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June 23, 1992

To: VLBA Test Group.
From: Craig Walker
Subject: Phase Cal Variations.

This memo gives some recent results relating to the phase cal variations reported in VLBA Test Memo No. 32. Most of the discussion concerns Los Alamos.

Much of Durga Bagri's testing of the phase cal variations was confused by what appeared to be 3 effects. There is a temperature sensitivity that clearly tracks the C rack temperature, there were strong drifts with time, and there were dropouts with no good signal. Also, the phase seemed to jump when it shouldn't, such as when the bandwidth was changed or the track assignment was changed. The temperature sensitivity is still very clearly there. The drifts and dropouts don't seem to be there now. I suspect that improved software and monitoring are as much responsible as anything. I have not tested for the jumps at bandwidth changes, although there are no jumps at track assignment changes.

On May 21, 1992, Durga recorded a tape with phase cal data and at the same time monitored the phase cals with the local monitoring system. Alan Rogers used the Haystack correlator to measure the phase cal tones off the tape. During this test, the temperature of the C rack was not oscillating. However there was a temperature jump at about 21 hours UT that could be used to check the temperature effects. Figure 1 shows the C rack temperature during the test. Figure 2 shows the phase cal phase as detected at Los Alamos. There is a clear phase jump at the time of the temperature jump. Following Figure 2, a memo from Alan Rogers reporting the results from Haystack for the time of the jump is attached. The magnitude of both the drifts and of the jump are about the same as in the locally detected data. The sign is opposite, for reasons that I have not attempted to determine yet. Prior to this test, we were not sure that the local detectors were not having a problem. It looks like they are working.

Tests by Durga and Paul Johnson at Los Alamos identified a temperature sensitivity in the 5 MHz distributer in the C rack. Additional tests by Larry Beno at the AOC identified a temperature sensitivity in the 5 MHz distributer in a maser at the AOC. The sum of the two sensitivities looked about right to account for the effect seen at Los Alamos with about 2/3 of the total being from the maser. The maser tests also showed a temperature sensitivity of the 100 MHz output from the maser that was about 4 times smaller than that seen in the 5 MHz output. Larry Beno was able to reduce the temperature sensitivity of the maser 5 MHz distributer by over an order of magnitude and before June 20, the unit at Los Alamos was replaced with one that had been modified.

On June 3 and on June 20, test data was taken at several VLBA sites. No tapes were recorded. Thanks to the maser modification, a much reduced temperature sensitivity was expected at Los Alamos. Instead, the sensitivity seems to have increased from about 45 degrees of phase in a 4cm channel per degree C in the C rack to about 59 degrees of phase per degree C. The June 20 phase cal amplitude and phase data for LA are shown in Figure 3. The temperatures in the C rack, the D rack, the recorder, room 104 (the room containing the maser, the C rack and the D rack), the vertex room, outside and dew point outside plus the cable cal measurement are shown in Figures 4a-4h.

Note that the C rack and the recorder show strong temperature oscillations between 12 and 18 hr and between 28 and 32 hr which are strongly correlated with the phase cal variations. The D rack, on the other hand, shows variations at about the same level at all times. It doesn't seem to have the 2 different states seen in the C rack. It is also nearly 10 deg C warmer so the devices in the rack may be smoothing the temperature while raising it.

The Room 104 temperature does not show the oscillations and is significantly warmer than the C rack. This is the temperature that the maser is likely to feel, so perhaps the reason that the maser modification did not help is because the room temperature does not oscillate and therefore the 5 MHz distributer in the maser was not the source of the phase variations in the past.

Note that the dew point is higher than the outside temperature between 23 and 29 hr. This probably indicates that the chilled mirror was dirty. The large drop at about 29 hr corresponds to a missing monitor point and is probably when the self cleaning cycle occured. We have seen this sort of thing before and something should be done about it, but it is probably not related to the phase cal problems that are the subject of this memo.

Figure 5 shows the amplitude and phase for a 13 cm channel. The ratio of the oscillations at 4 cm and 13 cm is about 2.8. The ratio of the RF observing frequencies is 3.6 while the ratio of the first LOs is 2.6. Evidence of this sort is what made Durga originally suspect the 500 MHz signal sent to the vertex room to which the first LOs are locked. However if that signal is stable while everything else varies, you might see the same thing and this would be the case if the 5 MHz is varying (the phase cal generator and the BBC's are locked to the 5 MHz).

Figure 6 shows the phase cal amplitude and phase for a 4 cm channel at Fort Davis on June 20 while Figure 7 shows the C rack temperature at that site. As before, there is almost no correlation and the phase cal phases are very steady. Whatever is causing the problem at other sites is not happening at Fort Davis. Note that the maser at Fort Davis is the one that was tested for environmental effects at JPL early in the project.

Additional data that is not included shows that the temperature oscillations in the C rack occur at most if not all sites. The phase cal phases show at least some sensitivity to these oscillations at at least LA, PT, KP, and OV which are the only other sites besides FD that have phase cal generators.

The new NRAO phase cal generator that runs off the 500 MHz LO reference which in turn is derived from the 100 MHz maser output is installed at PT. I do not yet have good data from it do to confusion about setting it to the right frequency.

We are still trying to understand the source of the phase cal variations. The prime suspect at the moment is 5 MHz distributer in the C rack, but that is not firmly established.

