AGS STUDIES REPORT NUMBER 129

Date 12/10-20/80 Time _____ Experimenters J.F. Ryan

Subject SEB Sizes Compared with Calculated Sizes

OBSERVATIONS AND CONCLUSION

Purpose:

To determine how well the "QTUNE" program models the beam transport in the SEB switchyard and to find causes for possible errors.

Procedure:

The beam sizes as observed from flags and SWIC's were compared with the calculated sizes from "QTUNE" using the magnetic fields calculated from the AGAST command currents. In the 'A' line AQ5 was varied to make the vertical beam width at the 'A' target pass thru a minimum. This was repeated for AQ6 for the horizontal beam size. In the 'B' line this test was repeated with BQ11 and BQ13 for 'B' target measurements. Careful beam size measurements were made from F10 to the B target using flags. The amount of stray magnetic field in the hole of AD2 and AD3 Lambertson magnets was measured by detecting the movement of the 'B' and 'C' beams at the CW223 SWIC.

These tests were made at different times so that HEP was only slightly affected.

Observations:

Most of these tests were made from 0200 to 0600 when the AGS and transport magnets were steady. The 'B' line flag measurements were made on December 20, 1980 after J. Glenn reduced the spiral pitch to 0.54 in. at F10. All of the measurments were done with a steady beam with low transport losses. Extraction efficiency was greater than 95% and inefficiency less than 7%.

The beam sizes were obtained from the 'A' target SWIC in the 'A' line only. The 'B' line beam sizes were measured from the 'B' target flag with the beam spot moved to a sensitive area.

Results and Discussions:

Figures 1 and 2 show the 99% half size beam width in the 'A' line as compared to the calculated value from "QTUNE" as AQ6 or AQ5 was varied. The beam size at the SWIC location, 91 in. before the A target, is plotted with "QTUNE". Figures 3 and 4 show the general shape of the calculated beam from F13 to the target. H. Weisberg's emittance is assumed. Figure 5 shows the horizontal SWIC's plotted on a log scale with the assumed background plotted as a solid smooth line. Using H. Weisberg's background subtraction method, the half width of the beam was obtained from these SWIC measurements.

The 'A' target optics were adjusted for a large beam at the 'A' target for the Adair experiment. The SWIC used was a 'maxi' SWIC with 0.160 in. wire spacing. The SWIC readings were clean with no missing wires. The measured widths from the SWIC's are much wider than the calcualted widths by a factor of 2.5 and 1.8 for the horizontal and vertical shapes. At the minimum of the curves of Figure 1 and 2, the ratio is much larger. The calculated minimum location do agree well with the observed minimum as a function of quad setting. The observed data indicate the ratios between observed and calculated emittances of 8.8 and 3.4 in the A line. This error will be discussed later, but is probably caused by extraction power supply ripple.

Figures 6 thru 12 show the results for the 'B' line. Figures 9 and 12 show that the beam size cannot be measured accurately from the 'B' target SWIC. Bad wires, channels with different gains, and a large beam appear to cause bad SWIC patterns. The wire spacing is 12.5 mils. The beam size that was plotted was observed from the 'B' target flag. Figures 8 and 11 show that the beam size is varying rapidly near the target and that the beam size as measured at the SWIC location 17 in. before the target can be 100 mils greater than at the target.

Figures 7 and 10 show a better agreement between the observed and calculated sizes in the 'B' line than in the 'A' line. In fact, the operating value of BQ11 is 2712A and "QTUNE" predicts a minimum horizontal beam size at 2713.5 A. The program also predicts a sharp minimum in horizontal size as BQ11 varies, but this was not observed on the flag. This may be due to the nonlinear response of the flag.

The plunging SWIC CW223 was inserted and the 'B' and 'C' beams were observed with AD2 and 3 on and off. Figure 13 shows that the beam moved horizontally to the left when AD2 and 3 was turned off corresponding to a move to the east or away from the 'B' line. The CW223 wire spacing is 50 mils. By observing only the peak of the 'C' beam, the SWIC shows a movement of 160 mils horizontally. From the whole vertical SWIC, the beam moved 47 mils up or down. From the transport matrix elements that can be printed from "QTUNE" using the current AGAST settings, the field in the hole is calculated to be 27.3 gauss for a magnetic field in the iron of 12.98 kG. The field is at a 23° angle with the vertical. The ratio is 475, the approximate permeability of the iron at 12.98 kG.

Figures 14 thru 18 show the 'B' line beam measured from flags compared to the "QTUNE" calculated values. The beam distribution to A, B and C targets was 0.25, 1.68 and 5.16 TP.

The agreement is poor. Figure 14 shows that agreement is bad after BB3 since the B line was split off the total beam. The flags of Figure 16 are important. CF011 shows a fuzzy tail on the horizontal beam indicating a wider beam. The hot core shown on CF011 is the correct size as predicted by "QTUNE", 1.25" by 0.255". On CF039 the beam is surrounded by this fuzzy beam before going into the splitters. At CF100 the beam is split into the A, B, and C beams but the B and C beams appear the same size. This is surprising since the 'A' intensity is 1/7 the 'B' intensity. This would indicate a higher emittance for the 'A' line especially in the horizontal plane. This may be the fuzzy area of CF011 transported down to CF100.

The fuzzy area should not probably occur at CF011 and is probably caused by ripple on the extraction magnet power supply F10. Misadjusted ramps would cause the beam to move at a visible rate.

In conclusion, "QTUNE" appears to predict the correct beam size, but more tests are necessary. These tests should be made only after the beam is the correct size after extraction. Observing the CF011 flag is an excellent way of determining if extraction is clean. One cannot predict downstream beam sizes if the wrong size or wrong emittance beam is coming out of the AGS.

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BY_____ DATE 12/22/81 SUBJECT_____ SHEET No._____ OF_____

