Thermal distortion of the AT antennas

29 sept 1987

During the last pointing run on antenna #5 it was noticed that the Elevation encoder was changing even though the antenna was parked. Subsequent investigations have shown that the antenna undergoes substantial movement, up to 35 arc secs during the course of a day. This note outlines the preliminary findings.

The results discussed here apply to two antennas, #s 4 & 5, with airconditioning ON in the pedestal room, and the exhaust fans operating.

1. Elevation.

On three days - sept 22, 23 and 24 the elevation encoder readings for a parked antenna (#5) were noted for various portions of a day. The results are shown in fig. 1. The effect is reasonably repeatable, with a locus which broadly follows the daily temperature cycle.

Electronic levels were then placed on antenna #4 in order to investigate the matter further: are the encoder readings honest? ie. is the antenna moving? Or is the encoder zero error changing? Or both?

Two levels were available. These were placed on the alidade structure, adjacent to the elevation bearing and encoder; the other was placed on the elevation axis. The readings taken during a morning are shown in figure 2. It is clear that both effects are present: the alidade is tilting, leading to changing encoder readings; and the dish itself is tilting.

In rough terms, the asymetrical alidade is distorting, leading to a tilt of the bearing platform; the platform is also being displaced sideways, causing the dish to pivot since its lowest point is pinned to the elevation pinion.

2. Azimuth.

An azimuth effect is also present, although the magnitude is substantially smaller, at about 3 arcsecs. The results for antenna #5 are shown in figure 3.

3. Non-perpendicularity of the azimuth and elevation axes.

A further effect noticed on both antennas was a progressive tilt, of large magnitude, in the direction of the elevation axis. The observations are shown in figure 4. This effect is hard to explain, except in terms of direct solar heating leading to north-south temperature differences across the alidade.

4. What is the mechanism?

Sunshine does not appear to be a dominant factor. The results shown in figure 1 were taken at different orientations: on september 22 the antenna was at azimuth 250° during the morning, and at 90° in the afternoon, whereas it was at azimuth 250° all day on sept. 23, and at 180° on sept 24.

At this stage we feel that a temperature differential is being set up, so that the effect will simply follow the daily temperature cycle. On the next round of tests the temperature will be monitored. We would hope/expect to see the temperature gradients playing a role.

