Beam Characteristics of the Resurfaced
300-Foot Telescope at 21 cm

by
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The beam characteristics of the NRAO 300-foot telescope at Green Bank, W. Va., have been described by R. Harten (1969). Since that report appeared, the telescope has been resurfaced. This paper reports the results of the latest measurements of the 300-foot telescope beam characteristics, taken in early July 1971 about a year after resurfacing was begun on the telescope. For a more complete description of the methods employed, see Harten's original report. The measurements were made using feeds 3 and 4 of the 4-feed system at 21-cm, to be used with line and continuum work.

The variation of halfwidth in declination and right ascension as a function of declination was determined from wobbles and drift scans respectively. The results for feeds 3 and 4 are shown in Figure 1.

From the drift scans the aperture efficiency η_A was determined as a function of declination. The resulting curve shown in Figure 2 agrees well with the one determined by Davis in December 1970; the approximately 10% lower efficiency (peak 49% instead of 54.5%) was expected since the December data were obtained with a more efficient (single) feed. The results for feeds 3 and 4 are identical.

In order to derive the beam efficiency η_B the main beam solid angle Ω' is needed, since $\eta_B = \eta_A \Omega' A_g / \lambda^2$. Assuming a Gaussian main beam, $\Omega' = 1.133 \times \Delta\alpha \times \Delta\delta$ where $\Delta\alpha$ and $\Delta\delta$ are the halfwidths in α and δ. From the drift curves a very consistent set of values for $\Delta\alpha$ was found; the standard deviation from the hand-drawn curve is approximately 0.1 minutes of arc. However, a smaller number of wobbles was used to determine $\Delta\delta$. The shape of this curve, unexpectedly, does not resemble that obtained for $\Delta\alpha$. The standard deviation is of order 0.2 minutes of arc. Clearly, more data are needed here.

Therefore, the resulting curve of η_B as a function of declination may be unreliable. In particular, previous measurements with the old surface, and experience with other telescopes, shows that η_B varies less than η_A because a portion of the η_A variation is due to changes in the beam shape.

We find that the beam solid angle remains about constant with varying δ, and as a result η_B varies by about the same amount as η_A.

The moon, being an extended source of brightness temperature 225° K, was used for a direct measurement of η_B. A measurement of T_A for the moon gives immediately $\eta_B = T_A / T_B$. We find $\eta_B = 0.67 \pm .01$ at $\delta = -10°$. This value is much higher than the value of 0.61 at $\delta = -10°$ found, indicating again that more data are needed to determine η_B properly.

The beam pattern was determined down to 30 db using wobbles about Cas A, and below 30 db, down to 69 db using the sun. Figure 3 shows the inner beam pattern using Cas A and feed 3. The peculiar lobe appearing at negative right ascension is due to the feed (part of the four-feed system) being slightly off-axis. Figure 4 shows the larger beam pattern using the sun and feed 4. In both figures, dashed lines indicate interpolation. The two patterns were fitted together around the 30 db level.

In Table I the beam solid angle Ω' is computed at different distances from the optical axis for the measured beam pattern (by numerical integration) and for a Gaussian main beam of half widths 10'.7 (North-South) and 10'.2 (East-West). The old telescope beam pattern is also listed for comparison. It is seen immediately that the effects of the error beam, so prominent before resurfacing of the telescope, have disappeared. The real telescope beam, at the 42 db level, has a beam solid angle of 0.0360 square degrees, or .0022 square degrees more than the Guassian main beam. Thus, about 6% of the energy goes into the sidelobes, as compared to 48% before the resurfacing.