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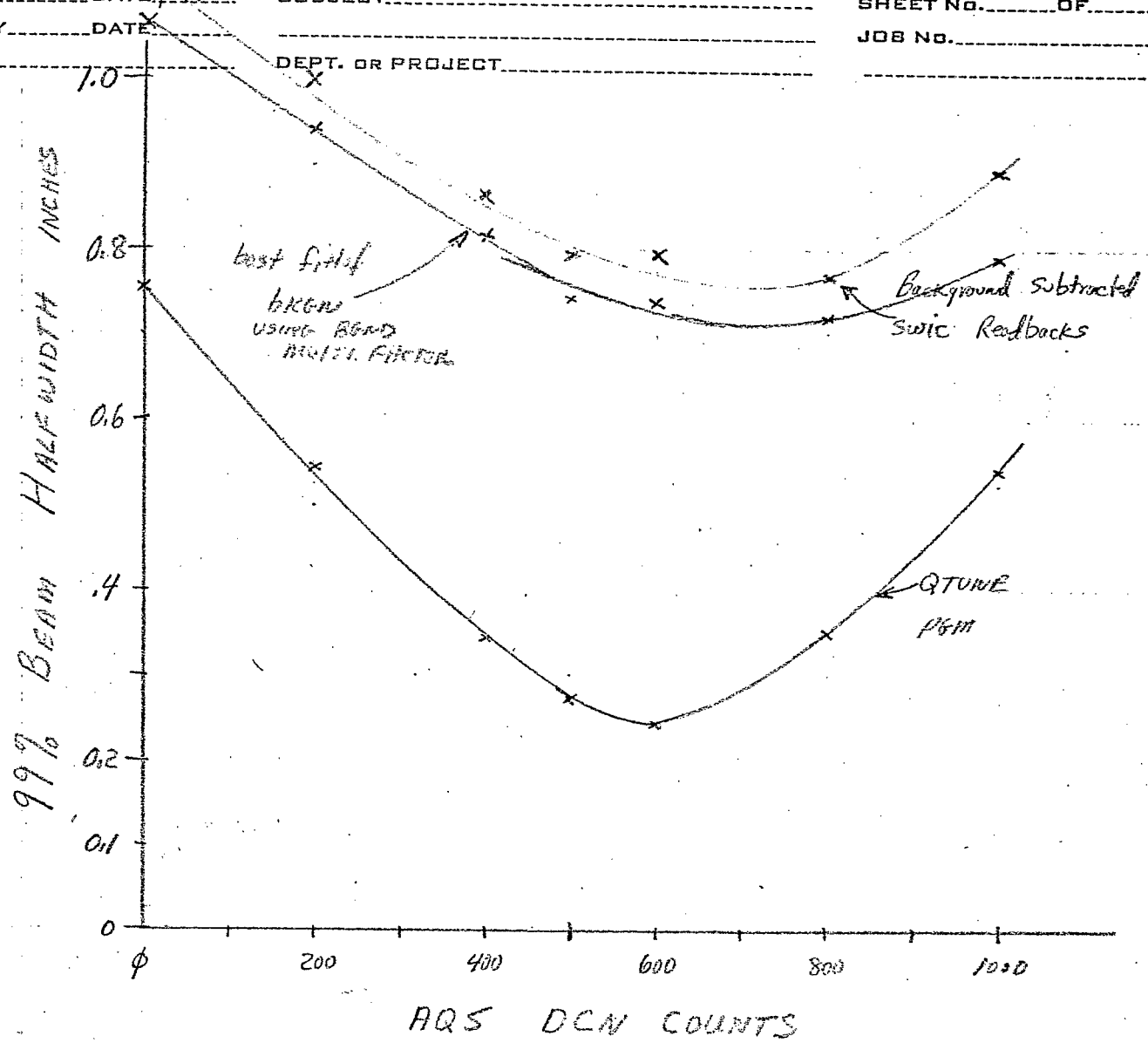

VERTICAL

Outsize of minimum – average difference = .442 inches

RMS Assumed emittance of F13 -- α, β, ϵ = 0.8708, 0.1279, .0095 (inch-mrad)

99% emittance = 0.08750 (in-mrad)

WIDTH = $K\sqrt{\beta\epsilon} = K\sqrt{\epsilon}$ $W_Q = 542$ $\epsilon = .08750$

$W_S = 1000$ $\epsilon_x = \epsilon_x = 0.2978$ (in-mrad)

SEB INFO - 12-Dec 1980 4 AM

A = 0.73 TP T/I = 80.5

B = 0 TP PLS = 6.9

C = 5.26 TP LLS = 6.4

XEFF = 98.6% MP = 12.0

XIEFF = 5%

$\frac{\epsilon_x}{\epsilon} = 3.40$

B. With beam fitting (given curve) $\frac{\epsilon_x}{\epsilon} = 3.0$ $\begin{cases} W_Q = 542 \\ W_S = 942 \end{cases}$

FIGURE 1

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BY_____ DATE 1/28/81 SUBJECT_____ SHEET No._____ OF_____

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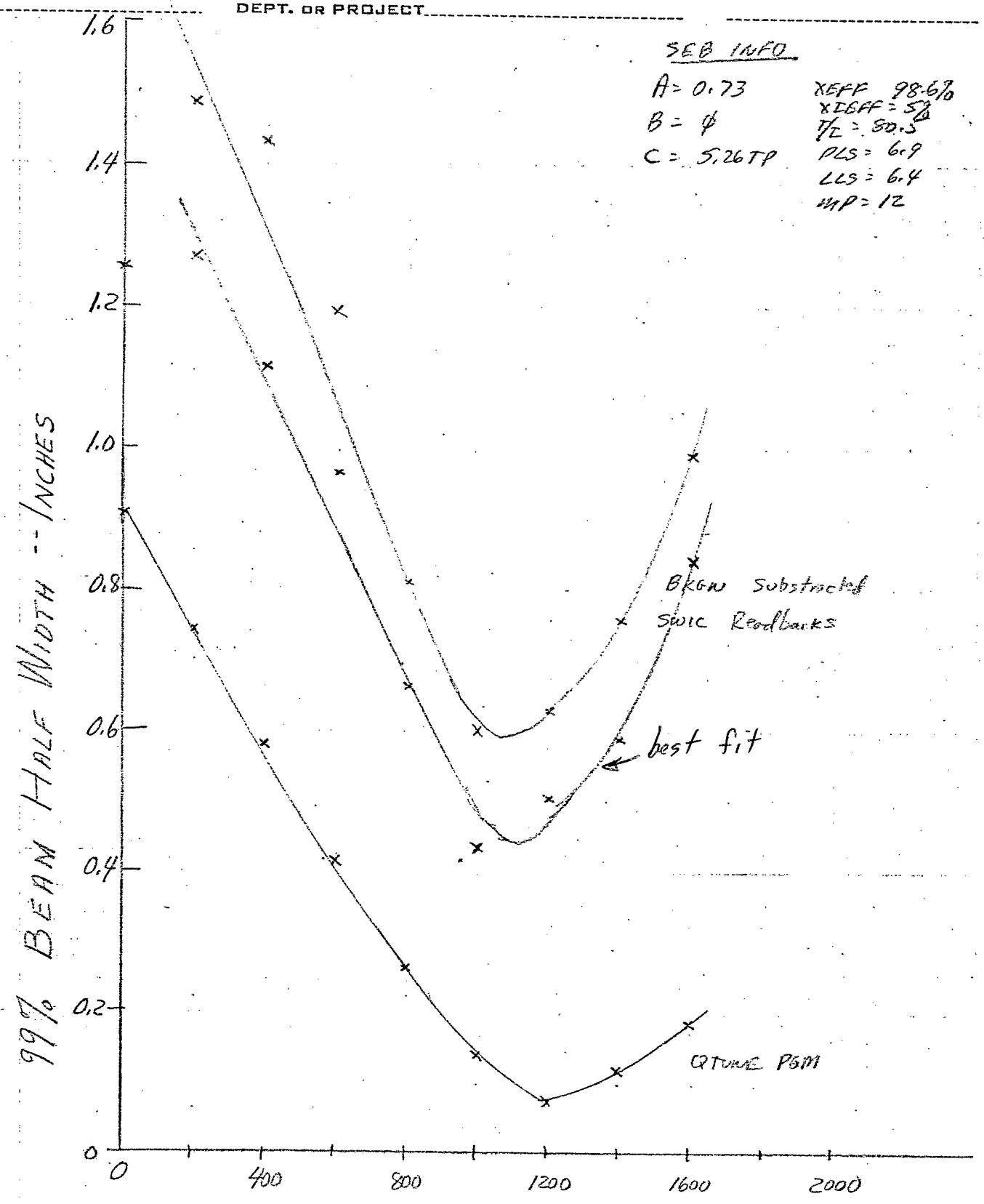
SEB INFO

A = 0.73
B = ϕ
C = 5.26 TP

XEFF 98.6%
XIEFF = 5%
η_L = 50.3
PLS = 6.9
LLS = 6.4
MAP = 12



AQ6. DCN COUNTS HORIZONTAL

FIGURE 2

QTUNE Assume emittance at F13 – .0078 (in-mrad rms) = 0.0718 (in-mm) 99% beam

Measured emittance = $\left(\frac{1.8}{1.27}\right)^2$ = 8.8 times ∈ QTUNE

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General effects in 'A' of varying AQ5 & AQ6

