possible only because of the recent eVLBI developments. Parkes and Mopra from ATNF will track the probe and background sources, and the ATCA will track only the background sources. Hobart and Ceduna will also record on disks using Mk5 at Hobart and the LBA eVLBI system at Ceduna.

The Huygen's probe will be transmitting in the 2050 MHz band, which is not a frequency usually supported at most radio telescopes. Special equipment (filters and IF converters) had to be built for Mopra and Parkes, at a cost of ~$40k paid by ESA. Hobart and Ceduna receivers were also modified to tune to this frequency.

The data rate required is 512 Mbps and this has been achieved at all LBA

participating telescopes. On November 17, 2004 a “dress-rehearsal” observation was conducted with all antennas, which recorded a special tone transmitted by Cassini. All Australian antennas reported successful observations and the disks have been shipped to JIVE for correlation.

9) ESA’s New Norcia Antenna

ESA operates a new 35-m antenna at New Norcia, 100km N-NE of Perth, in support of space missions. It is technically possible to use this antenna for VLBI at the 12 and 3 cm bands, but the VLBI equipment must be provided.

In September 2004, we held discussions with the ESA operations team at Darmstadt, Germany. They became very interested in the VLBI operations, especially in the possibility of spacecraft tracking using eVLBI, as demonstrated by the Huygen’s project.

The ESA funded equipment to be used for the Huygen’s tracking at Mopra can also be used at New Norcia with minimal modifications. The cost of this project would be less than $20k.

It is proposed that ATNF continues working with ESA to demonstrate VLBI operations at New Norcia in 2005.
*** ATUC may want to comment on the desirability of including New Norcia in the VLBI network.*

10) VLBI Operations and Planning meeting

A meeting of the LBA network participants is being planned for 1-4 February 2005, at the University of Tasmania, Hobart. The aim is to review LBA operations and consider plans for the future of the LBA network. Progress and plans for eVLBI will be considered in detail, both technical and operational aspects. An announcement and program details will be circulated shortly. This is an open meeting and anyone interest should contact the vlbi group.

11) International eVLBI workshop

The 3rd eVLBI workshop was held in Japan in October 2004. The previous two workshops were held in the USA and Europe respectively. ATNF offered to host the 4th eVLBI workshop in Sydney, 12-15 July 2005 and this has been accepted. About 30-50 international participants are expected. Details will be available in due course.

12) eVLBI observations

The 1st phase of the eVLBI project would be completed by mid-2005. Limited operations would then be possible, either with the disk-based systems or the fast networks if they are available. Correlation would be done on software correlators developed by Swinburne.

We plan to offer such limited observations to the user community in the next ATNF call for proposals. Projects that have special requirements (wide bandwidths, software correlation) would be given priority.