Table I

db level	main beam	telescope beam	telescope beam 1967
13	.0321 □	.0321 □	.0324 □
20	.0334	.0349	.0365
23	.0335	.0352	.0373
28	.0337	.0355	.0418
30	.0338	.0356	.0455
42	.0338	.0360	>.0642

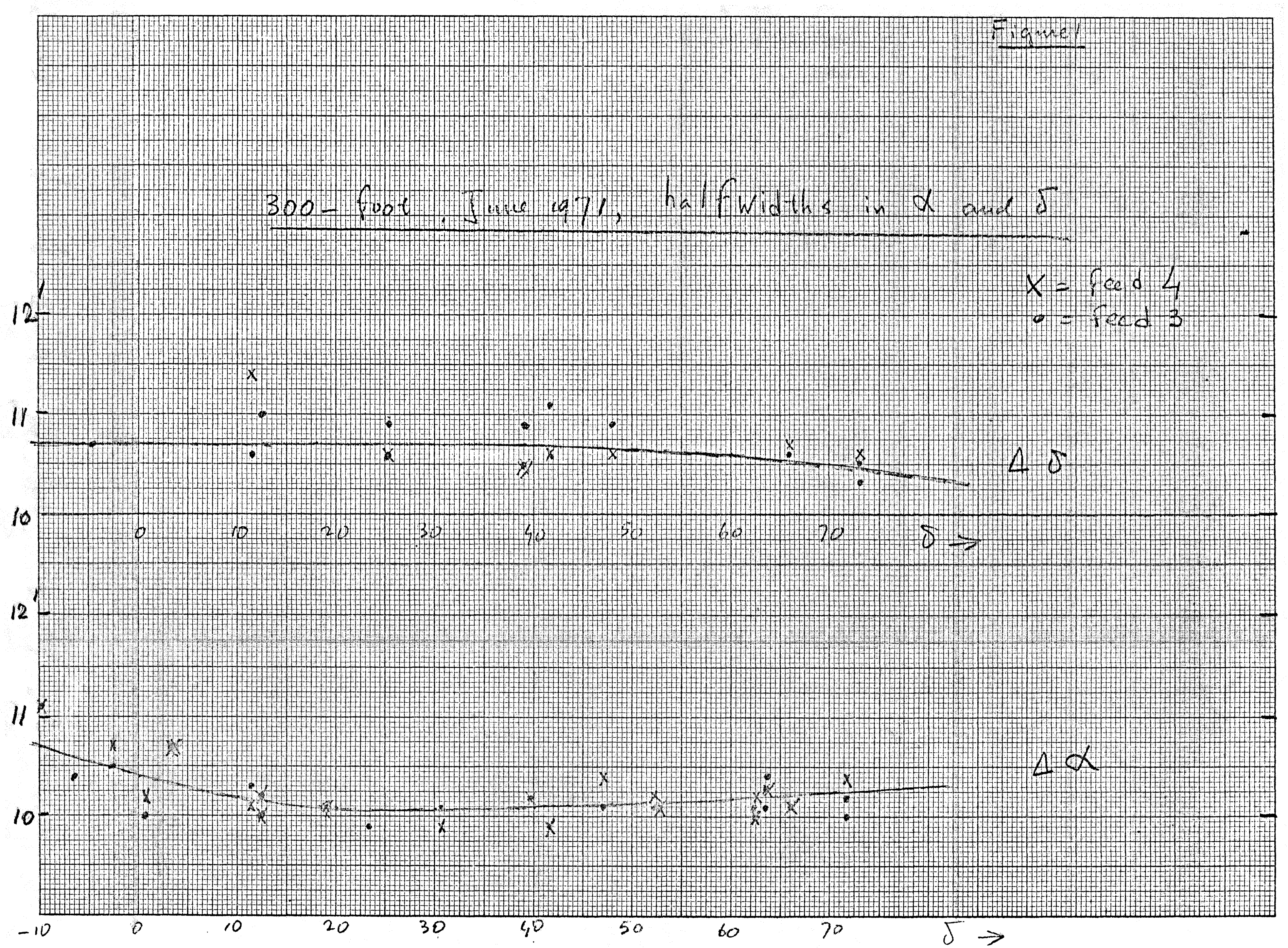


Figure 1
300-foot, June 1971, halfwidths in α and δ
X = feed 4
• = feed 3
Δδ
Δα
12'
11'
10
12'
11
10
0
10
20
30
40
50
60
70
δ →
-10
0
10
20
30
40
50
60
70
δ →