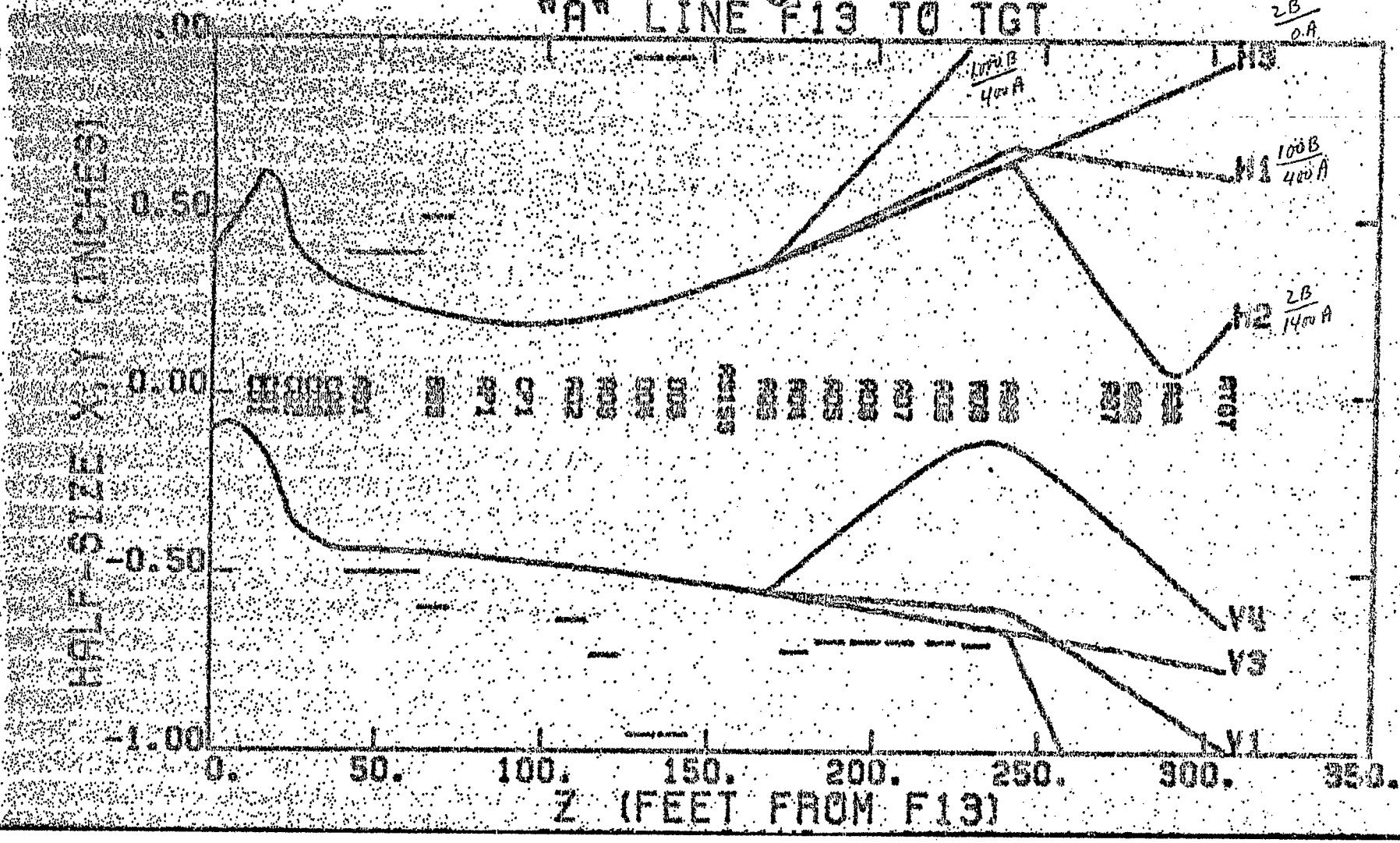

FIGURE 3

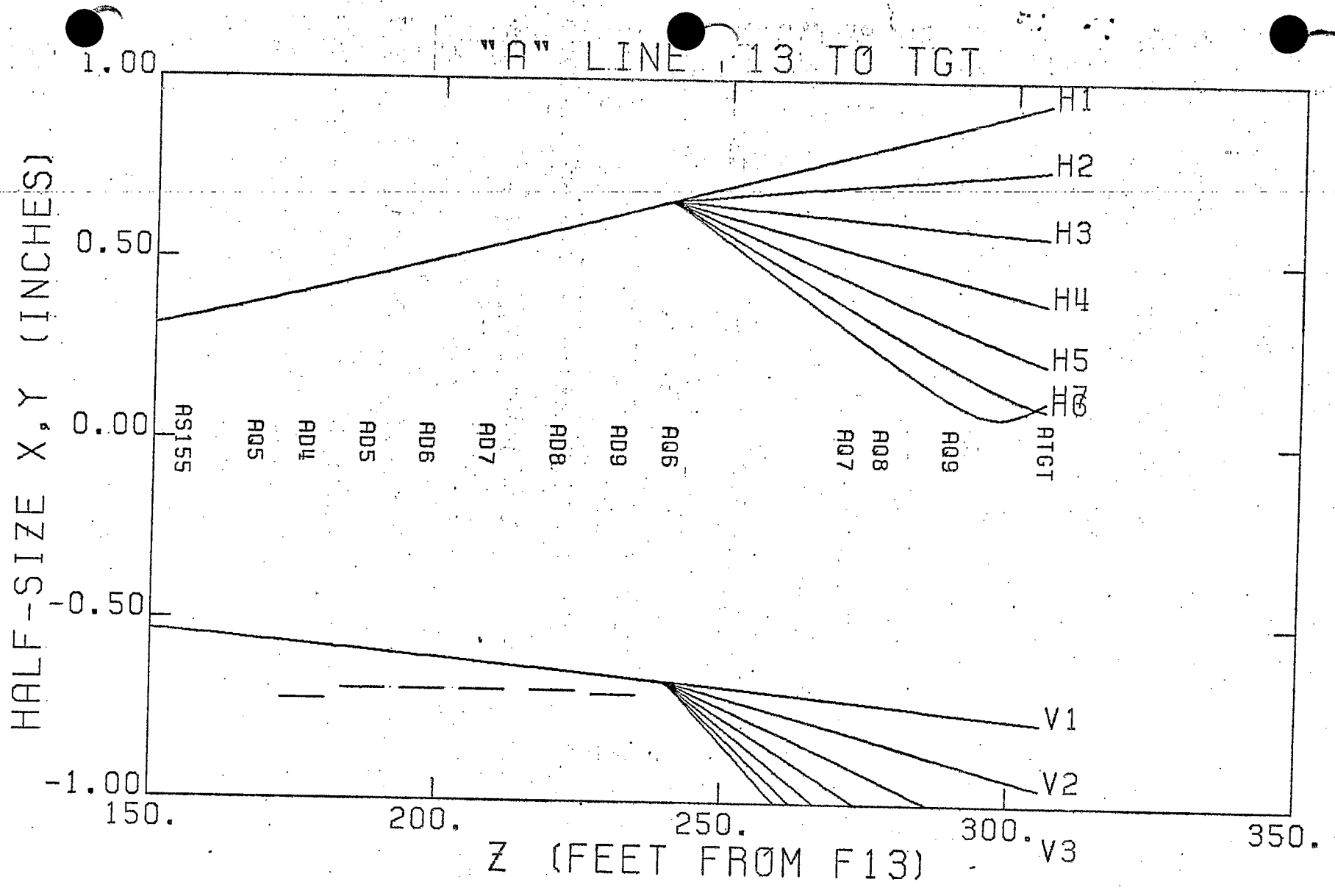
"A" LINE F13 TO TGT
1.00
0.50
0.00
-0.50
-1.00
HALF-SIZE X, Y (INCHES)
150.
200.
250.
300.
350.
Z (FEET FROM F13)
H1
H2
H3
H4
H5
H6
H7
V1
V2
V3
V4
V5
V6
V7
AS155
AQ5
AQ4
AQ5
AQ6
AQ7
AQ8
AQ9
AQ6
AQ7
AQ8
AQ9
ATGT

