National Radio Astronomy Observatory
Tucson, Arizona

August 26, 1983

MEMORANDUM

TO: 12-Meter Group

FROM: R. Howard

SUBJECT: 12-Meter Antenna Performance Over First Observing Period (March 21 to June 30, 1983).

Although the first scheduled observing period on the 12-Meter was a short one, it provided a good period to evaluate and measure the performance of the telescope.

Antenna Stability

The most dramatic improvement in the 12-M over the 36-Ft is the antenna's thermal stability. The improvement was seen in several areas.

1) Pointing - The pointing of the antenna (with no direct sun on the feed legs or the dish) is repeatable (over the entire sky) to within 5 arc seconds for periods up to several weeks. Unlike the 36-Ft, there are no pointing changes (to within 3-5 arc seconds) from night to day even when the ambient temperature has changed by 10-15°C. However, over the time period of one month to several months, the pointing changed from one region of

the sky to another by 10-20 arc seconds (mainly in azimuth). This is exactly the way the 36-Ft behaved, although the 36-Ft saw these sort of changes in as short a period as a few days. The pointing of the 12-M when in direct or partial sun can change by as much as 10 arc seconds. Most of this effect is accounted for by the differential heating of the feed legs. Measurements of pointing error versus feed leg temperature indicate that a $5^{o}C$ difference between the east and west feed legs will produce about a 5 arc second azimuth pointing error. Although the pointing changes due to sun on the antenna, the gain does not seem to be affected by direct sun (at least at 3 mm).

2) Focus - The focus of the antenna is nearly independent of temperature. Figure 1 shows the relative position of the secondary (to focus the antenna) as a function of dome ambient temperature. These measurements were made using the 3 mm Cassegrain system. The best fit linear equation for the focus is:

$$\mathrm{FOCUS(mm)} = (39.52 \pm .21\ \mathrm{mm}) - (.033 \pm .02\ \mathrm{mm}/{^{o}C}) \times T_{AMB}({^{o}C})$$

3) Spectral line data - Spectral line observations were made with the 3 mm Cassegrain receiver (plus path length modulator) using the standard vane calibration scheme. Since the antenna coupling efficiency to the sky, the secondary solid angle and the illumination taper are all the same as for the 36-Ft, the standard TC (DSB) value of 800K at all frequencies except ^{12}CO and ^{13}CO can be adopted. Standard line strengths are about 25% stronger than those for the 36-Ft. The standard sources used were IRC+10216, W3(OH), S146 and M17SW (^{13}CO only). Assuming that the calibration is correct, this means that the source coupling efficiency to these standards has increased by 25%. For very extended sources, the

observed line strengths are about the same as for the 36-Ft, as expected. All observers found that the baselines are flatter than those with the 36-Ft. This was true even when using both 1 MHz filter banks. Integrations as long as 850 minutes produced flat baselines over 256 MHz, gave a T_A* (RMS) of 7.5 mK and showed that the noise is going down as $T^{-\frac{1}{2}}$.

4) Continuum data - There are two significant improvements in 3 mm continuum observing. One is that in the normal beam switching/position switching mode (on-on scheme), the sky or background cancellation has improved by a factor of at least 10. The 36-Ft produced "ghost detections" and large systemmatic elevation offsets that made it very difficult to believe detections less than 0.5 Jy. Figure 2 is a plot of the observed antenna temperature for scans of 360 seconds integration versus source elevation for two sources (both about .1 Jy). There are no systemmatic offsets to within ± 1 MK. Observation on 1704 + 608 for a total of 288 minutes showed that the noise continued to go down as $T^{-\frac{1}{2}}$, reaching a final RMS of 30 mJy.

Antenna Parameters

The aperture efficiencies and half power beam widths that have been measured since the setting of the panels in February '83 are listed below.

Wavelength	Configuration	Aperture Efficiency (%)	HPBW (arc sec)	Comments
3.3 mm	Prime Focus	39±2	72±2	Measured before final panel setting
3.3 mm	Cassegrain	30±1	78±2	Average over March - July '83
1.33 mm	Prime Focus	15±3	29±2	
1.33 mm	Cassegrain	10±3	36±2	July '83

The efficiencies at 1 mm are not well determined because of high receiver temperatures at prime focus and marginal weather conditions with the new Cassegrain receiver in July. The Cassegrain HPBW's (both at 1 mm and 3 mm) are broader than theoretical and in fact the 3 mm HPBW is the same as the 36-Ft.