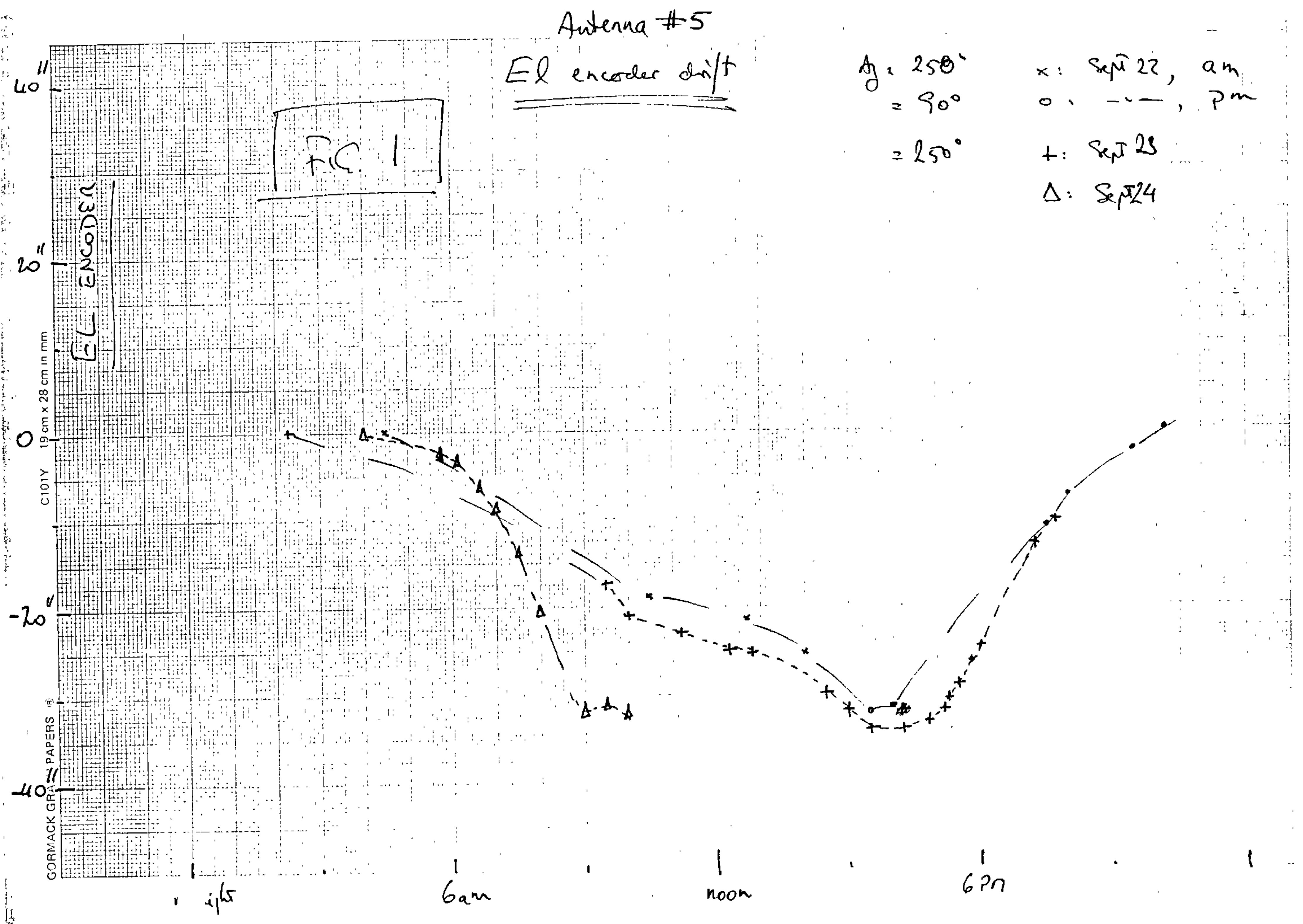
The magnitude of the effect is a problem - 35".

30 arcsecs rotation about the elevation axis corresponds to a sideways displacement of 0.6 mm at the bearing, 30 arcsecs dip in the elevation axis corresponds to a relative vertical displacement of 1.1mm between the two elevation bearings.

With a coefficient of thermal expansion of $\sim 10^{-5}$ per °C, we require a temperature differential of order 10°C to provide the N-S dip. A 1°C difference across the I-beams will produce a curvature in the beams, and a tilt at the top of about 82 arcsecs.

5. Future investigations.

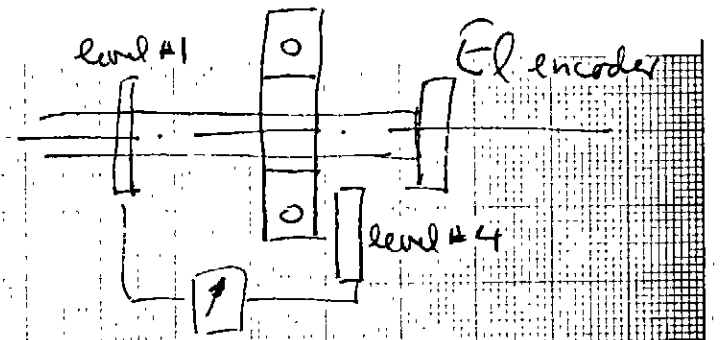
The present results were made in somewhat of a hurry, with many parameters changing. The obvious next steps are a more systematic investigation to locate the origin of the troubles, and to suggest possible cures. At the present time the antenna is adequate for day one observations, but falls far outside the 8 arcsec expected performance.