FIGURE 4

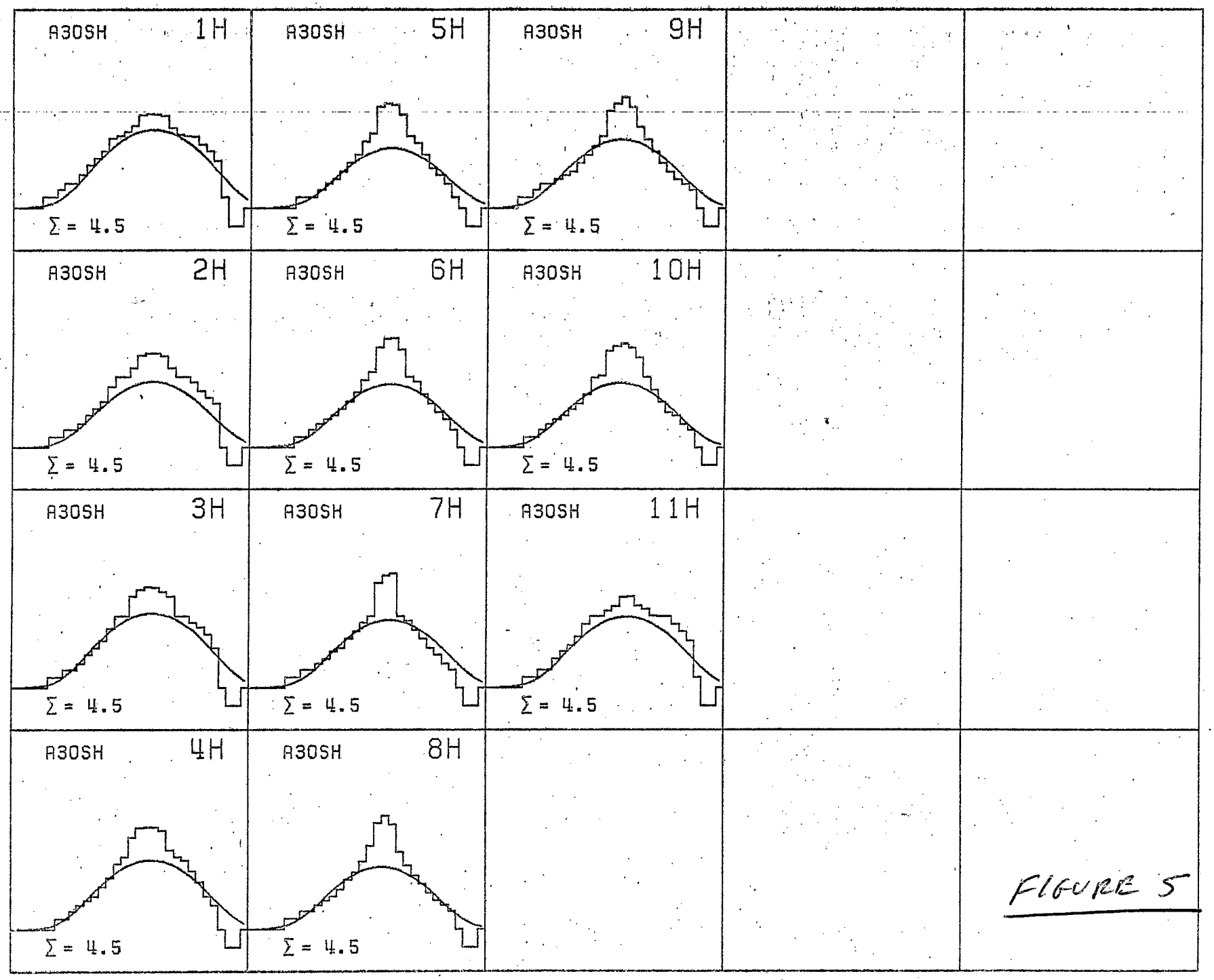

FIGURE 5

VARYING AQ6 - Best fit USING BKOW FACTOR

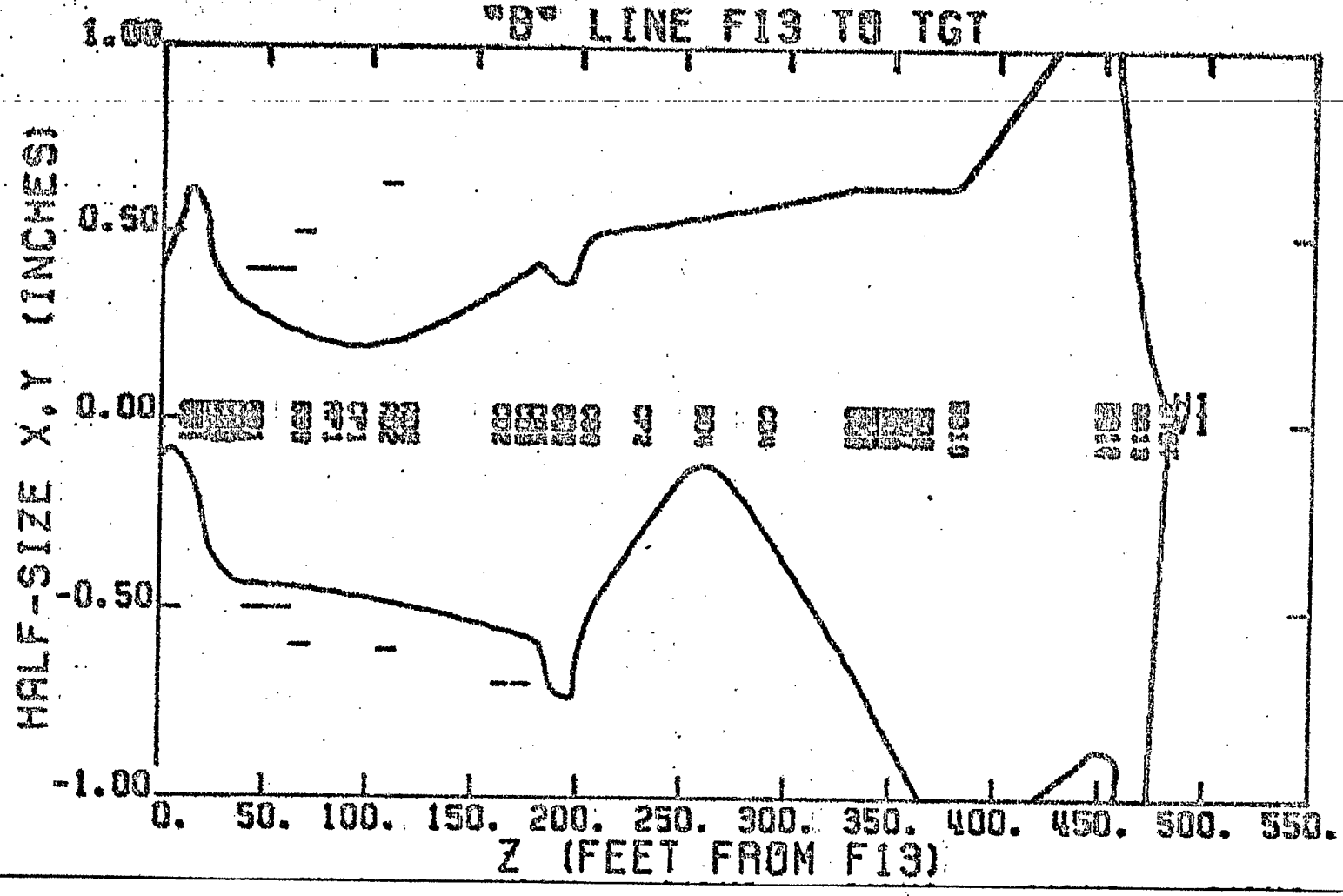
"B" LINE F13 TO TGT
1.00
0.50
0.00
-0.50
-1.00
HALF-SIZE X,Y (INCHES)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500. 550.
Z (FEET FROM F13)

