Attd. 4

CSIRO DIVISION OF RADIOPHYSICS
THE AUSTRALIAN TELESCOPE

AT/20.1.1/051
GJN
24 February 88

Report to the 15th meeting of the Australia Telescope Advisory Committee.

Systems Overview

Site Works

All 22 KV and 415 V power supply cables to the 3 km array have been laid.

Local oscillator coaxial cable, IF optical and fibres and multicore comunication cables for the 3 km array are also in place although considerable work is yet required to terminate them in connectors at the 35 stations.

No decision has yet been made on the medium for LO and IF transmission to and from the 6 km site. It is quite likely however that monomode optical fibre will be used in both applications. Problems introduced by the need for reliable connectors on the 3 km array do not arise in this case.

Most of the 3 km track has now undergone ~100 antenna passes and an average settlement of ~2 cm has occured. The track was initially set 1 cm high and is therefore 1 cm low at the present. Some tilting of the sleepers has also occured. These effects are currently being rectified under the original contract. Subsequent settlement should be much less.

Some erosion has occured on the banks of the track and an extensive grass planting program has been undertaken to control this.

Problems have been encountered in locating the tying down pins of the antennas at the stations. The locations of the track and stations are currently being re surveyed. This will establish whether a simple adjustment of the track position at each station will be sufficient to rectify the problem. If not, a more basic change will have to be made to the antenna tie down arrangements.

All antennas have now been handed over but a large number of mostly minor problems remain to be rectified. The measured surface accuracy is better than 0.2 mm RMS.

Fitting out of the antennas with CSIRO supplied equipment has begun.

(a) #4 and 5 have prototype servo controllers.

(b) #1, 4 and part 3 have cryogenic piping.

(c) All have L/S feeds.

(d) #5 is fitted out with a 12 GHz receiver for pointing and focussing tests on AUSSAT and methanol maser sources. it can also be used as a 500 MHz wide continium receiver with noise adding for gain stability.

(e) #5 is also fitted with TV camera and CCD array for optical pointing tests.

(f) #4 has tiltmeters for investigation of thermal, wind and gravitational deformation effects.

(g) Uninteruptable power supplies are installed in #3 and 4.

Antenna Performance

Initial observations of bright stars using optical telescopes mounted on one of the quadruped legs of #5 were used to test the antenna pointing model developed by M. Kesteven and M. Calabretta. The resolution of the observations was ~5 arc sec and the model fit resulted in residual of ~7 arc sec after several hours of observations. After larger periods of observation however the residual became more (~18 arc sec). This led to the discovery of very large thermal effects in the antenna pointing. The investigation and correction of these effects must obviously precede any further work on the pointing model. Our current understanding of these thermal problems is the subject of a separate report.

Observations using the AUSSAT receiver have been used to focus the subreflector on antenna #5 (both radically and transversely). Insufficient lateral movement had been allowed for in the original design but a suitable modification will correct this. The first side lobes were equalised to within 0.2 dB and the first null was ~#32 dB down on the main beam.

Feed sand Polarizers

All L/S and C/X feeds are now complete. A new quad-ridged polarizer design has now been adopted. It is less massive than the "F" shaped design and will allow the use of a smaller diameter Dewar for the L/S receiver. Being symetrical it should result in better orthogonality between polarizations resulting in good interferometer cross-polarization performance. The prototype C/X model had acceptable loss and matching but both of these should be better on the production models.

The method of construction should result in lower insertion loss. The design of the coupling probe will be optimized on the large L/S model and then later scaled to C/X. This will result in better matching than acheived in the C/X prototype.

Receivers

As a result of experience with the protype receiver at Parkes it was decided to increase from 3 to 4 the number of stages in the X band LNA and later to replace the first 2 stages with HEMT 6. A significant improvement in performance has resulted.

The first of RF and conversion modules are now complete and wired into their final rack.

One complete channel from LNA to IF digitizer is undergoing system tests. (Only 27 to go.)

Narrowband backend

Local Oscillator and IF Data Transmission

As mentioned before a single coaxial cable for transferring the LO reference to each station and 4 multimode optical fibres per station for digital IF transmission are in place. Optical fibre connectors which each cater for 4 fibres are on order and should arrive shortly.

One complete front end LO channel is available for system testing. It can drive 2 RF/conversion channels but separate phase and delay rotations for 2 IF channels are not yet available.