Figure 3 is a map of the beam (on Jupiter) at 3.3 mm using the Cassegrain receiver (10 dB taper). The sidelobe features are about 8 dB lower than those for the 36-Ft.

At 1.4 mm, both the bolometer (2 dB taper) and the coherent Cassegrain receiver (11 dB taper) show asymmetrics in the beam at levels as high as 3 dB for the bolometer and 8 dB for the coherent receiver. Figure 4 is a map of the beam (on Jupiter) at 1.4 mm using the He_3 bolometer system.

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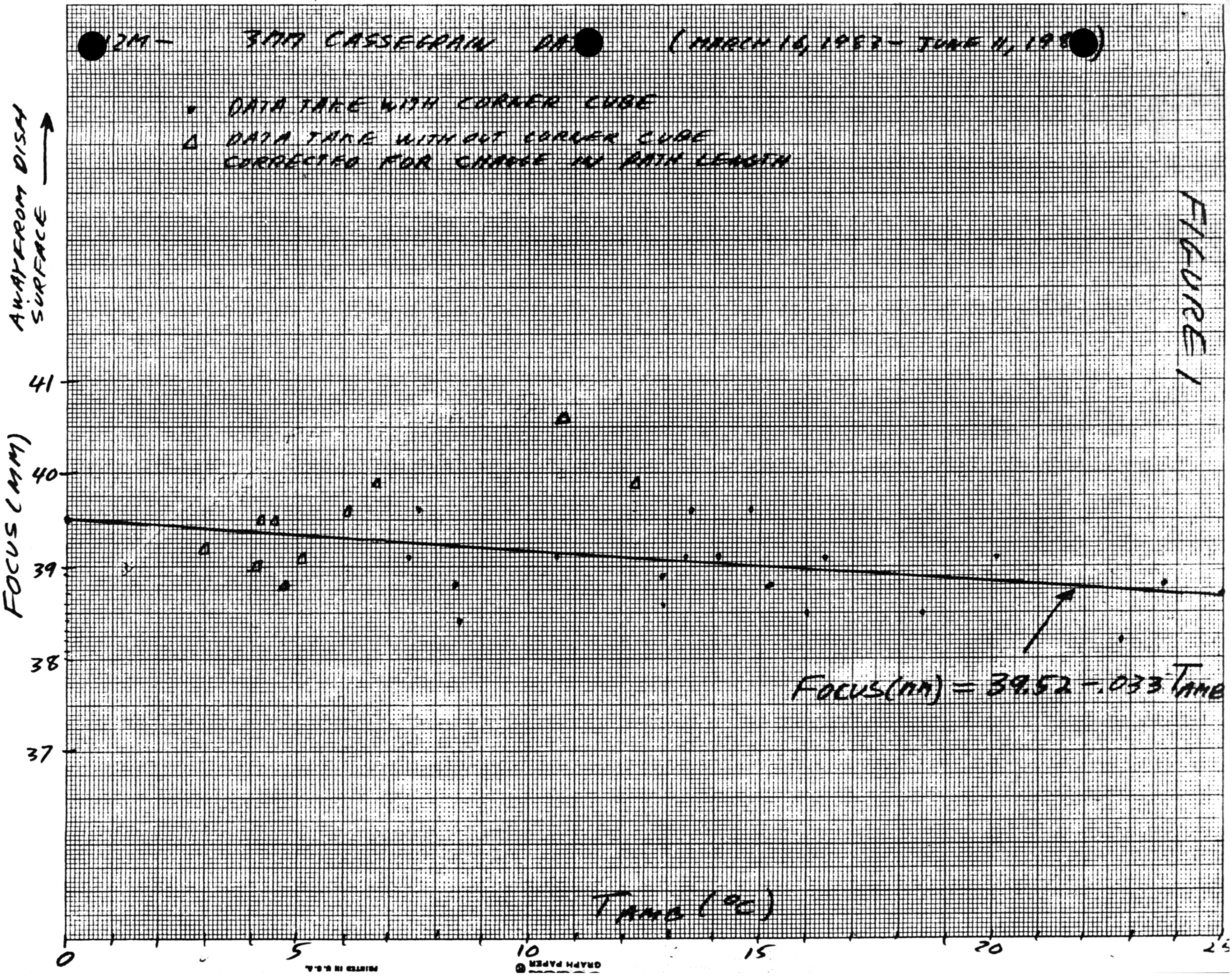

12M - 3MM CASSEGRAIN DA
(MARCH 16, 1987 - JUNE 11, 19
• DATA TAKE WITH CORNER CUBE
Δ DATA TAKE WITHOUT CORNER CUBE CORRECTED FOR CHANGE IN PATH LENGTH
AWAY FROM DISH SURFACE
FOCUS (MM)
41
40
39
38
37
FOCUS(MM) = 39.52 - .033 TAMB
TAMB (°C)
0
5
10
15
20
25
GRAPH PAPER
PRINTED IN U.S.A.