FIGURE 6

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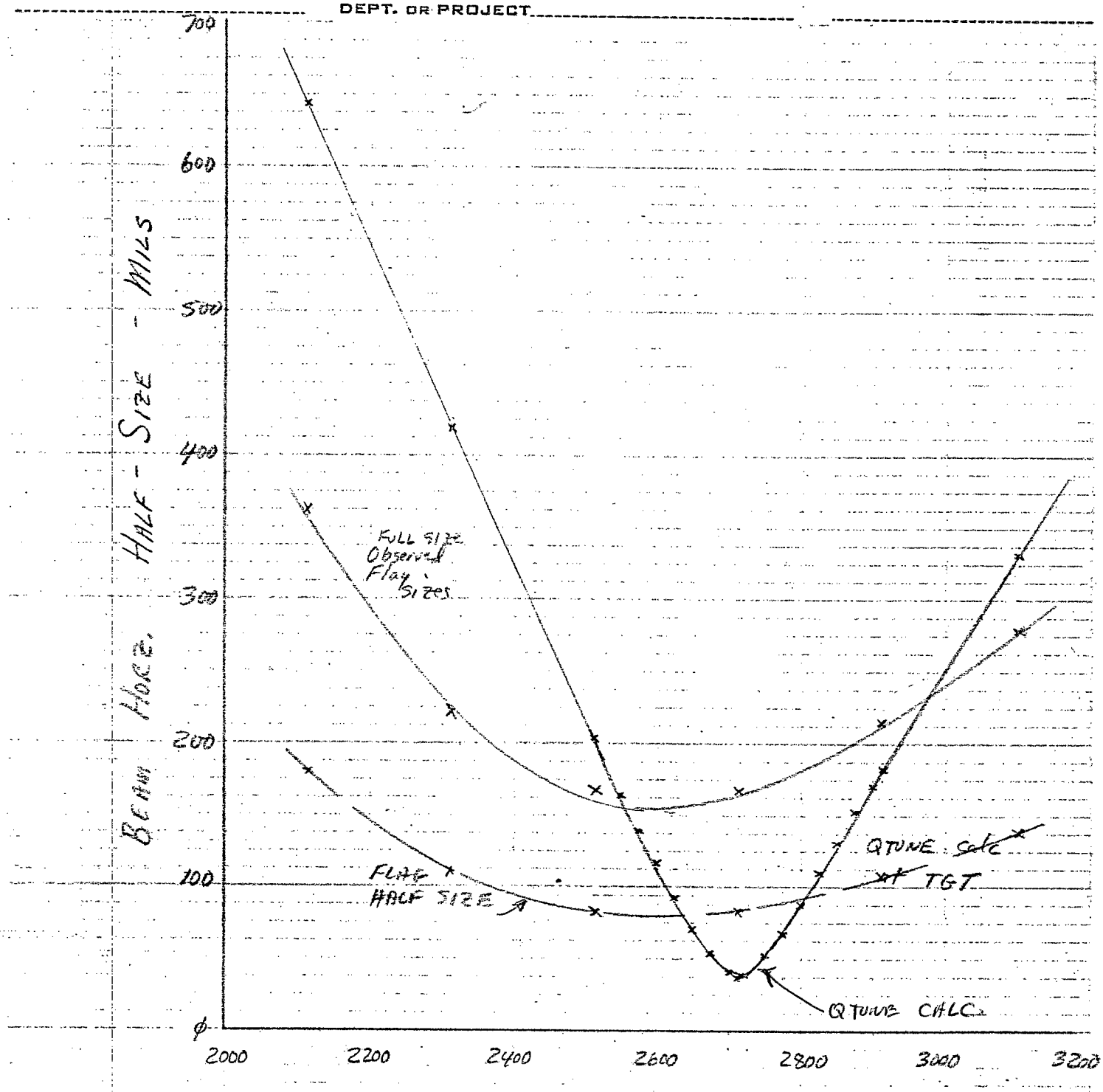


BQ 11 DCM COUNTS

A = 0.55TP
B = 1.17TP
C = 4.62TP

Note: The operating point is 2712; the minimum calc occurs at 2713.5 very good check