No work has been done to date on the narrowband backend LO system.

For the LBA a 4.8 m dish has been installed at Epping and tests are about to commence to evaluate the different methods of LO transfer via AUSSAT. The favoured scheme involves transmitting a pair of tones separated in frequency by 250 MHz from the remote station to Culgoora. The 250 MHz tone is subtracted from a reference 500 MHz tone and the resulting 250 MHz tone transmitted back to the remote station, again as a difference between a pair of tones at spacecraft frequencies. The resulting signal is effectively locked to the reference standard. Thus all sites remain phase related and no time defendent corrections are required. The generation of synchronizing code on the data is also made possible by this procedure.

The VLBA DAS recorders are still the favoured medium for transmitting IF data from the remote stations to the correlator. Delays in production and cost increases sway as yet cause us problems in this area.

Correlators

Fairly complete tests of the correlator system have now been carried out.

If data was sampled by 2 separate samplers and synchronizing code added. The two streams are transmitted along separate optical fibres and delay lines to the correlator which was under the control of an 11/21 block control computer and event generators. The output from the correlator block was then transferred to the correlator control computer and array processor and the processed data output to the VAX.

Synchronizing worked well and error rates better than 1 in 10^9 were achieved over 500 m of fibre. Communication between the various computers marked well and the final output spectra behaved as expected.

Computers

The 11/73 antenna control computers are currently controlling two antennas at Culgoora and one at Alice Springs. The one in antenna #5 at Culgoora is under the control of a N VAX II which simulates the operation of the synchronous central computer. It in turn controls the position control computer. Communications between these computers and the SWEO controller is working well.

The VAX 8250 synchronous and assynchronous computers are currently installed at Epping. Apart from relieving the congestion on the Divisions computers this allowing AT system evaluation and program development. They will be moved to Culgoora in time for the official opening in August, by which time the much larger AT off line processor will be in place to meet Divisional needs. In the meantime the N VAX intended for correlator and antenna control at Siding Spring will be used at Culgoora for interferometer testing.

An order has been placed for a Convex C2 computer for off line processing. A C1 will be in place soon and will be replaced by a C2 in midway.

There is some doubt now whether optical discs will become sufficiently cheap to be used as the archival medium for the AT. VHS tapes are certainly a possiblity now. No decision needs to be made for several years yet by which time the situation will be clearer.

System Testing

As mentioned above important areas of system testing have already taken place within and between the correlator and computer groups. It is also planned that an overall system test will be performed before equipment transported to Culgoora for the first interferometer tests. So this end a C/X Dewar, an RF/conversion rack and an LO rack have been located in Room 200. Testing at the moment involves identifying and removing LO "birdies" from the IF.

After our best efforts in this area we will decide whether $0^0/180^0$ phase switching is required to further reduce interference coupled within the circuitry. Similarly the level of interference coupled via the feed will determine the degree of RF shielding needed in the vertex rooms of the antennas.

At present a spectrum analyser is in use for detecting birdies. The prototype correlator is also being used and allows a more sensitive search to be undertaken. Interference produced by the sampler can also be investigated when using the prototype correlator.

The ultimate test involving transmitting the sampled data via optical fibre to the production correlator will then be carried out. As described earlier this part of the test has already been carried out within the correlator and computer groups. Only the question of synchronizing operations at two widely separated sites remains to be tested.

Interferometer Tests at Culgoora

Two antennas at Culgoora are now fitted out with servo controllers and are in principle available for interforometer tests. It will however be some time yet before two additional receiver systems are available to enable these tests to take place.

In the interim these antennas are being used for tests of antenna performance (pointing, thermal etc.)

Three stations have been prepared with additional cables and will be the first to have completed wiring. Baselines of 30, 235 and 265 m will be available.

LBA

With work on the CA system only about 60% complete not much attention is currently being given to the LBA. LO transfer via AUSSAT and data transfer via VLBA tapes were discussed above. Ray Norris has recently produced a review of the LBA status indicating the magnitude of the task ahead. Very little of this work can be commenced this year or even I suspect next year. He discusses the interesting possiblity of using Mk II technology in the interim, possibly in conjunction with the independent and recently formed Australian VLBI Foundation.

G.J. NELSON & M.J. KESTEVEN