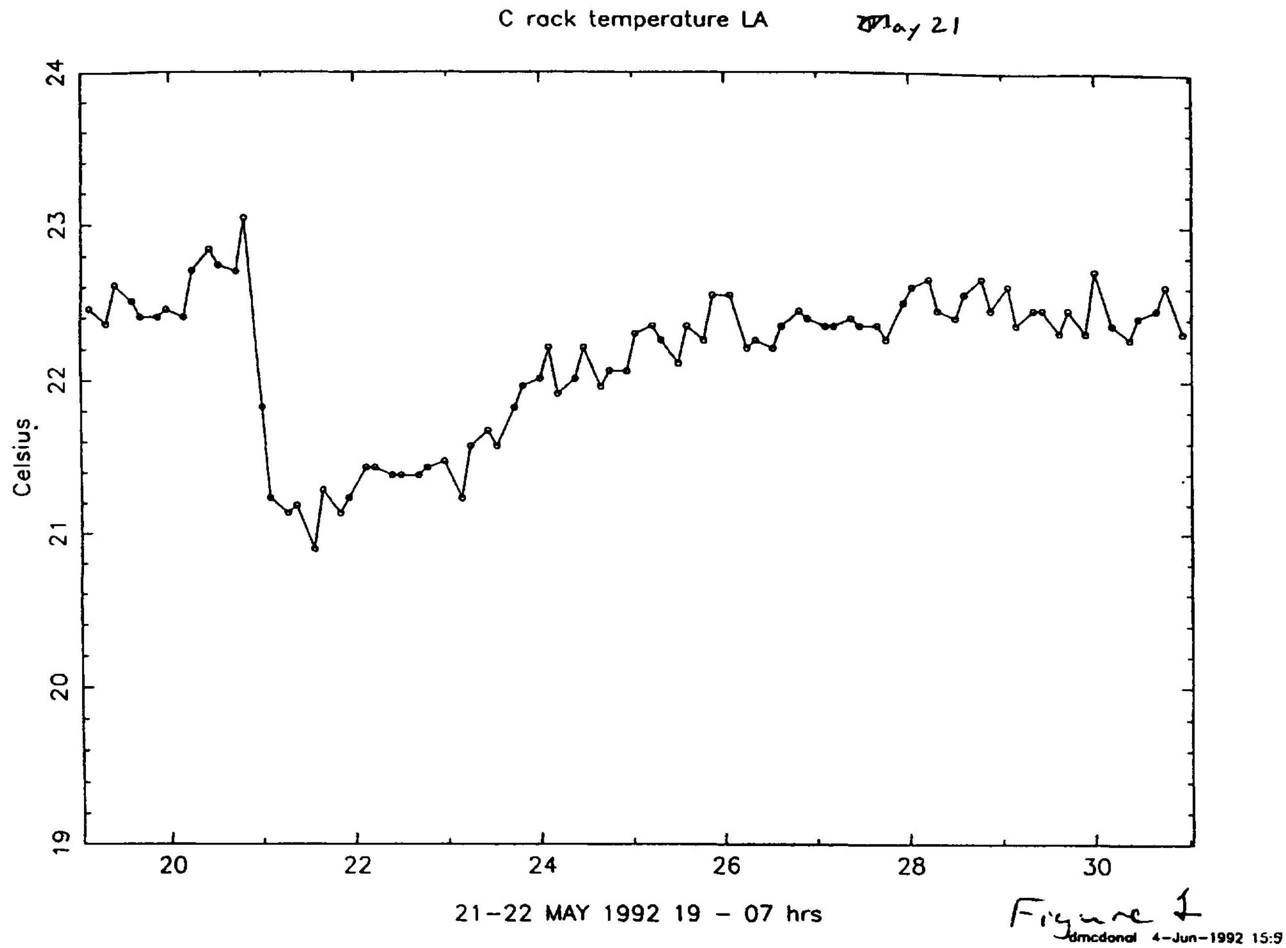


Figure 1

LA PCAL Phase Channel 1 /pingora/pointing/may92/may21pcal.dat

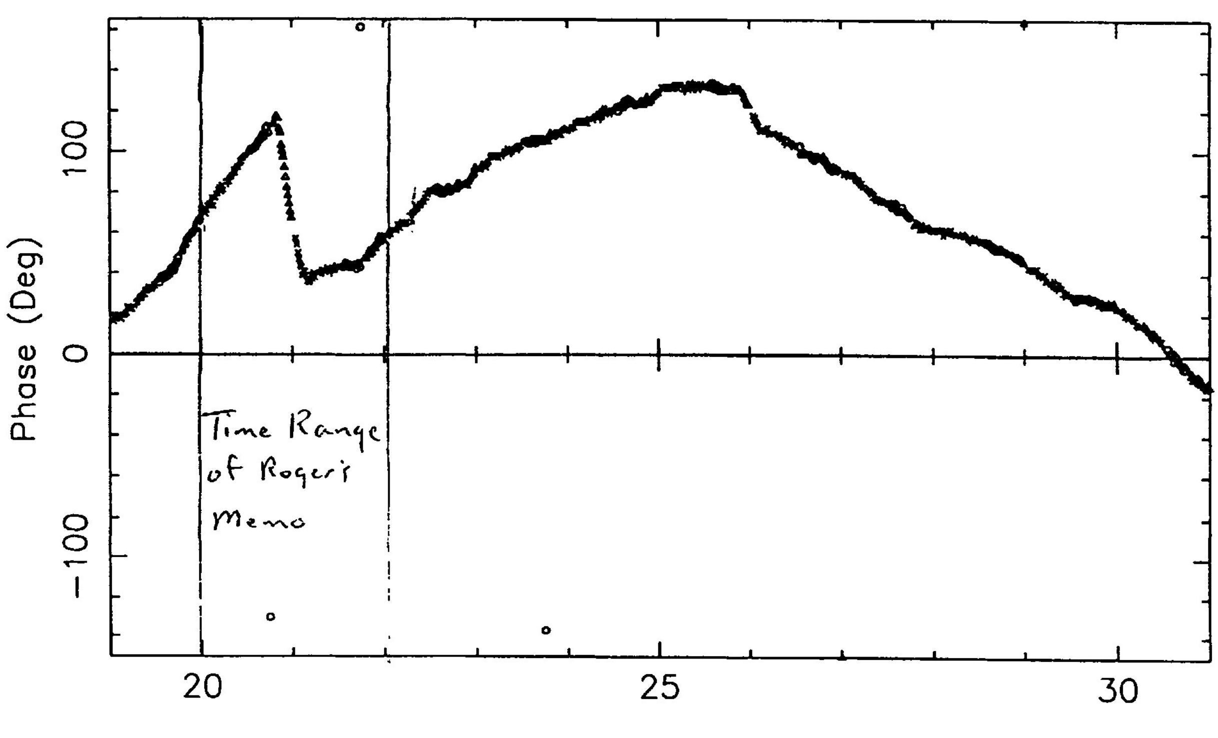


Figure 2

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

22 June 1992

Telephone: 508-692-4764
Fax: 617-981-0590

TO: VLBA Tests

FROM: Alan E.E. Rogers

SUBJECT: Los Alamos pcal phases from tape for 21 May 92 20-22 hours

Figure 1 shows a rough plot of phase cal phases taken from the fringe printouts. It is evident that a temperature event starts at about 2052 ut. If I look at the average pcal phases for the 2045 (centered at 2050) scan and the following scan at 2100 (centered at 2105) I get the following:

	Phase		Phase change
Ch #	2050	2105	2105-2050
1	-109.3	-44.6	64.7
2	-71.6	-5.4	66.2
3	26.5	5.4	-21.1
4	32.5	12.4	-20.1
5	132.3	-160.5	67.2
6	93.5	161.3	67.8
7	-132.1	-62.2	69.9

Apparent phase delay change at S-band 25 ps (ch. 3 & 4)
Apparent phase delay change at X-band 22 ps (ch. 5 & 6)
Apparent group delay change 34 ps (ch. 1 & 7)
Apparent group delay change 8 ps (ch. 2 & 5)

The apparent change in group delay is not very well determined so it is hard to distinguish between variations in the phase calibrator (which produces equal changes in phase and group delay) and other parts of the system.