FIGURE 1

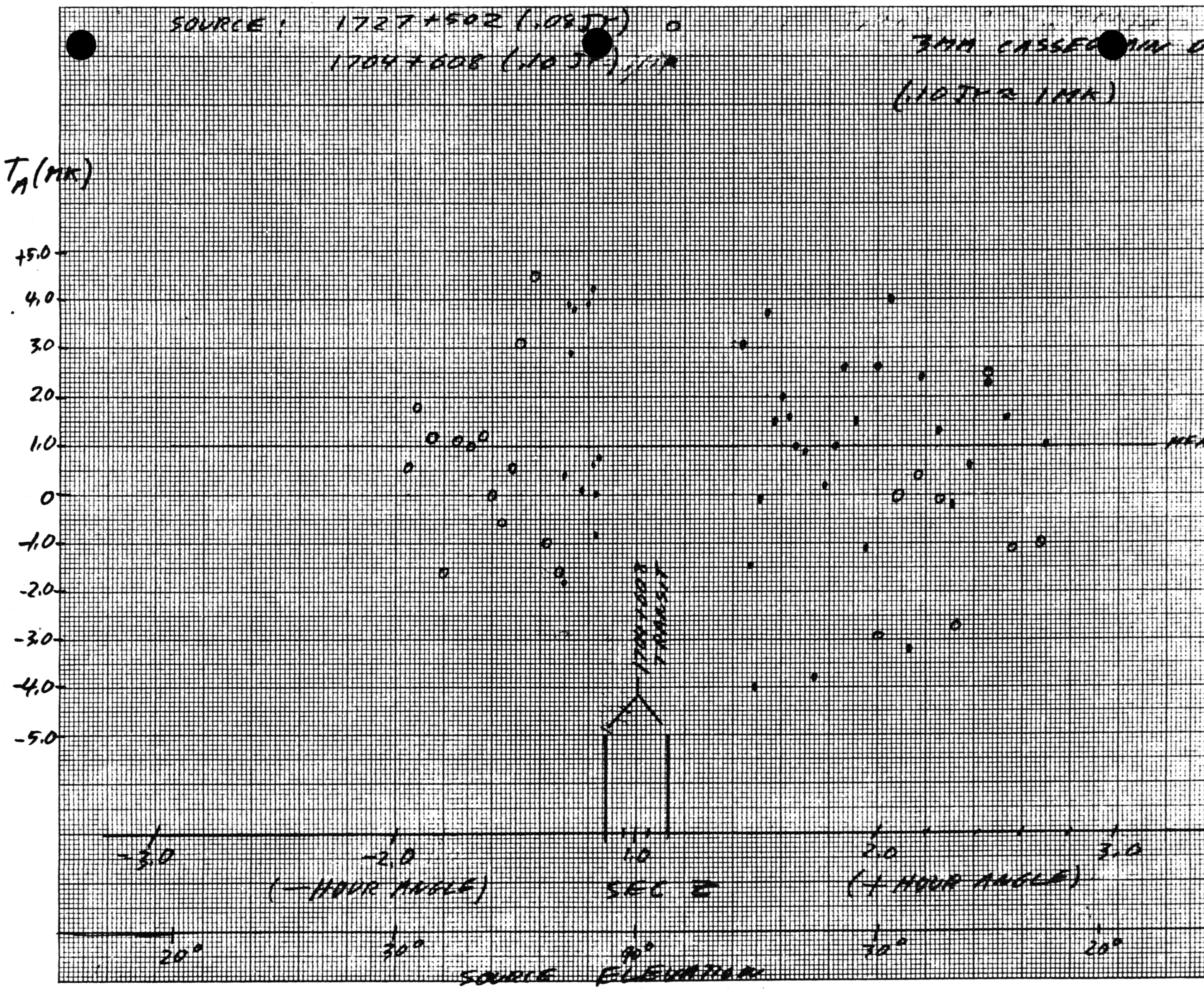