SP 11037A

FIGURE 7

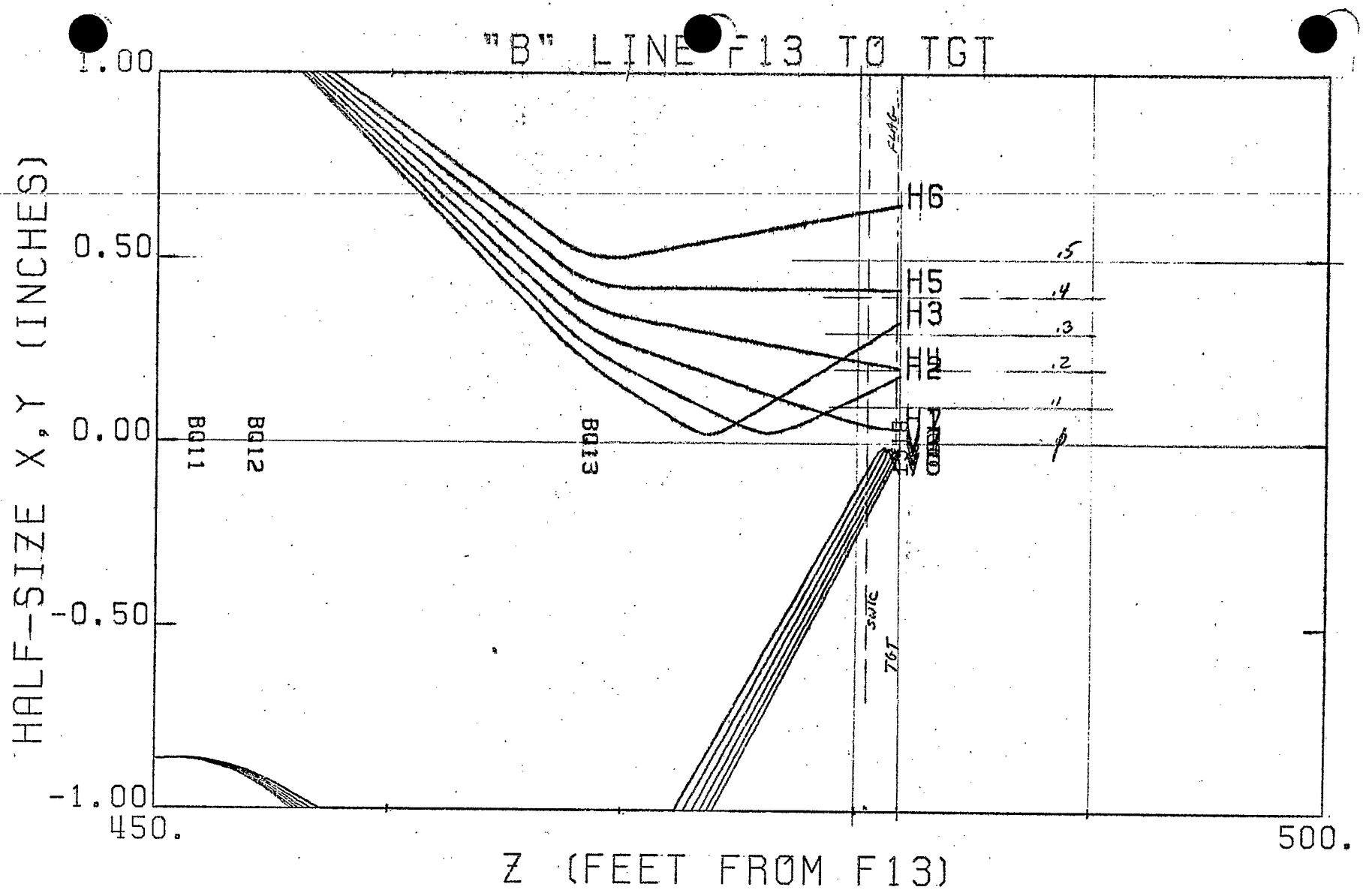

"B" LINE F13 TO TGT
HALF-SIZE X,Y (INCHES)
1.00
0.50
0.00
-0.50
-1.00
450.
500.
Z (FEET FROM F13)
BQ11
BQ12
BQ13
H6
H5
H3
H2
H1
.5
.4
.3
.2
.1
0
FLAG
SWIC
TGT

FIGURE 8

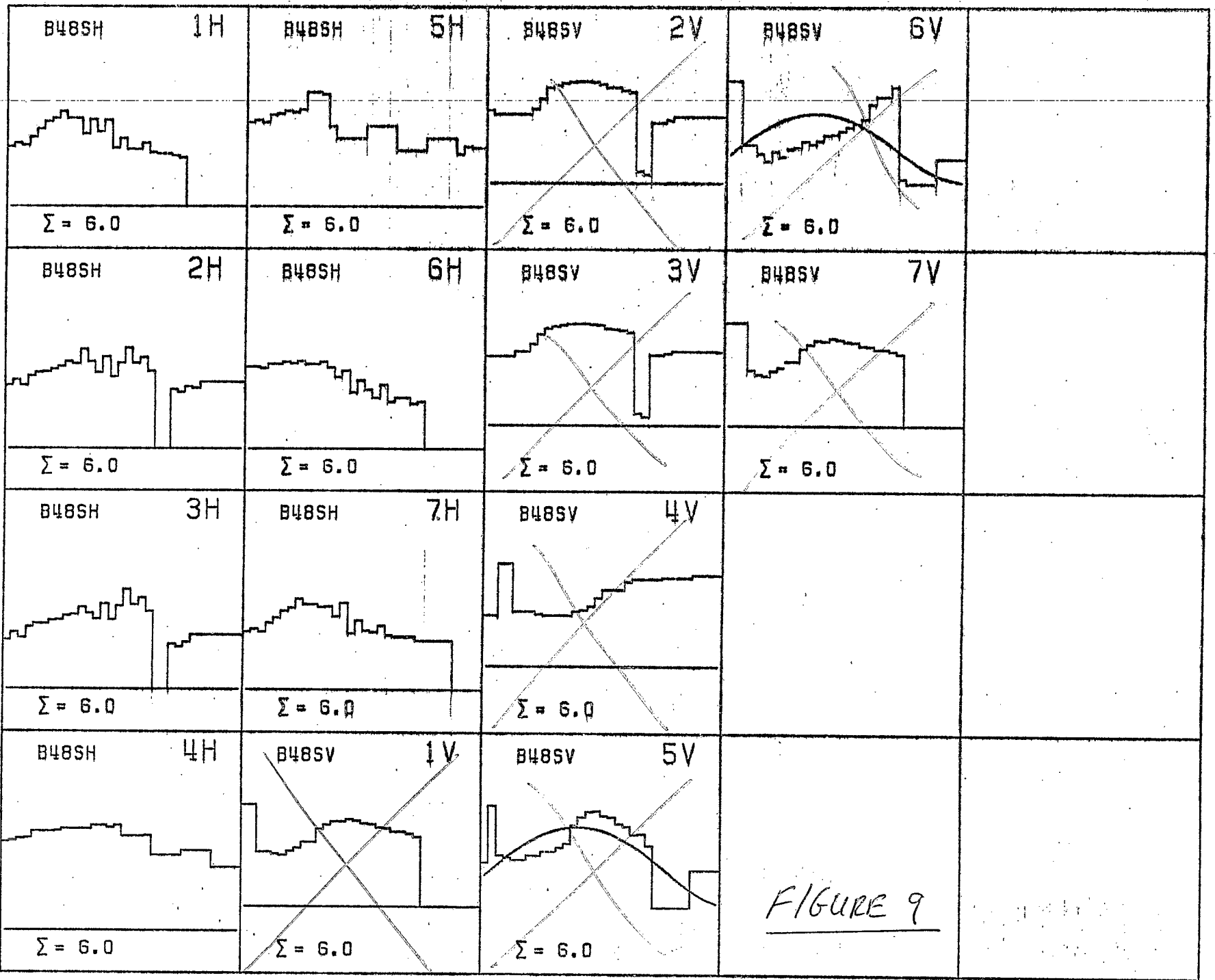
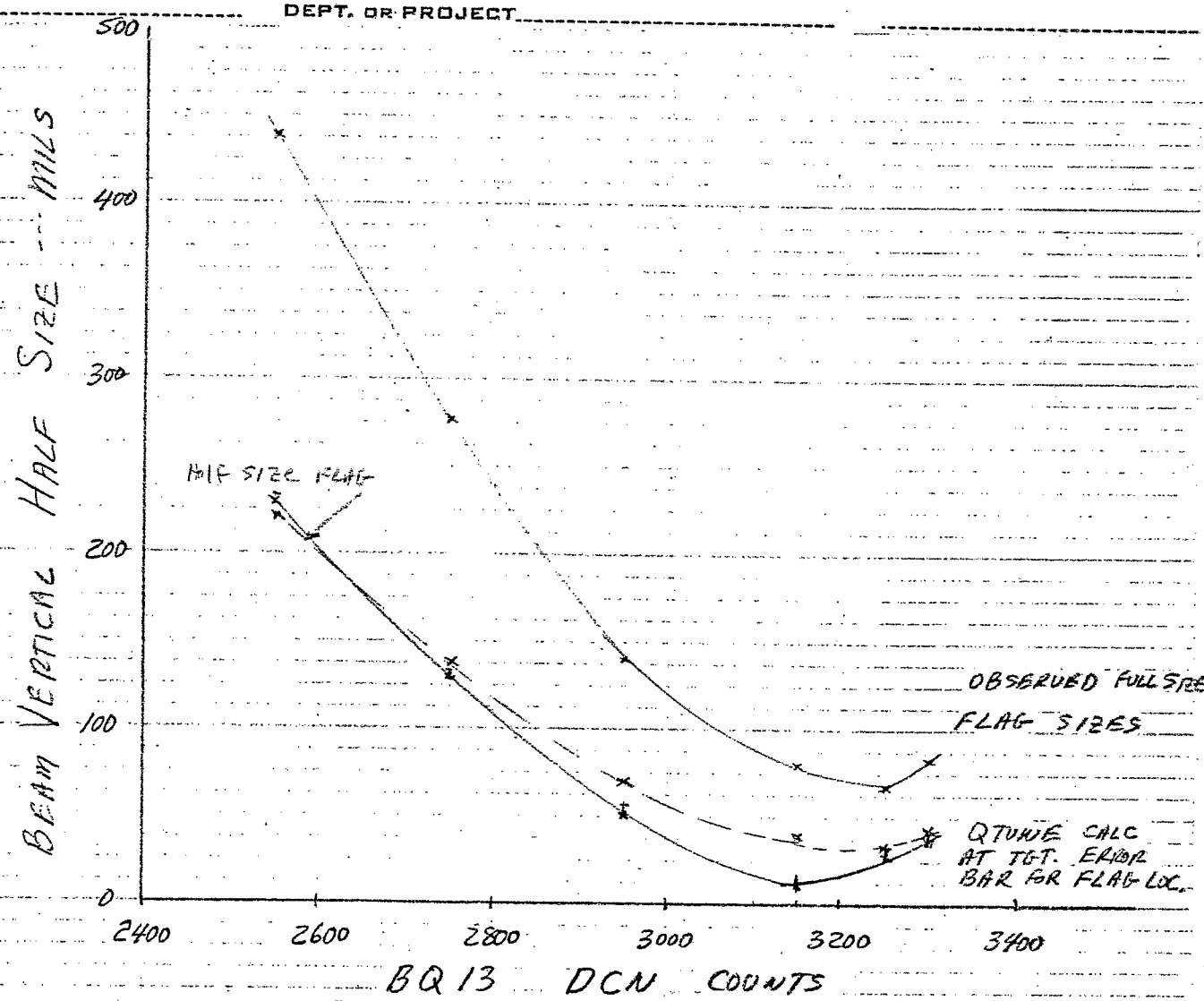