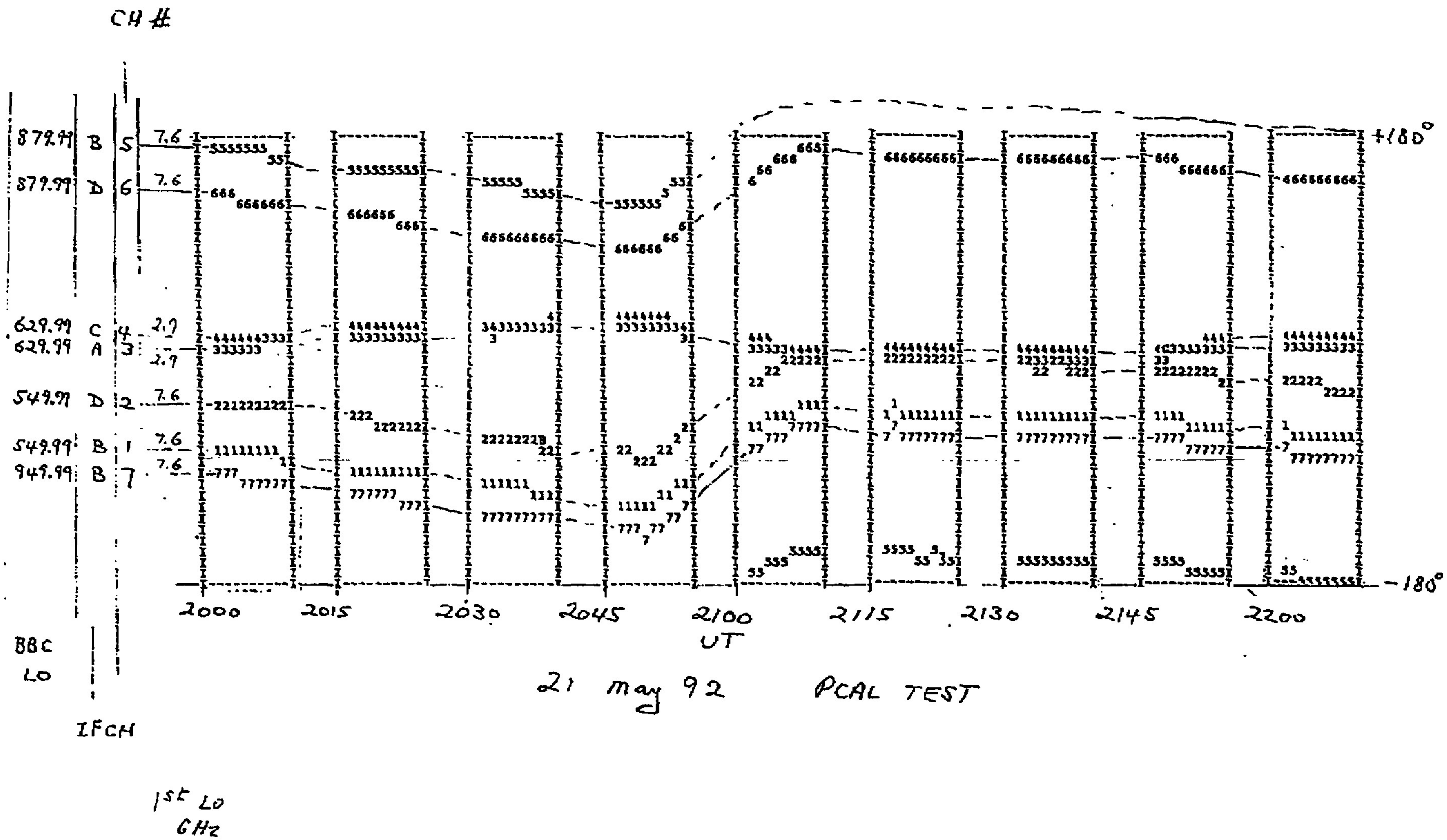
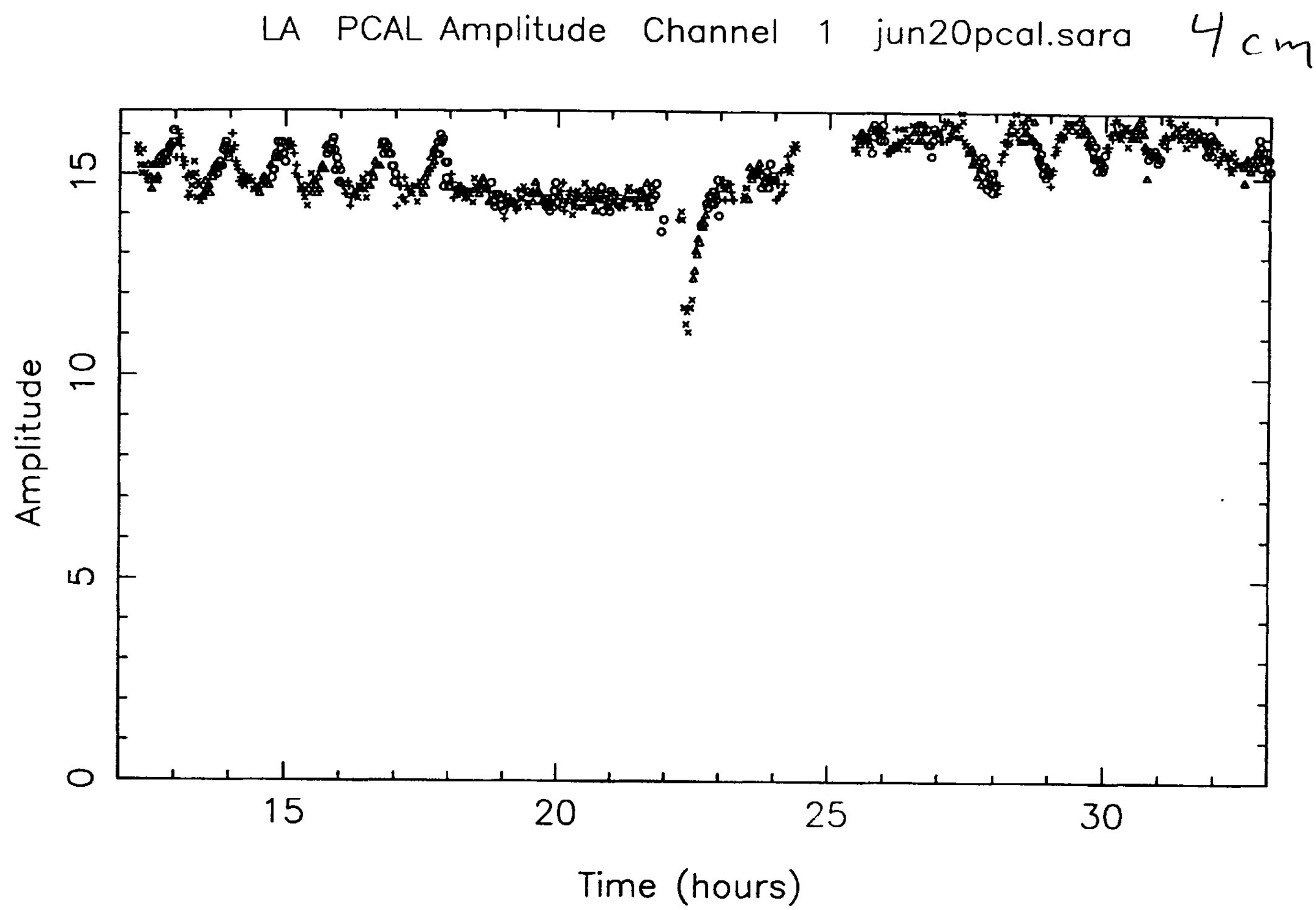
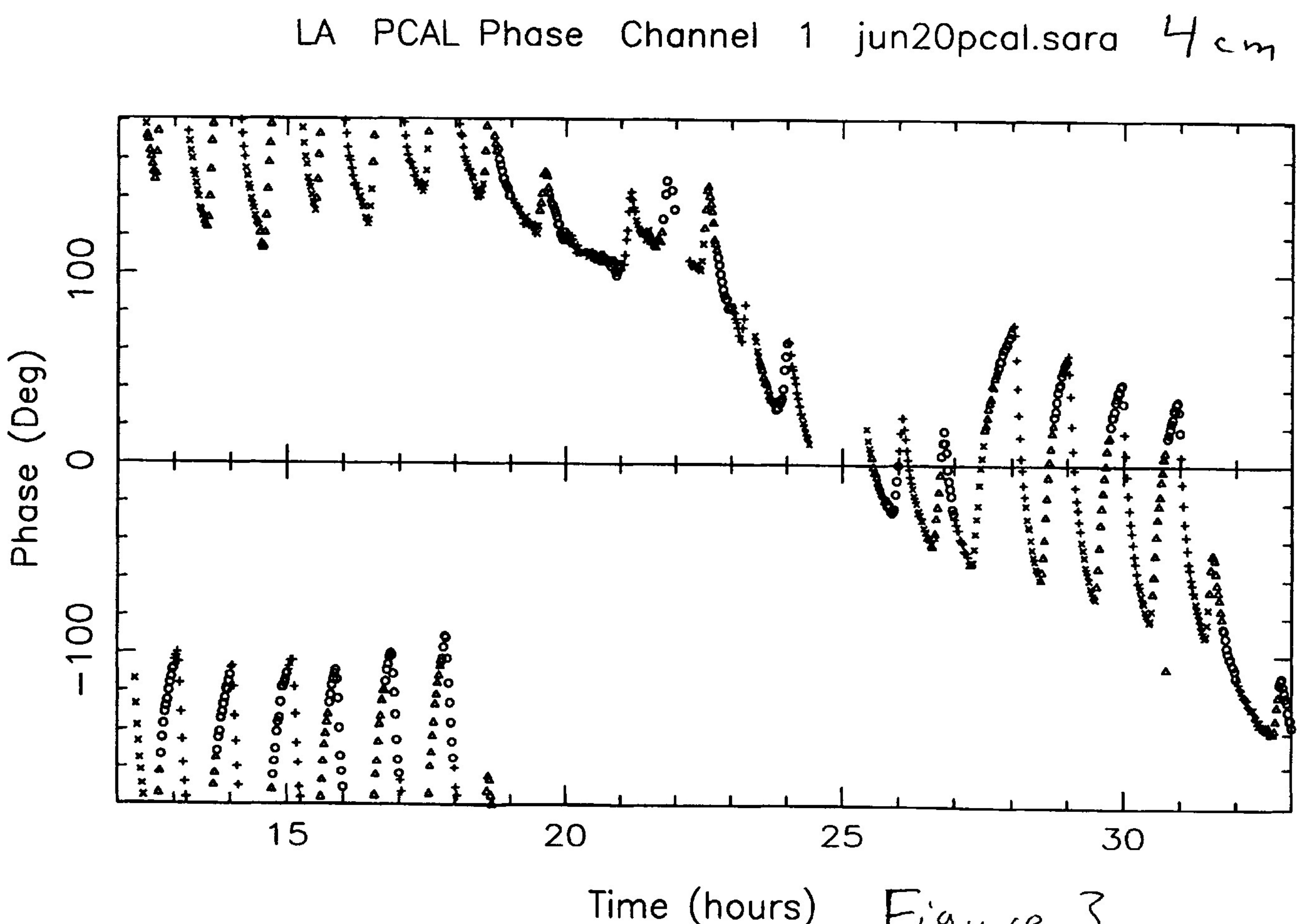


Figure 1. PCAL Test at Los Alamos

Compare CH#1 with data of Walker memo Figure 1 & 2



LA PCAL Amplitude Channel 1 jun20pcal.sara 4 cm
Amplitude
0
5
10
15
15
20
25
30
Time (hours)



LA PCAL Phase Channel 1 jun20pcal.sara 4 cm
Phase (Deg)
−100
0
100
15
20
25
30
Time (hours)

