Test Memo 225

VLA Wideband Tests of June 7,2001

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1. Closure and Editing.

a) Closure.

The first scan, on 3C48, was taken in the standard 50 MHz configuration in order to set the gain, and should have been fine. Instead, IF A had extensive closure errors (peak 250%,174 degrees). Inspection showed large phase gradients, attaining rates of four cycles in 8 minutes on correlator 1-17. Apparently the fluke was not initialized correctly. The problem corrected itself by the next scan.

There were closure errors on antennas 24 and 28 for sources 0319+415.T and 0319+415.WT, as expected, since these were observed with the delays deliberately in error.

There were no other closure errors (amplitude >5%,phase >5 degrees) at 50 MHz, and the average closure errors were less than the reporting limits of 0.5% and 0.5 degrees in all cases.

At 70 MHz the data were much better behaved than in the past, with only 2 closure errors reported in all of the correlators for three calibrator observations. However, the average closure errors were higher than at 50 MHz. IF A,C, and D all exceeded the reporting levels on all three scans, and had typical values of 0.6% and 0.25 degrees. Only IF B was consistently below the limits 0.5% and 0.5 degrees.

b) Editing.

A number of "first records" had to be edited out. Particularly bothersome were first records on the scans made with the delays altered for antennas 24 and 28, because the amplitudes were very high, as if the delays had not yet kicked in properly.

As in the past, a preliminary map made of the blank field at 70 MHz showed the presence of excess noise which was quickly found to arise in Antenna 8, IF#1, L, ie IF C. This is the same problem which was present in the data from March. The data for 8C were edited out of all of the 70 MHz observations.

Antenna 7 shows raw amplitudes that are high by about 50%, on all correlators. It is corrected satisfactorily in the calibration, so no editing was needed.

Antenna 18 behaved erratically during the second scan on BLANK50, the 50 MHz configuration, times 0/22:40:53-0/23:06:27. Most of the data were missing, presumably flagged on-line, and the remaining data had amplitudes in excess of 1 Jy on this blank field. All IF's on antenna 18 were edited out for this scan.

2. Experiment to explore possible differences in the digitizers in the samplers.

B. Clark suggested that it might be worth looking at a strong calibrator with the position offset a little so that the phase rolls along. A plot of amplitude versus phase is sensitive to a time difference between the cosine and sine digitizers in the samplers.

We made an observation of 3C84 in the usual configuration at 50 MHz, followed immediately by an observation in which the position of 3C84 (3C84OFF) was displaced to the north by 10.0 arcseconds. A plot of all of the data for IF A shows that (Figure 1a) the phases are distributed over 360 degrees, and that the amplitude shows a hint of structure. A similar plot for the standard observation shows the (Figure 1b) expected concentration in phase, with apparently a smaller dispersion in amplitude.

Inspection of individual baselines shows that many have no systematic variation of amplitude with phase. An example is baseline 2-13. Some show a distinct gradient in the data for 3C84OFF, but not for the corresponding data for 3C84. Examples are baseline 9-13, Figure 2a, gradient -7.1 degrees per 100 mJy (~ 5% of the total amplitude) with a correlation of -0.65, and baseline 25-27, Figure 2b, gradient 7.6 degrees per 100 mJy, correlation of +0.64. A number show gradients in both data bases. One curious example is baseline 1-16, showing no pattern for 3C84OFF and a systematic variation for 3C84. Also notable is baseline 2-15, showing a truly intricate dependency between amplitude and phase for 3C84OFF (Figure 3). This pattern is not seen in the data for this baseline in the other IF's. I did find a similar pattern in the LL correlators (IF's C and D) of baseline 21-22 in the scan 0319+415.WT, a 70 MHz observation of 3C84 made with offsets in the delays for antennas 24 and 28 (Figure 4).

The analysis was made on IF A, since it was expected that any problems would appear there most clearly. However, plots of all data for the other three IF's show that the results are very similar, and that in general no one IF is significantly poorer than the others.

3. Experiment to explore the effective bandwidth of the modified system.

B. Clark suggested that the amplitude modulation might be increased if the delay on the relevant baseline was offset to half power. In this experiment we offset the delays on antennas 24 and 28 to half power. These antennas were chosen because they appeared to show reliable modulation during an observation made June 1.

We observed 3C84 in the 50 MHz configuration with the modified delay file (0319+415.T), and in the 70 MHz configuration (0319+415.WT). We also observed 3C84 with the usual delay file(s), at 50 MHz (0319+415) and at 70 MHz(0319+415.W). Each observation lasted about 10 minutes.