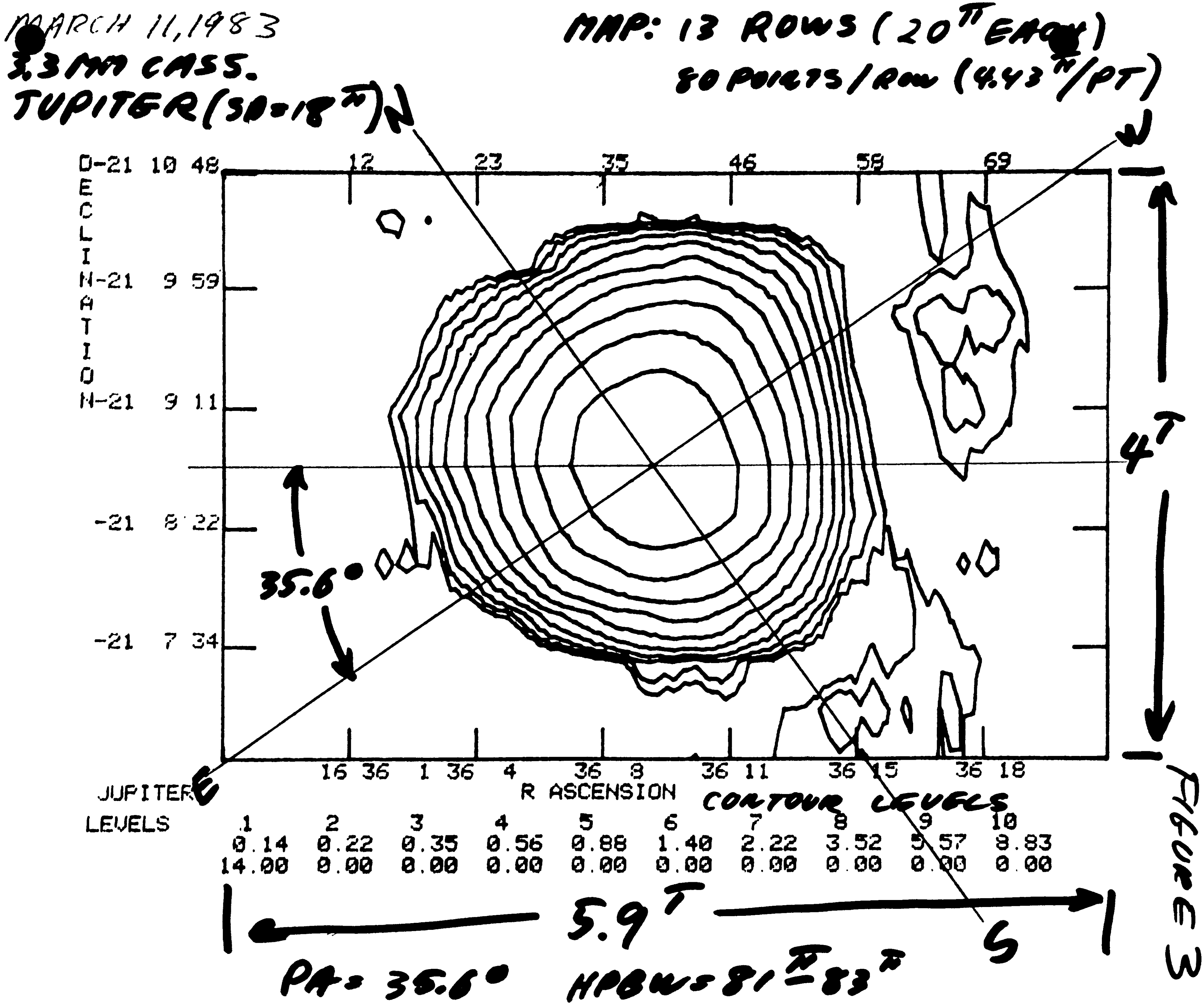
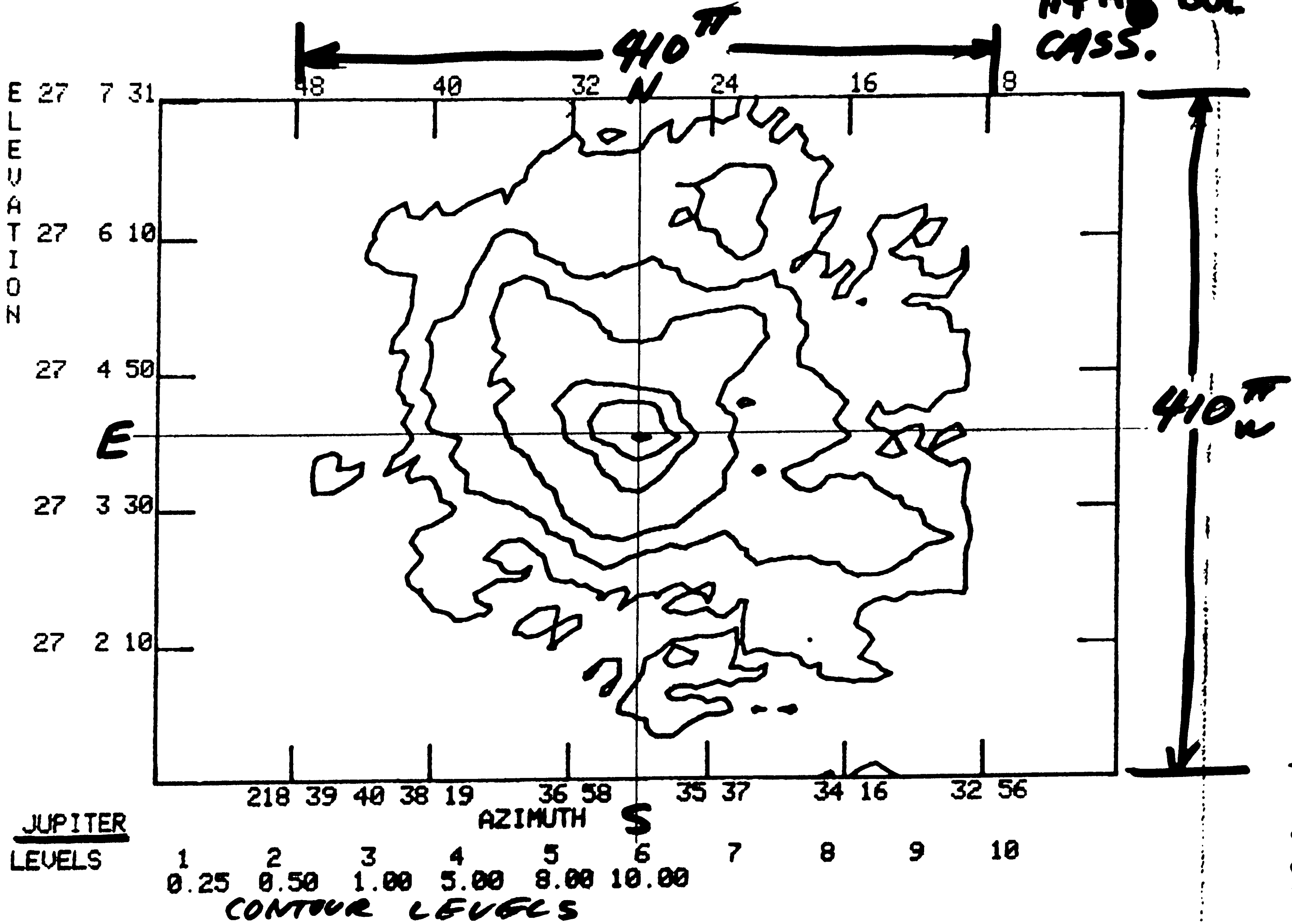