Figure 3

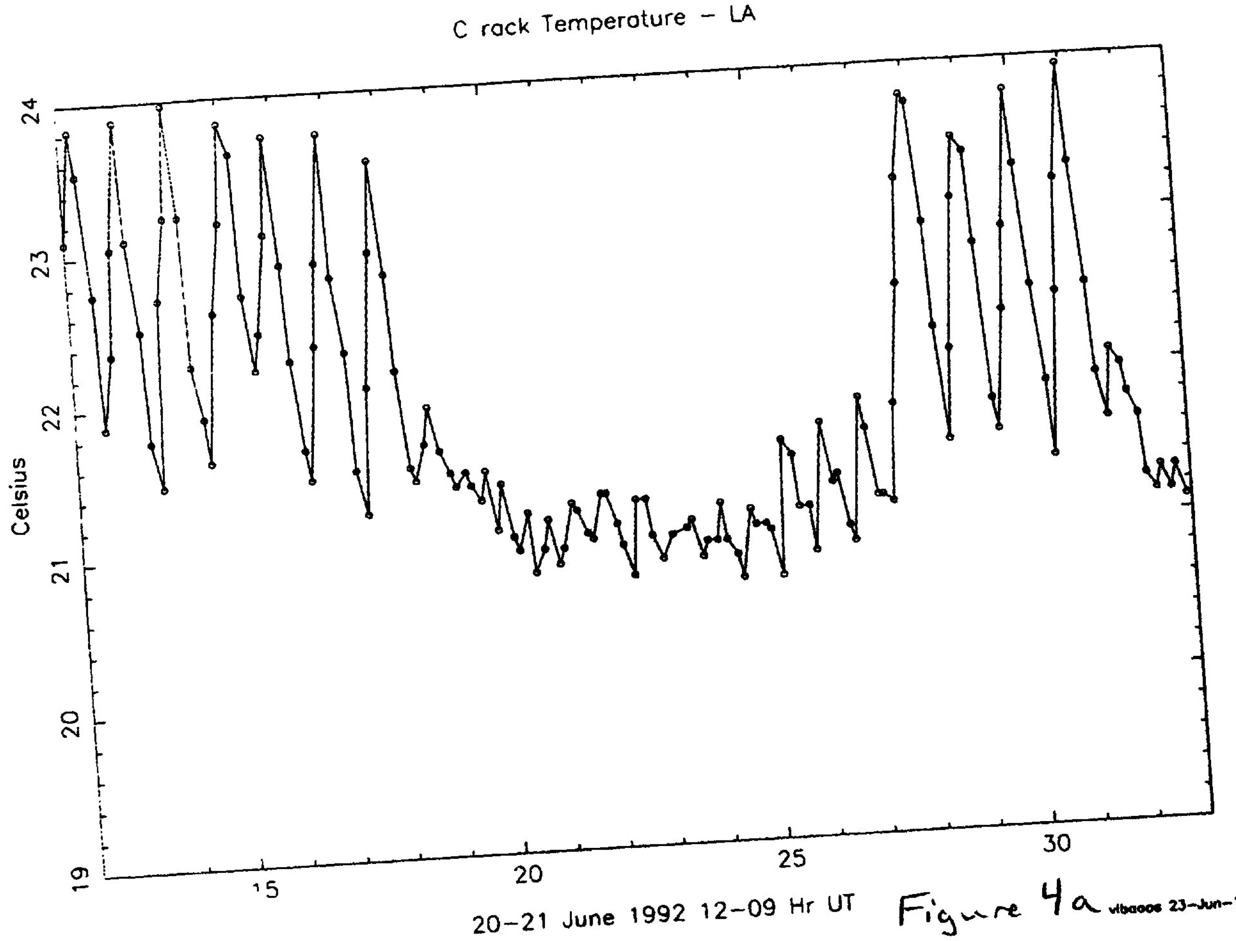


Figure 4a vlbaops 23-Jun-1992 13:12

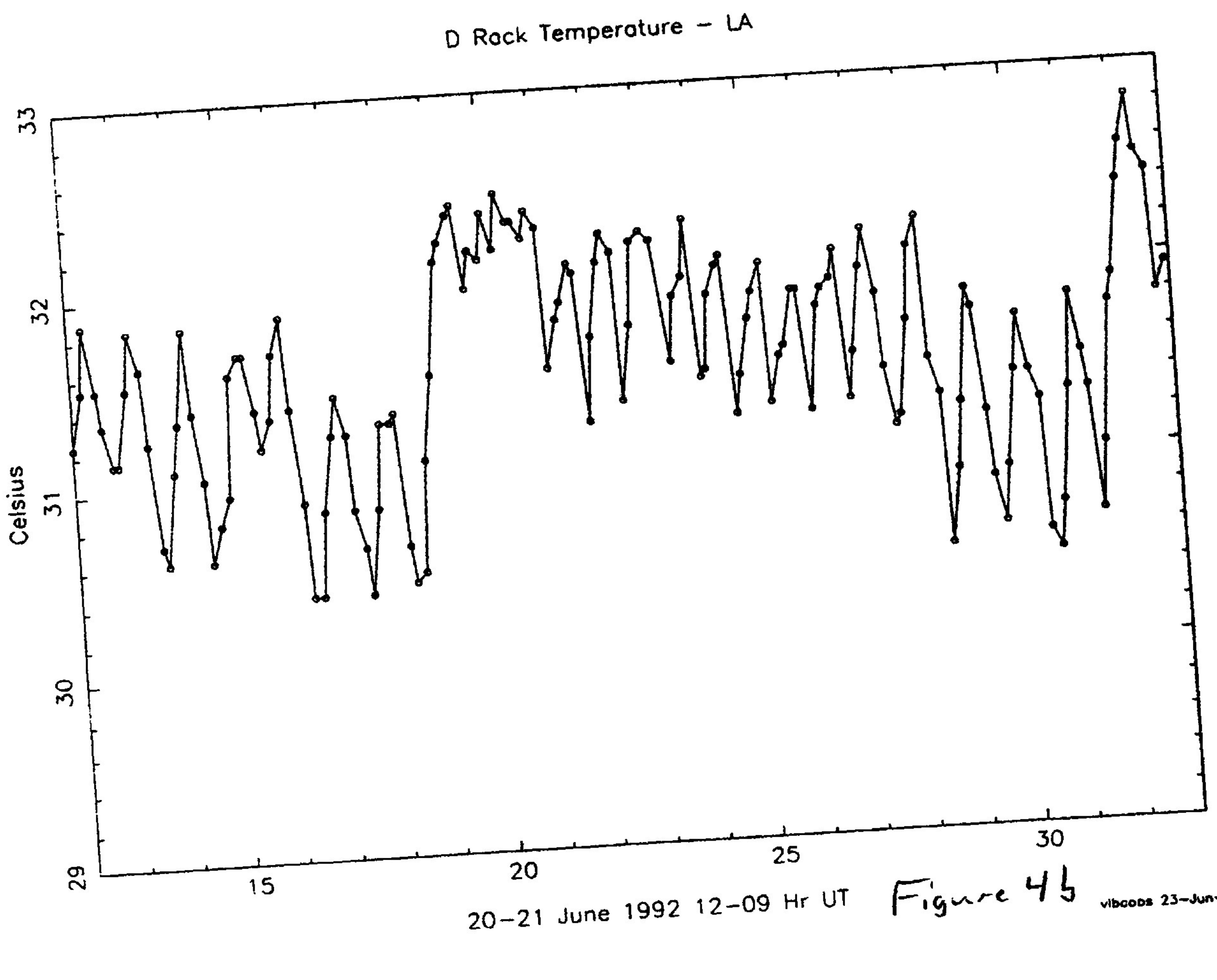
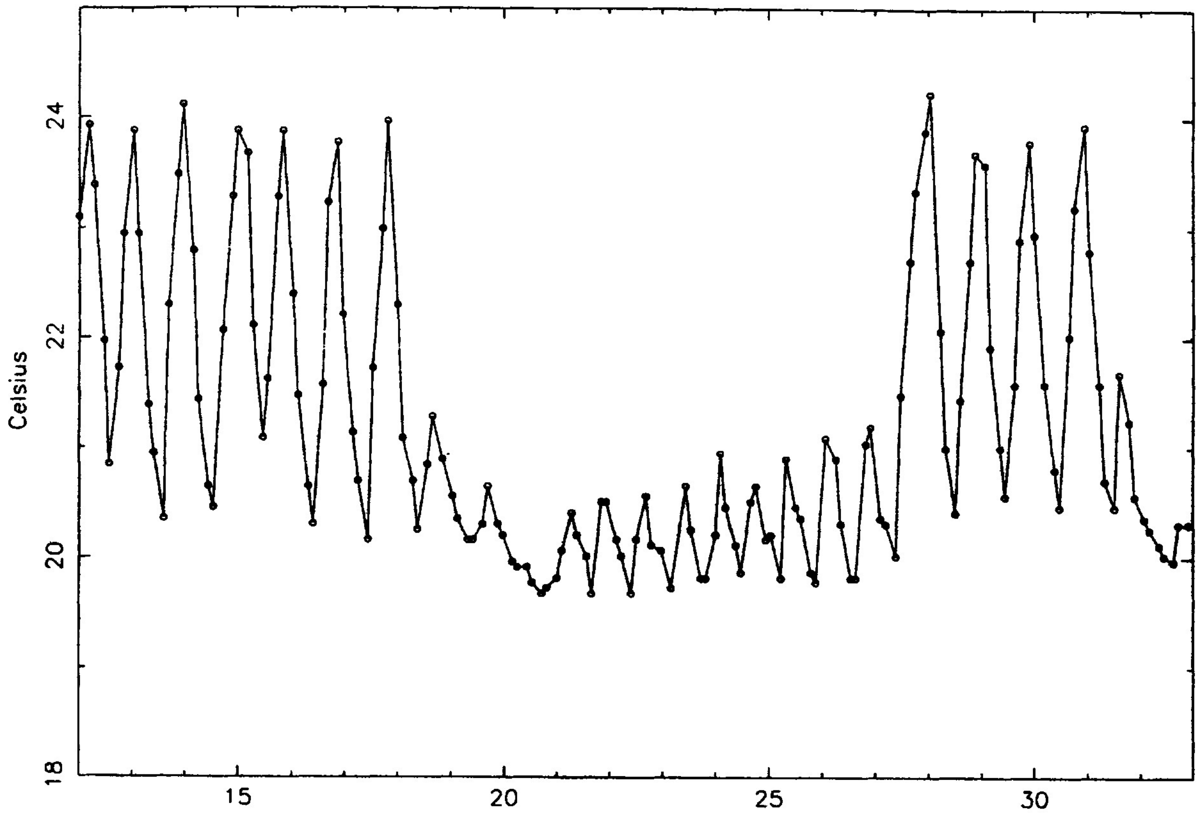