This experiment failed to produce conclusive results. In part this is because the performance of the 70 MHz system was much improved over that seen in March, so the modulation effects were much more subtle, or missing completely. In part we had very bad luck, in that

the control scan at 70 MHz (0319+415.W) was marred by a decrease in amplitude of 3-5 % which lasted about one minute and affected all correlators and IF's. This instability tends to mask the weak periodic modulation in amplitude.

There were no baselines involving antenna 28 which had clean modulation. A few baselines involving antenna 24 showed modulation, and the relative amplitude of the modulation was greater when the delays were offset. Using IF A, the IF for which the modulation is seen most clearly, the results on the "best' three baselines are given in the following table.

Baseline	0319+415.W				0319+415.WT			
	No. Cycles Obs	Period sec	Amplitude p-p Jy	%	No. Cycles Obs	Period sec	Amplitude p-p Jy	%
24-02	3	89	0.71	4	5	81	0.51	25
24-18	2	130	0.98	6	3	130	0.41	17
24-23	1	170	0.72	4	3	156	0.48	11

In these cases the effect is in the expected sense. But there are so few examples that the result is not conclusive.

Operating with the delays offset also produced a strange result of a different kind. Figure 5 shows the plot of amplitude against time for IF D (LL, IF#2) on baseline 24-21 showing a pattern of variation. A similar pattern is present in the data for IF's B and C, but not for IF A. Perhaps we are seeing individual delays switching in, but I haven't checked this by calculating the rate at which delays are being switched in this case. Note also that the fringe amplitude is low compared to the value 3-5 Jy seen on other baselines. A pattern similar to this is seen on baselines 24-4 and 24-10, so it is more widespread than simply one antenna pair.

4. Tests of sensitivity.

We made observations of the blank field as we did in the past, to see if the individual correlators attain the expected sensitivity, and to see if the data integrate down properly. For this report I have looked only at the rms in the map using the entire data base, since it appears that the data do indeed integrate down quite well.

At 50 MHz (BLANK50):
The rms in 3 seconds on an individual correlator was found to be 22.4 mJy, and was of essentially the same value for all IF's. The expected value is 22.2 mJy. For comparison, the data for 20010322 (my report of May 4,2001) gave 22.7 mJy for IF's A and C, and 22.1 mJy for IF's B and D.

The rms in Stokes V is observed to be 16.0 mJy, compared to the expected value of 15.7 mJy.

I made a naturally-weighted map in Stokes V using 595632 visibilities. The map is 1024 x 1024, with pixels 0.4 arcsec. The restoring beam is 3.07 x 2.22 arcsec, and the map peaks are -103 and +95 microJy.

The map looked OK, but does have faint residual structure in it, suggesting that the data may not be completely clean. The rms in the central one-quarter of the map (512 x 512) is 20.8 microJy, compared to the expected value of 20.7 microJy.

At 70 MHz (BLANK70.W):
The rms in 3 seconds on an individual correlator was found to be 19.4 mJy for IF A, and was 18.7 mJy for B, C, and D. The expected value is 18.8 mJy. For comparison, the data for 20010322 (my report of May 4,2001) gave 22.4 mJy for IF A, and 19.1 mJy for IF's B, C and D. Thus IF A has improved considerably, though it has not yet reached equality with the other three IF's. IF's B, C

and D are comparable with, or perhaps slightly improved over the earlier observations.

The rms in Stokes V is observed to be 13.0 mJy, compared to the expected value of 13.3 mJy.

I made a naturally-weighted map in Stokes V using 519095 visibilities. The map is 1024 x 1024, with pixels 0.4 arcsec. The restoring beam is 2.54 x 1.90 arcsec, and the peaks on the map are -104 and +101 microJy. The map looked OK, but does have faint residual structure in it, suggesting that the data may not be completely clean. The rms in the central one-quarter of the map (512 x 512) is 19.0 microJy, compared to the expected value of 18.0 microJy. Thus the 70 MHz map does have lower noise than the 50 MHz map, though the improvement is somewhat less than expected.

5. Summary

The 70 MHz system is much closer to being usable than it was in the earlier tests in March. IF A still shows a higher rms than do the other IF's, but by only 4%. Antenna 8, IF C continues to have correlated noise which ruins the map of a weak source. But in the end, the map of a blank field achieved a lower rms than did the map made with the VLA in the standard configuration.

The two tests produced inconclusive results although there may be enough information from them to help identify hardware problems. A couple of anomalies were found which may point to low-level problems with the system.