FIGURE 9

Horz. size can not be interpeted



A = 0.55TP
B = 1.17 TP
C = 4.62TP

FIGURE 10

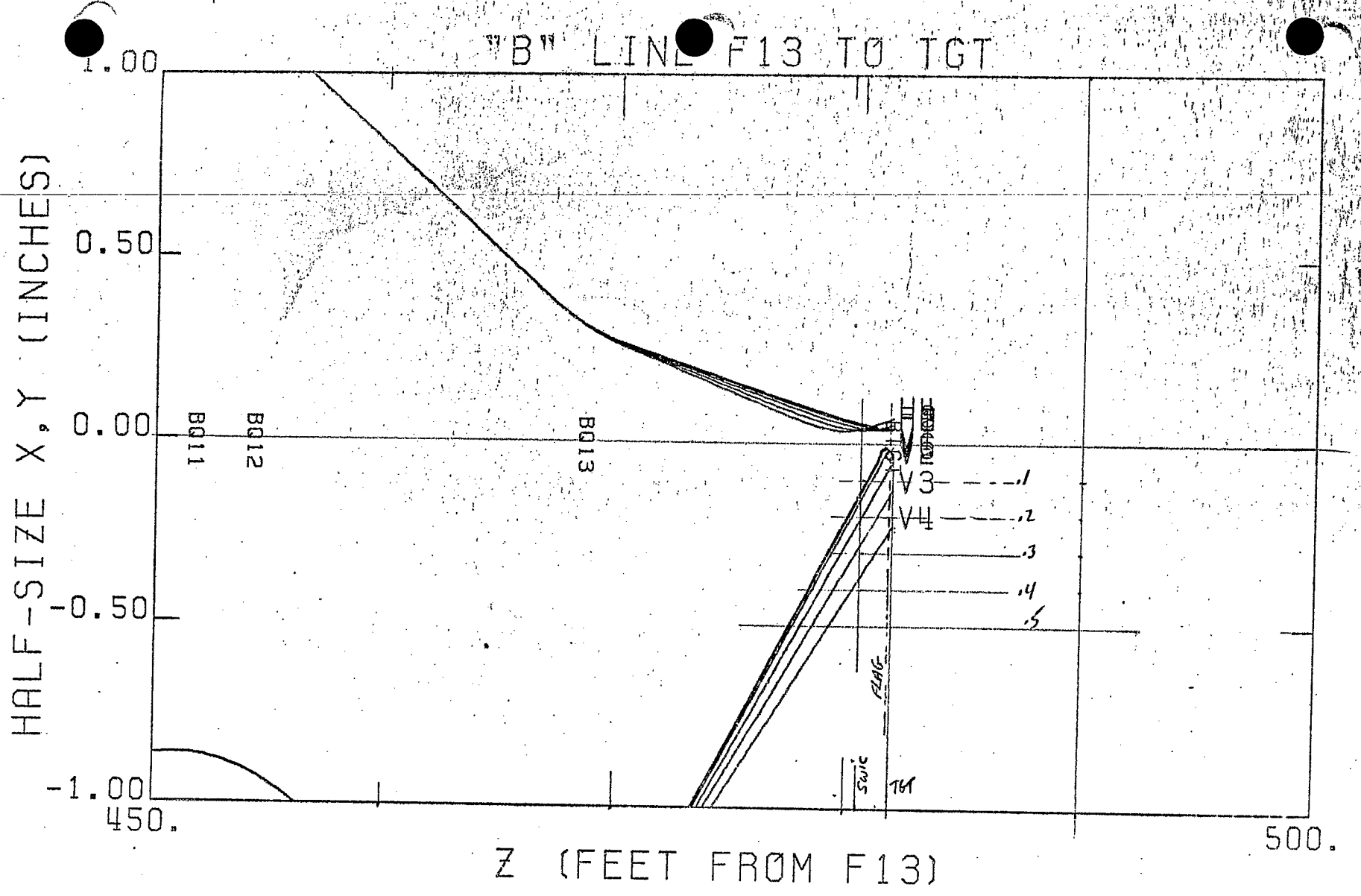

"B" LINE F13 TO TGT
1.00
0.50
0.00
-0.50
-1.00
HALF-SIZE X, Y (INCHES)
BQ11
BQ12
BQ13
V3
V4
.1
.2
.3
.4
.5
FLAG
SWIC
TGT
450.
500.
Z (FEET FROM F13)