Figure 4b vlbaops 23-Jun-1992 15:09

Tape Recorder Temperature – LA

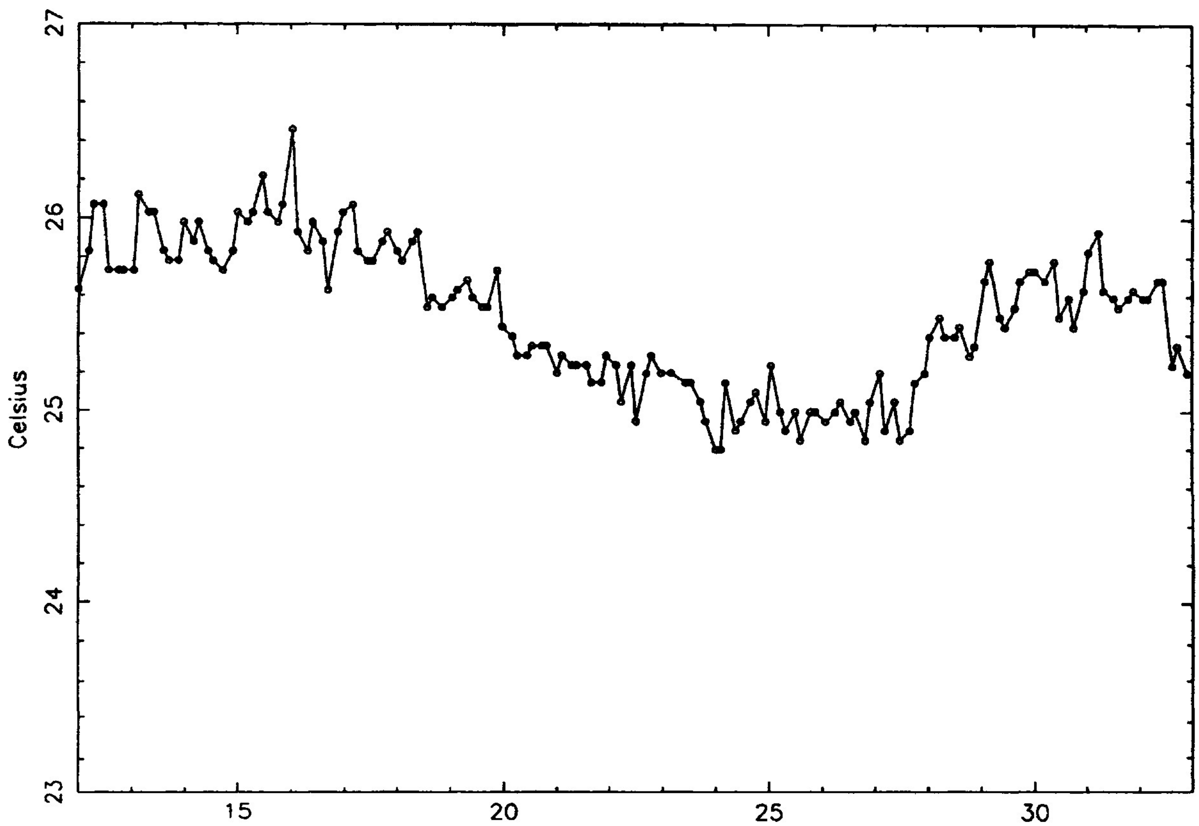


20–21 June 1992 12–09 Hr UT

Figure 4c

vibooos 23–Jun–1992 13:13

Room 104 Temperature – LA



20–21 June 1992 12–09 Hr UT

Figure 4d

vibooos 23–Jun–1992 13:08

Ambient Temperature – LA

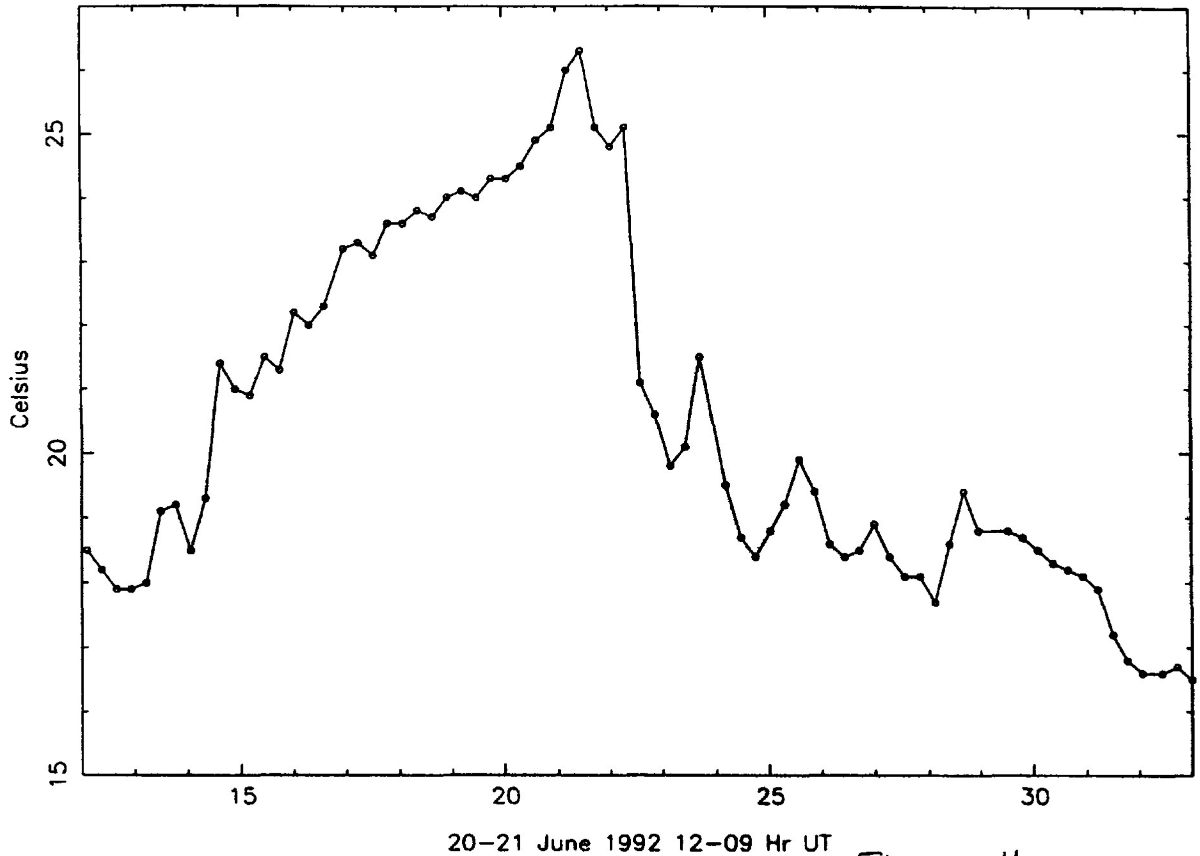


Figure 4e

vlbaoas 23-Jun-1992 13