Antenna #5
El encoder drift
FIG 1
EL ENCODER
Az = 250°
= 90°
= 250°
x: Sept 22, am
o: —·—, pm
+: Sept 23
Δ: Sept 24
40"
20"
0
-20"
-40"
6am
noon
6pm
GORMACK GRAPH PAPERS
C101Y 19 cm x 28 cm in mm

Fig. 2

Antenna #4



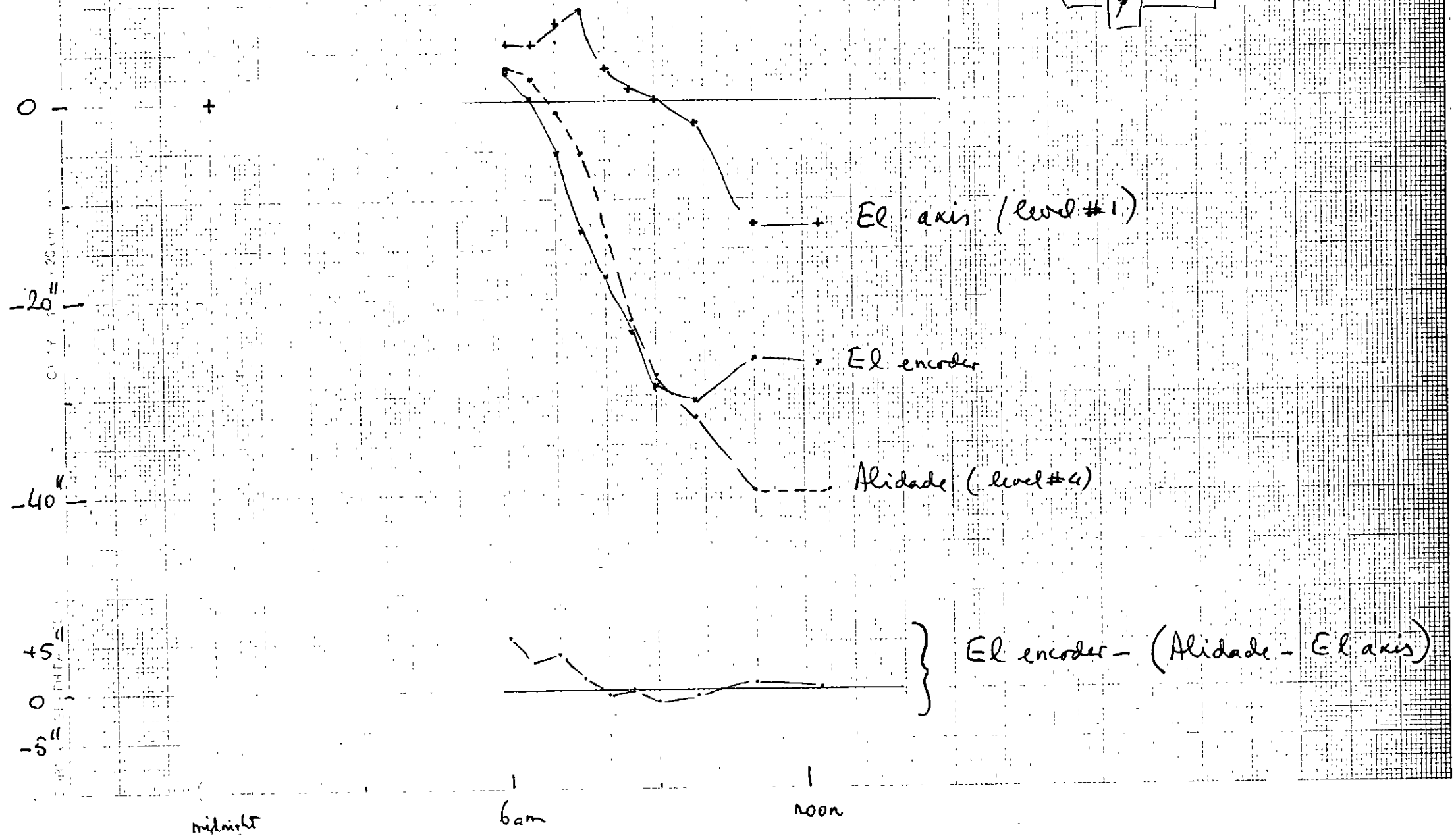


Fig. 3

Antenna # 5

AZ encoder drift

x : Sept. 22 (am)

Δ : Sept 22 (pm)

+ : Sept 23

o : Sept 24

AZ encoder

0

-5"

ag = 180°

ag = 250°

ag = 90°

ag = 260°

midnight

6 am

noon

6 PM

Fig. 4

~~tilt~~ tilt in El axis
(levels placed on Vertex room floor, parallel to El axis).