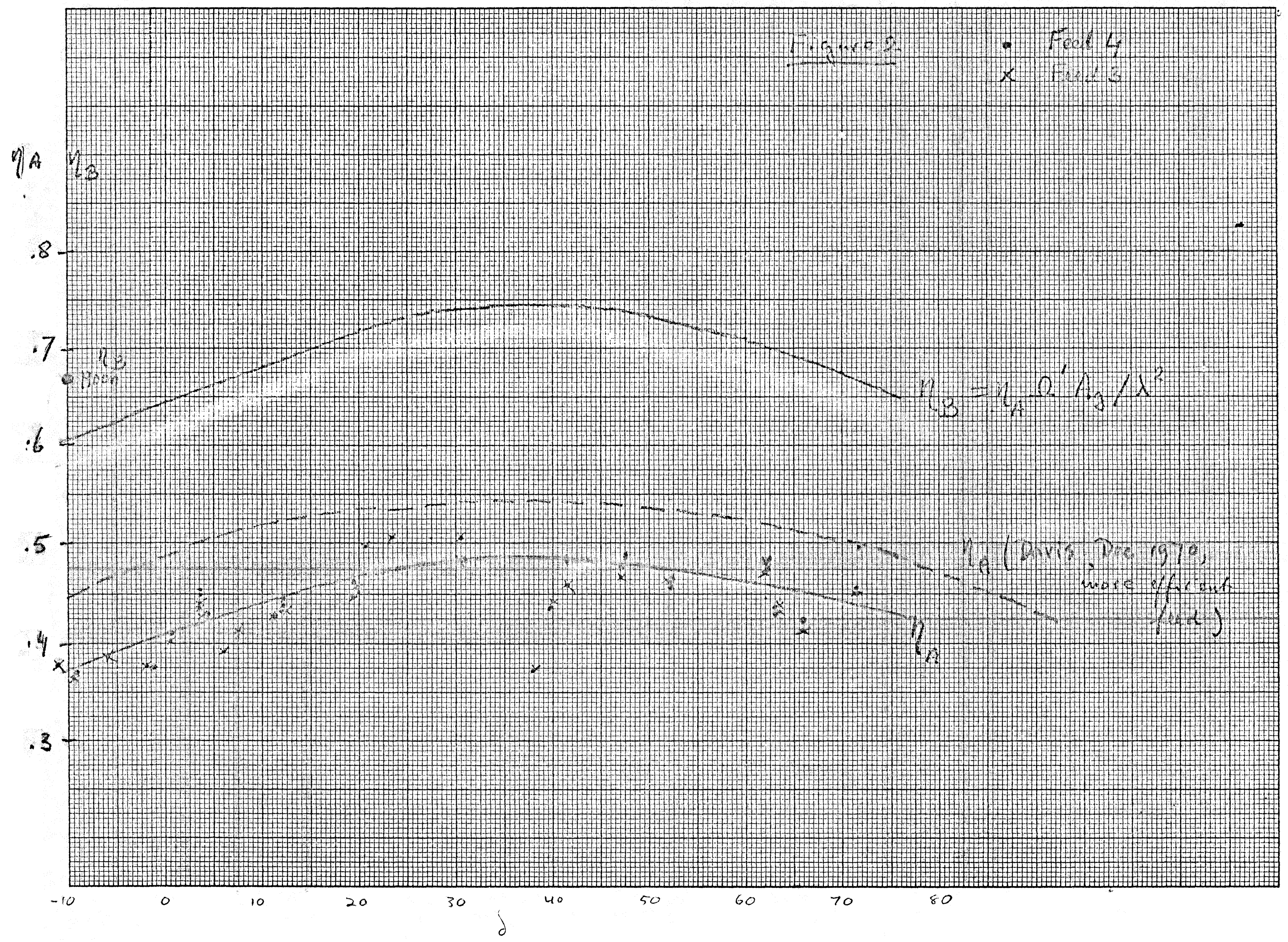