Dew Point Temperature – LA

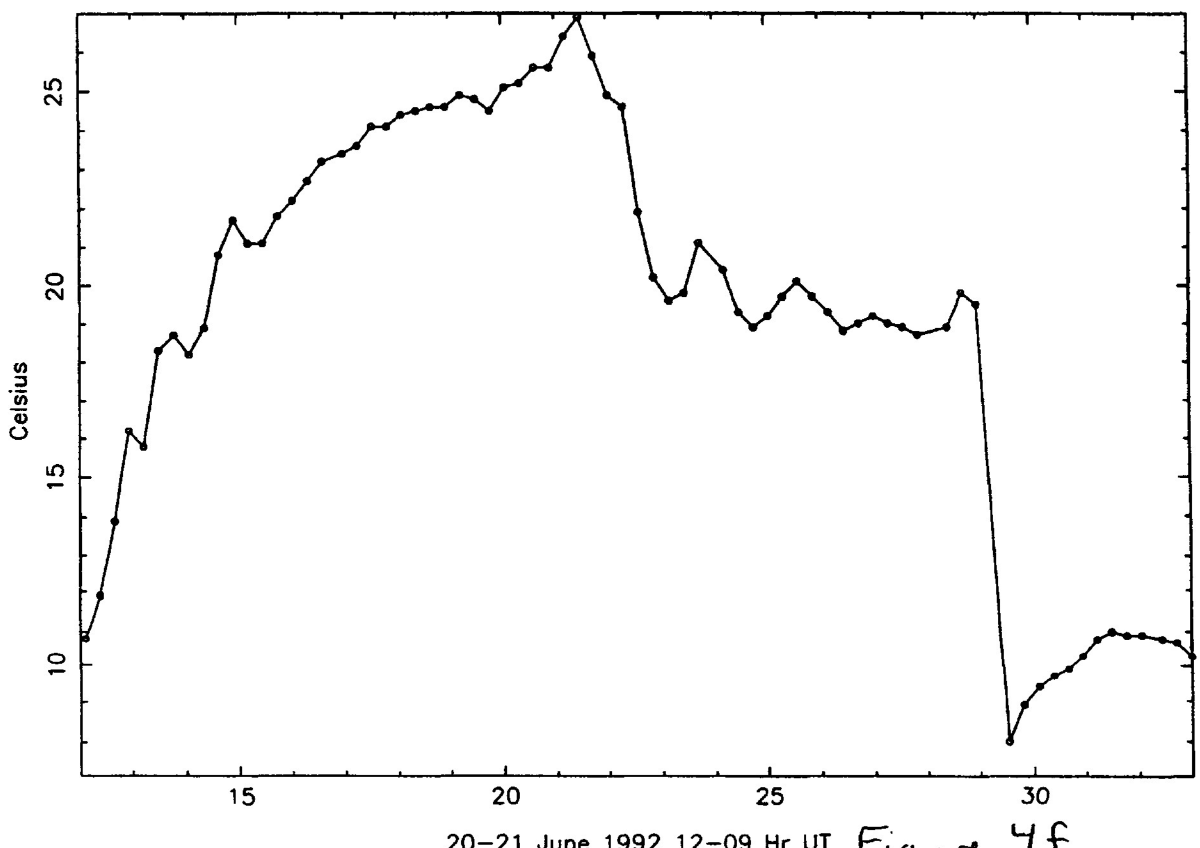
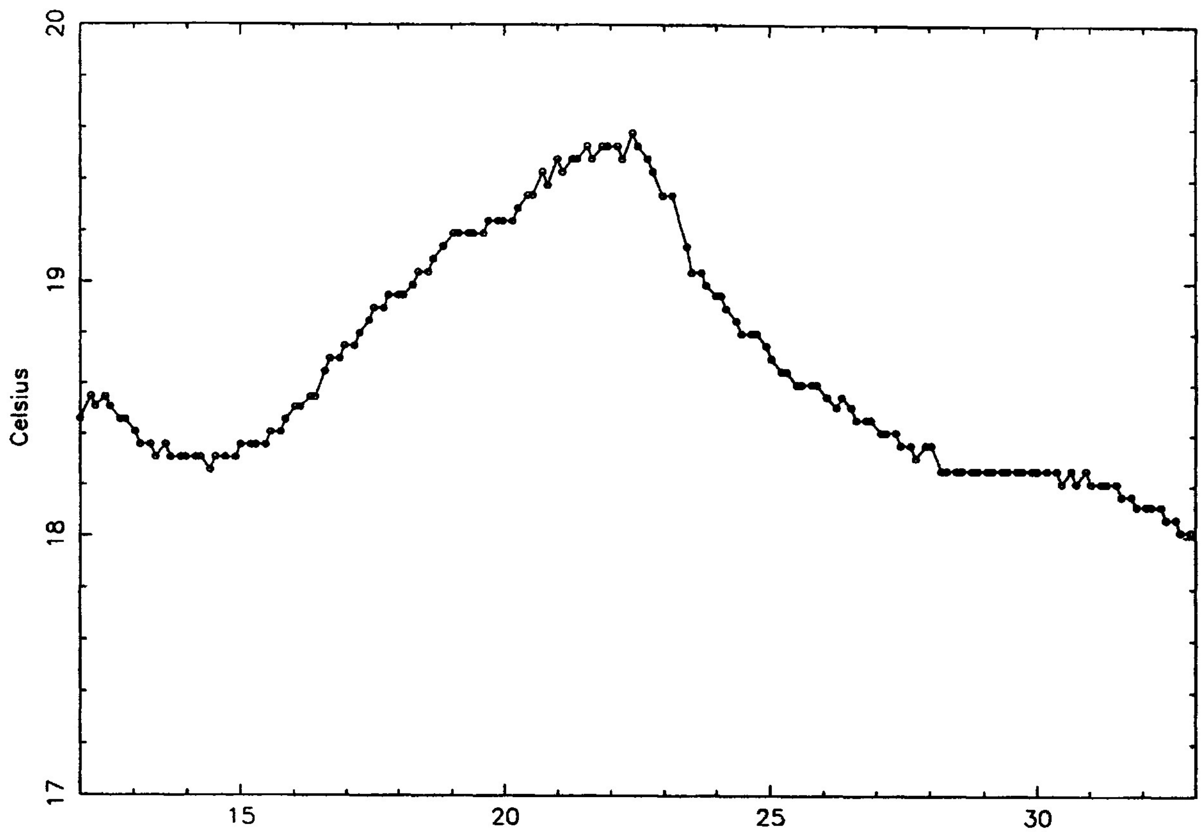


Figure 4f

vlbaoas 23-Jun-1992 13

Vertex Room Downside Temp – LA

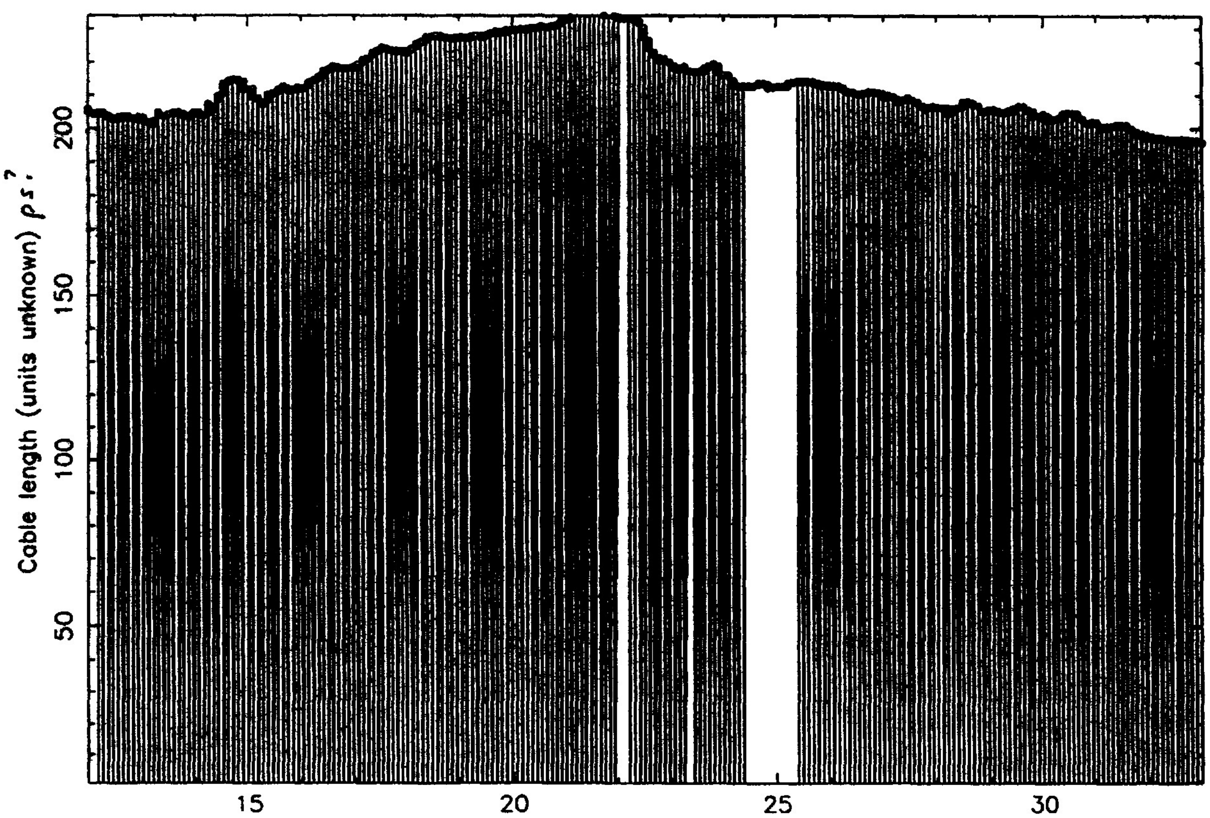


20–21 June 1992 12–09 Hr UT

Figure 4g

vlbaoos 23-Jun-1992 13:2

One-way cable length – LA



20–21 June 1992 12–09 Hr UT

Figure 4h

vlbaoos 23-Jun-1992 13:

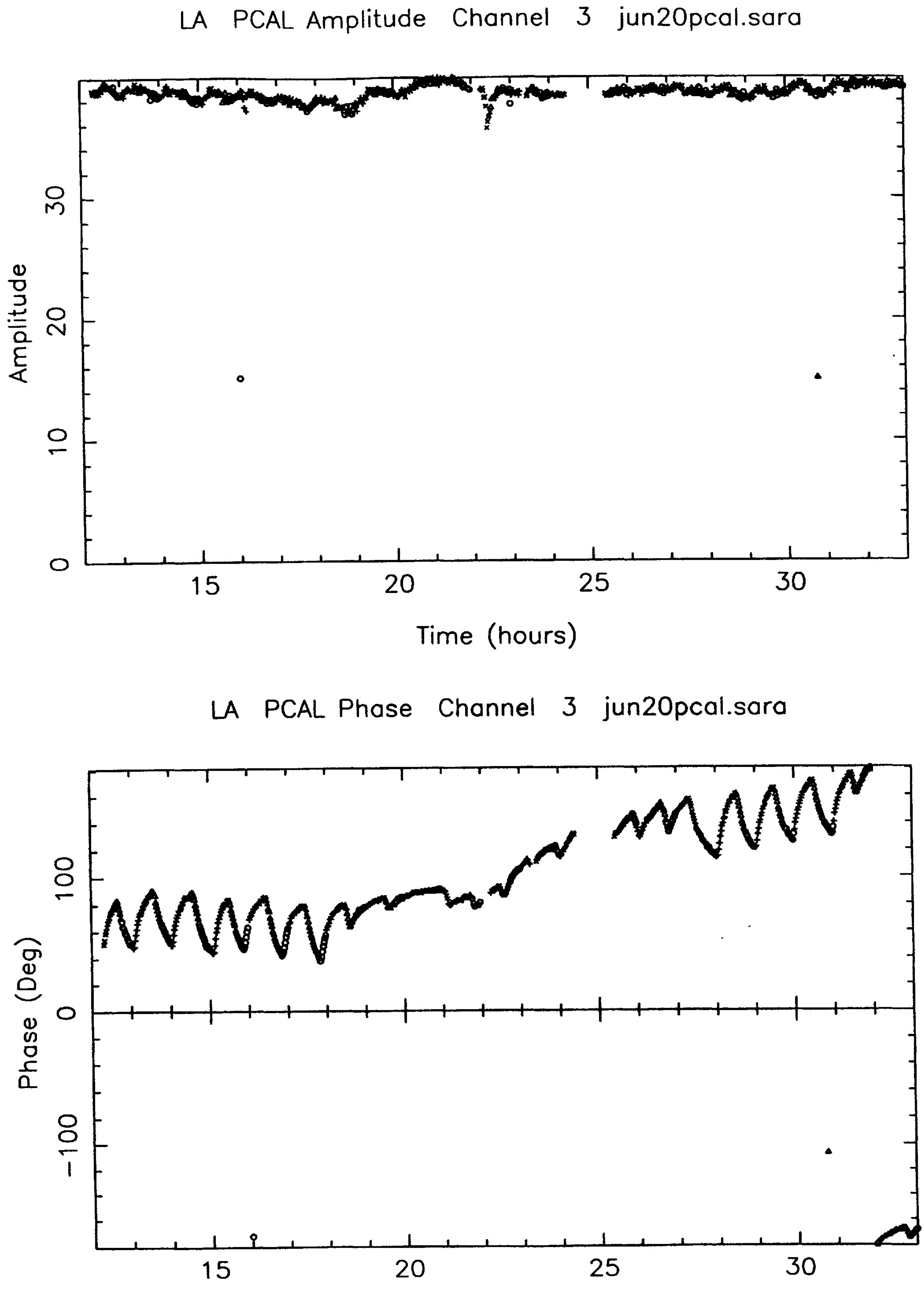
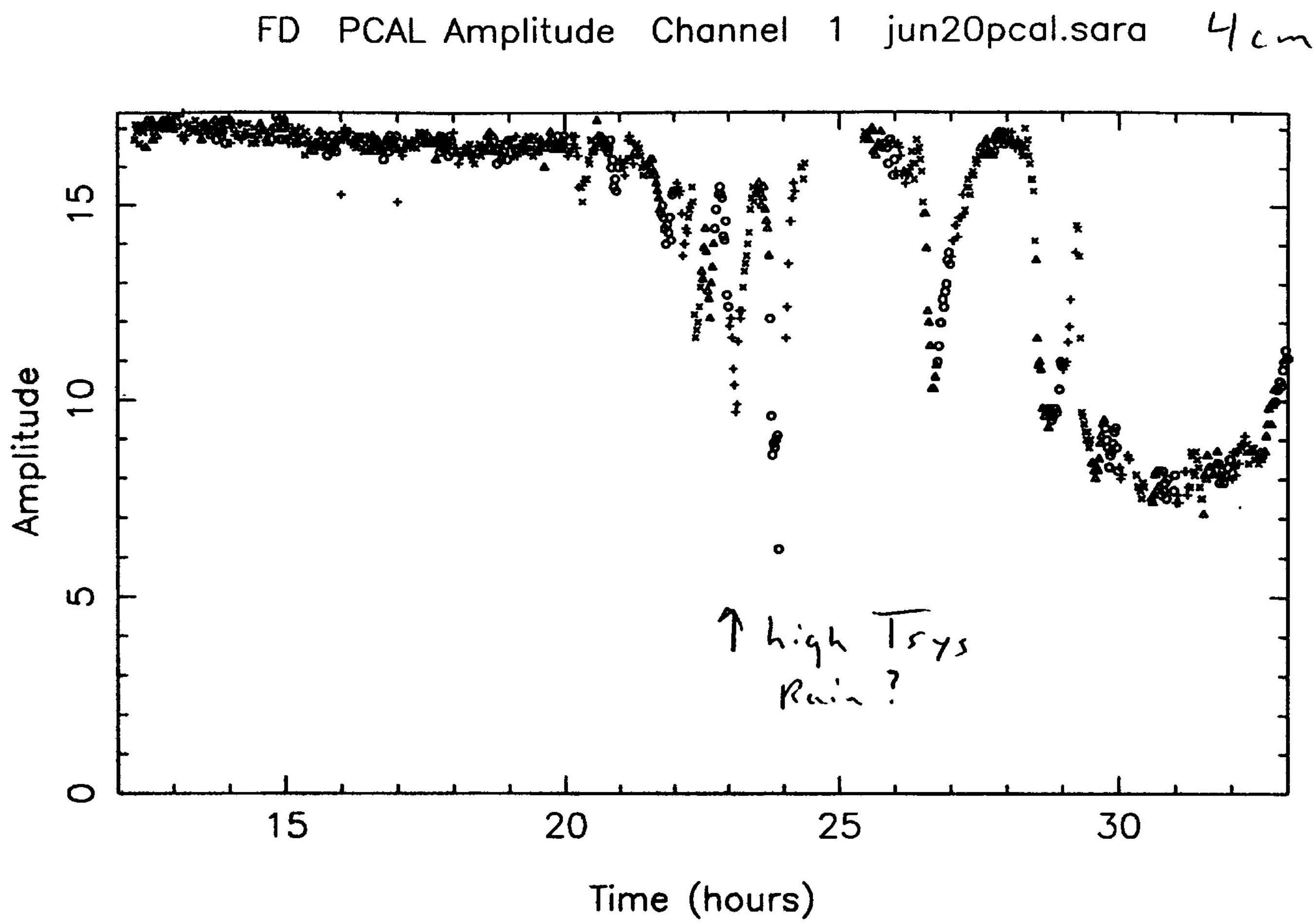