SOURCE: 1727+502 (.08 JY) o
1704+608 (.10 JY) •
3MM CASSEGRAIN DATA
(.10 JY ≈ 1 MK)
T_A (MK)
+5.0
4.0
3.0
2.0
1.0
0
-1.0
-2.0
-3.0
-4.0
-5.0
MEAN
-3.0
-2.0
1.0
2.0
3.0
(- HOUR ANGLE)
SEC Z
(+ HOUR ANGLE)
20°
30°
40°
30°
20°
SOURCE ELEVATION

FIGURE 2


MARCH 11, 1983
3.3 MM CASS.
JUPITER (SD=18")
MAP: 13 ROWS (20" EACH)
80 POINTS/ROW (4.43"/PT)
N
W
E
S
D-21 10 48
DECLINATION
N-21 9 59
N-21 9 11
-21 8 22
-21 7 34
12
23
35
46
58
69
16 36
1 36
4
36 8
36 11
36 15
36 18
R ASCENSION
4'
35.6°
JUPITER
LEVELS
CONTOUR LEVELS
1 2 3 4 5 6 7 8 9 10
0.14 0.22 0.35 0.56 0.88 1.40 2.22 3.52 5.57 8.83
14.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
5.9'
PA = 35.6°
HPBW = 81"–83"
FIGURE 3



5/23/83

FIGURE 4