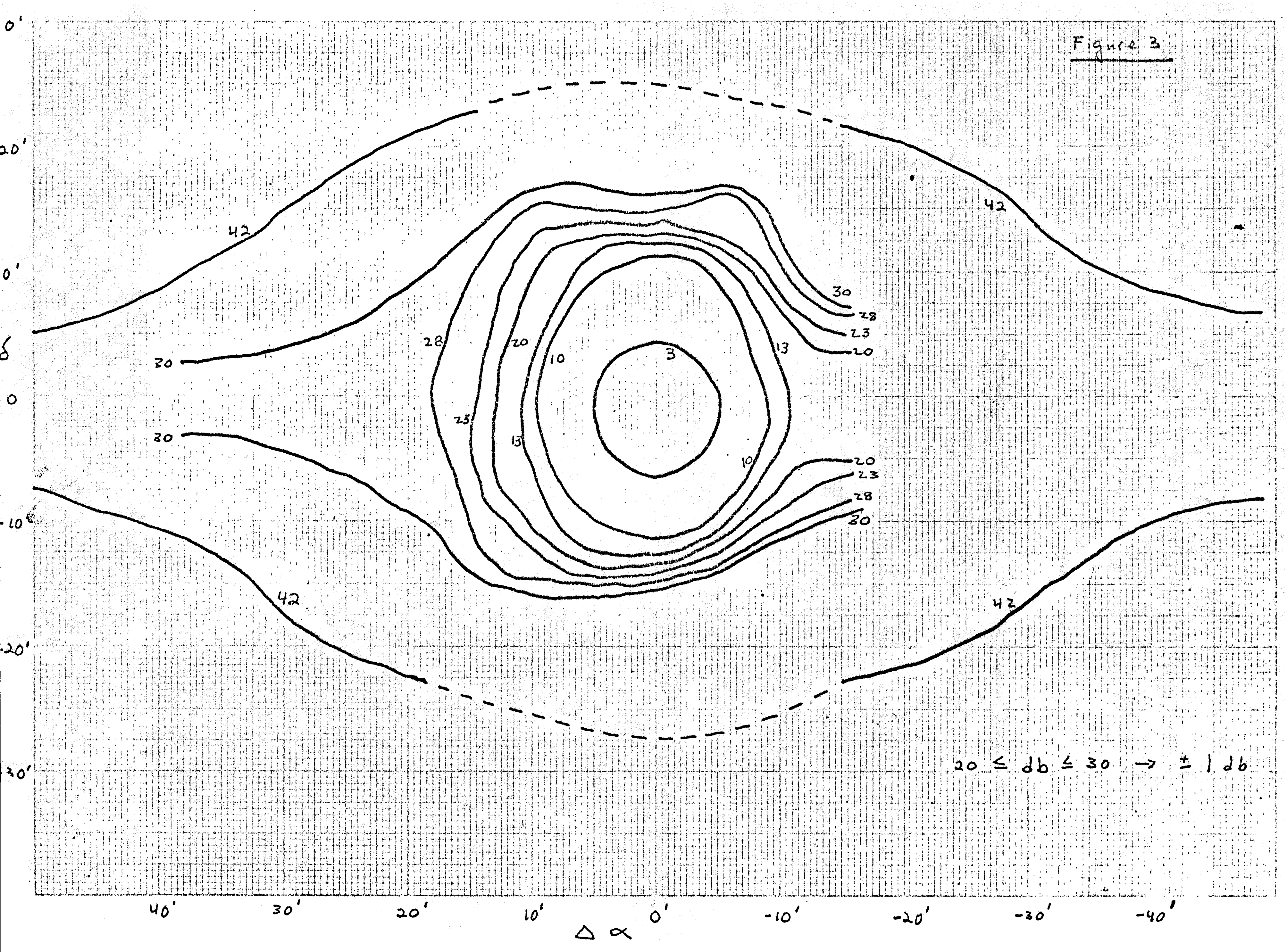