LA PCAL Amplitude Channel 3 jun20pcal.sara
Amplitude
0
10
20
30
15
20
25
30
Time (hours)
LA PCAL Phase Channel 3 jun20pcal.sara
Phase (Deg)
−100
0
100
15
20
25
30
Time (hours)

Figure 5


FD PCAL Amplitude Channel 1 jun20pcal.sara
4cm
Amplitude
Time (hours)
↑ high Tsys
Rain?
0
5
10
15
20
25
30

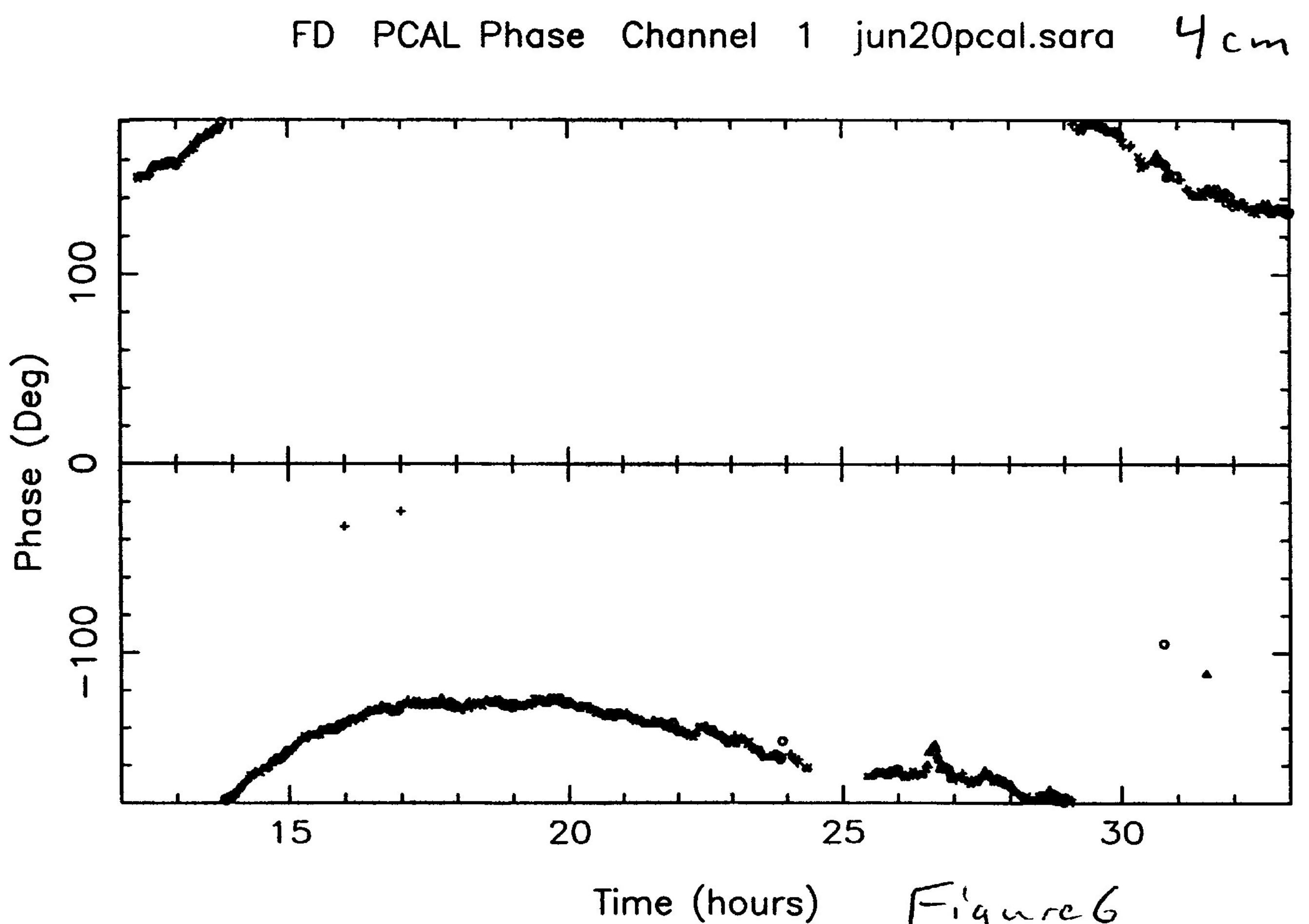

FD PCAL Phase Channel 1 jun20pcal.sara
4cm
Phase (Deg)
Time (hours)
100
0
−100
15
20
25
30

Figure 6

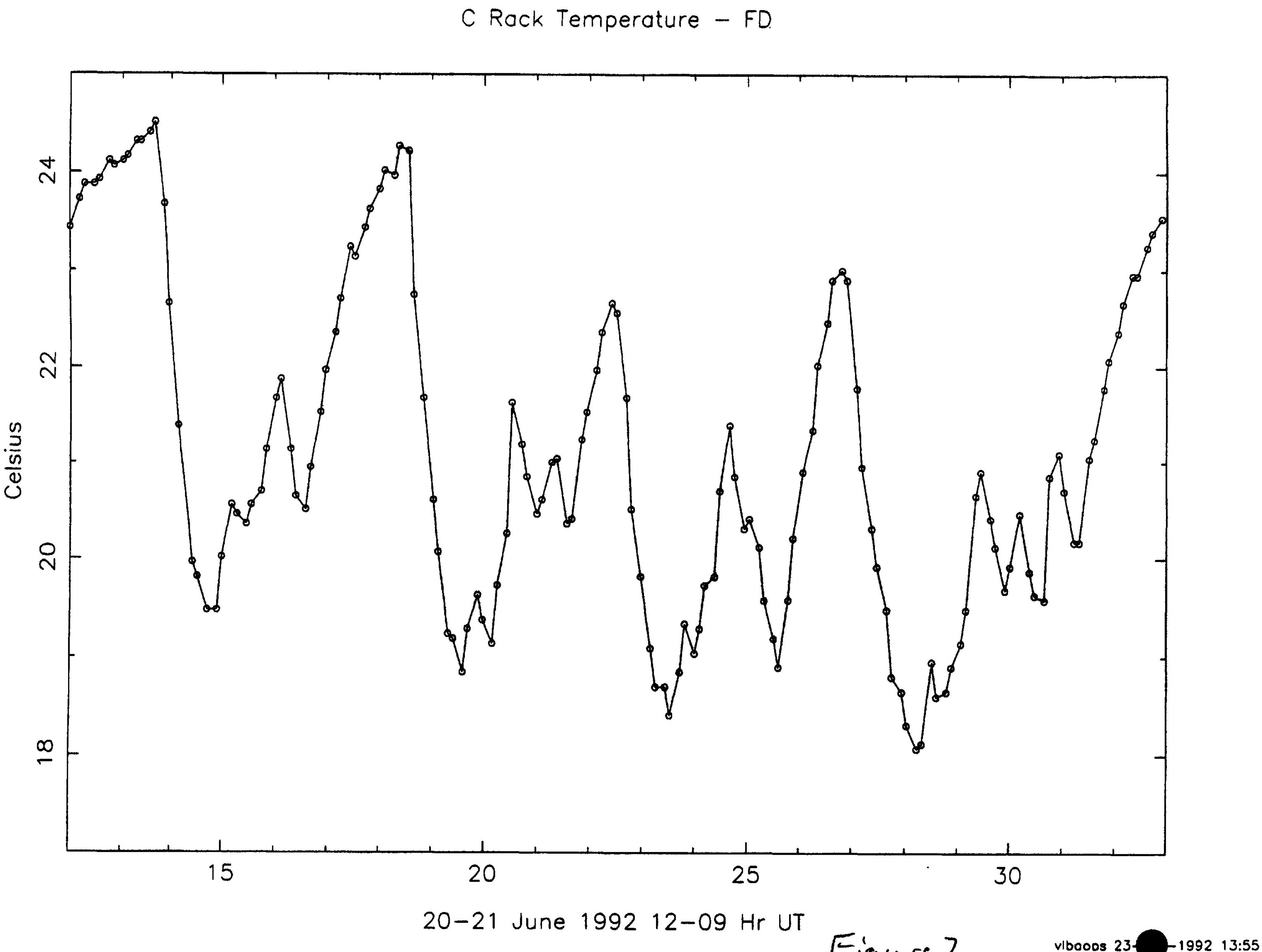

C Rack Temperature – FD
Celsius
18
20
22
24
15
20
25
30
20–21 June 1992 12–09 Hr UT
vlbaops 23- -1992 13:55

Figure 7