Figure 2
• Fuel 4
x Fuel 3
η_A η_B
.8
.7
.6
.5
.4
.3
η_B Moon
$\eta_B = \eta_A - 0.1 A_3/\lambda^2$
η_A (Davis, Dec 1970, more efficient fuel)
η_A
-10
0
10
20
30
40
50
60
70
80
δ

Figure 3


42
42
42
42
30
28
23
20
20
23
28
30
30
30
28
23
20
13
13
10
10
3
20 ≤ db ≤ 30 → ± 1 db
0'
20'
0'
δ
0
-10'
-20'
-30'
40'
30'
20'
10'
0'
-10'
-20'
-30'
-40'
Δ α

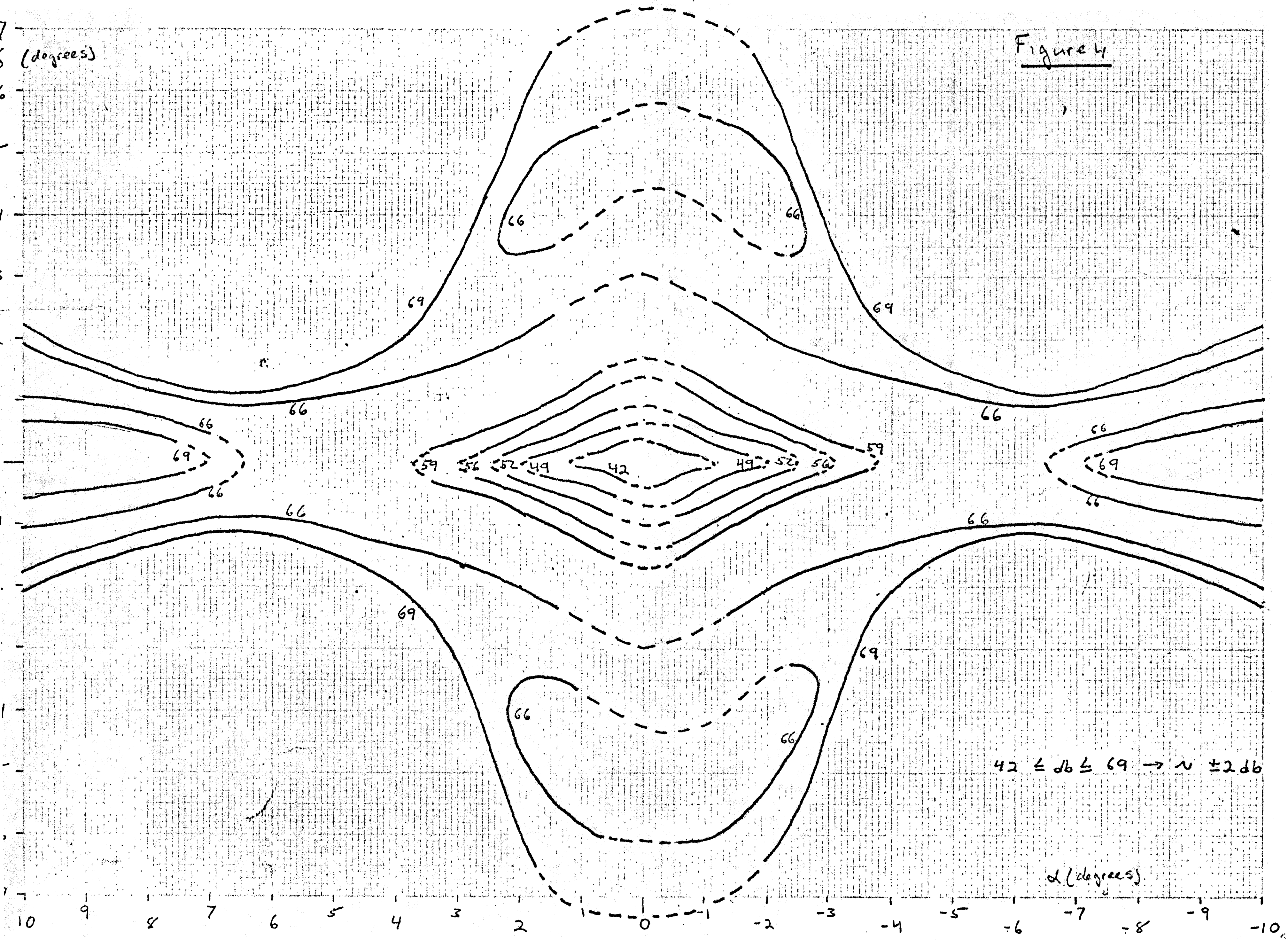


Figure 4
(degrees)
42 ≤ db ≤ 69 → ~ ±2 db
α (degrees)
69
66
59
56
52
49
42
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10