FIGURE 11

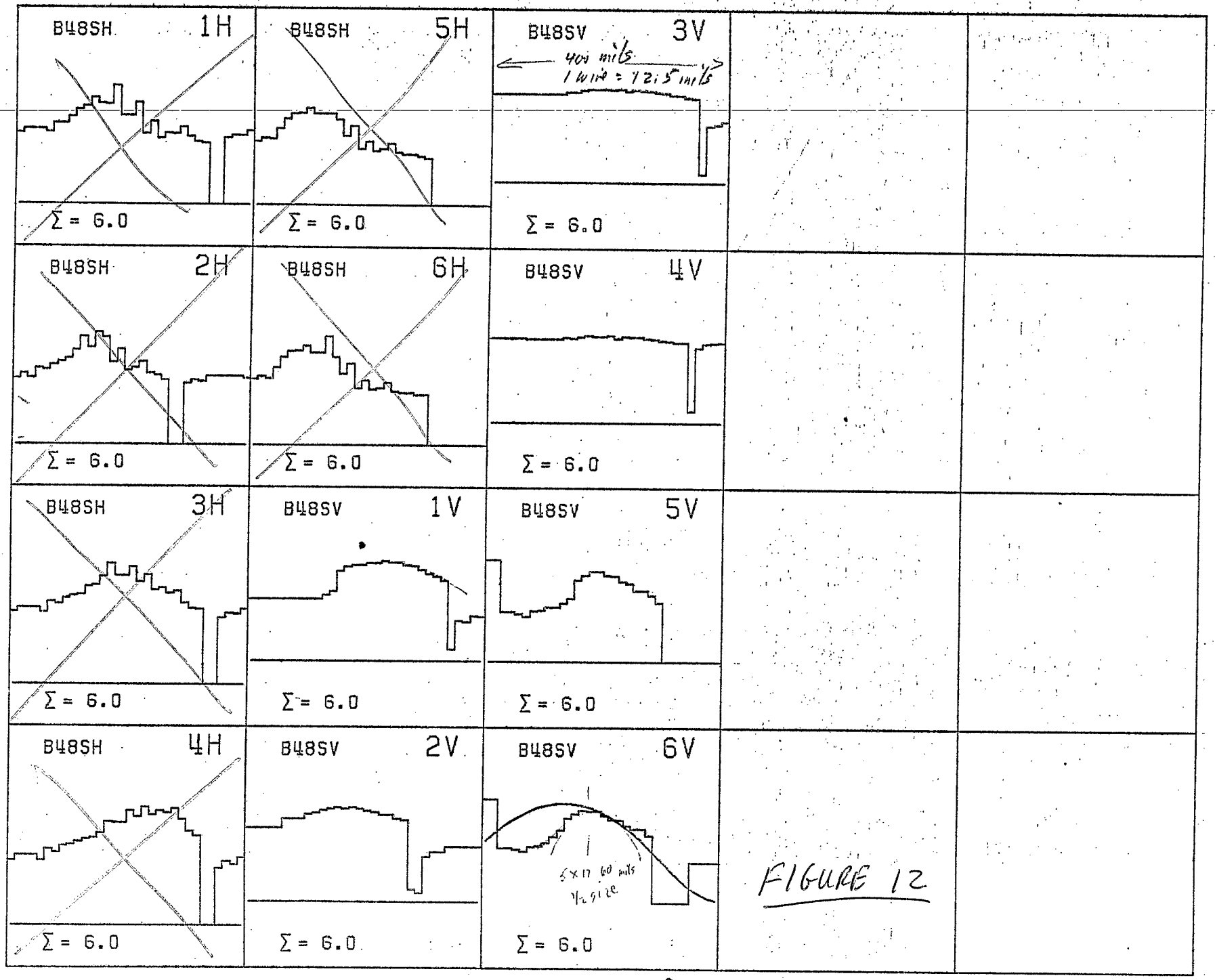
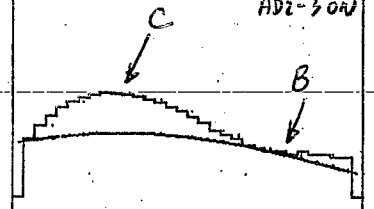


FIGURE 12

Can not interpet the vertical patterns

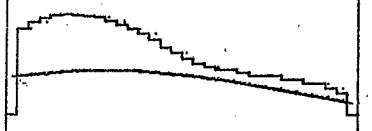
C22SH 1H ADL-3 ON



Σ = 12.0

This program can not accurately determine the horiz. centroid movement because the beam is cut off on the swics. If it is moved to far to the left on the swic

C22SH 2H ADL-3 OFF



Σ = 12.0

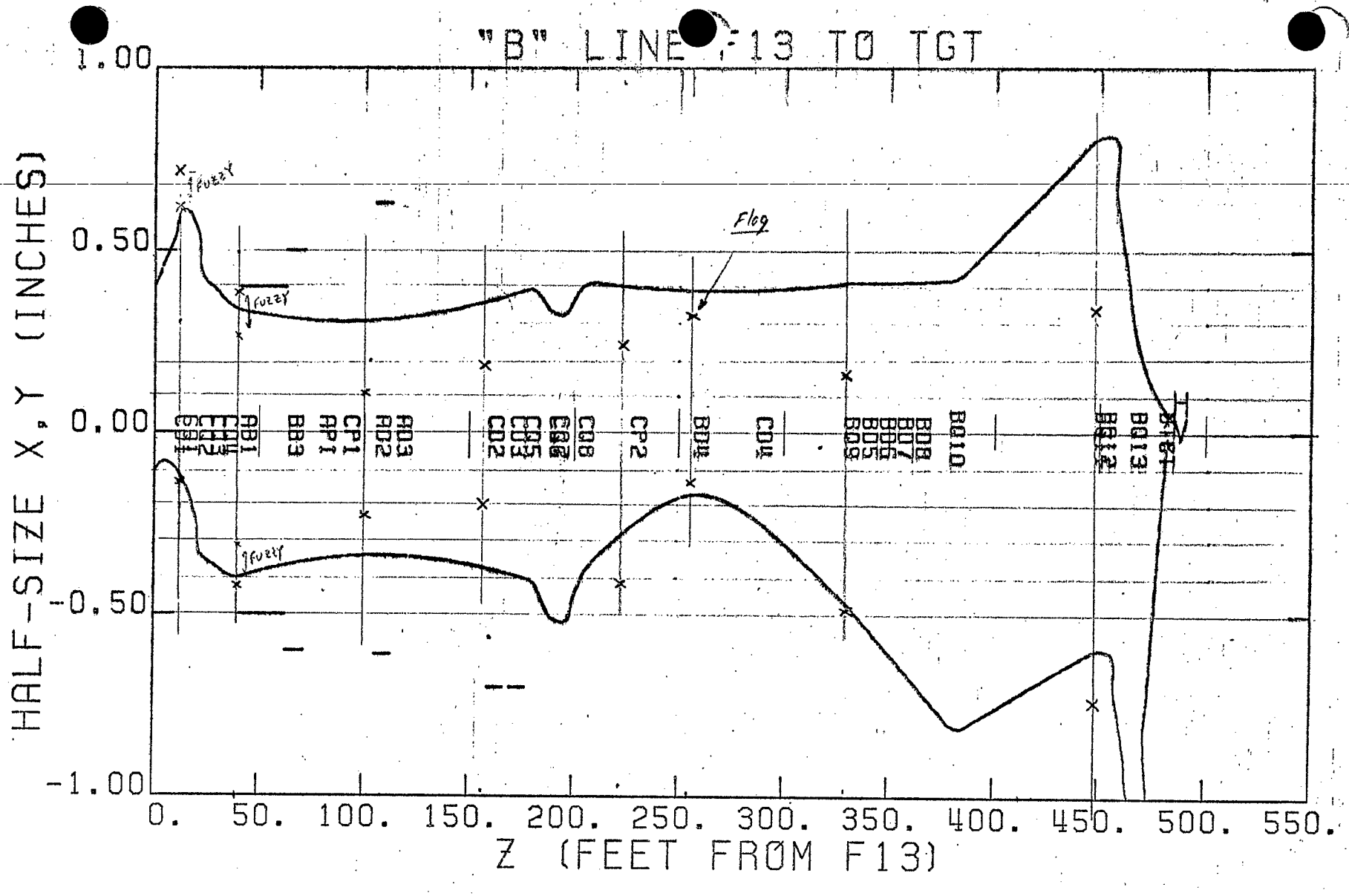
C22SV 1V ADL-3 ON

Σ = 8.0

C22SV 2V ADL-3 OFF

Σ = 8.0

FIGURE 13



Comparison Of Calculated & Observed 'B' line Beam Half-Sizes.

FIGURE 14

F10 1549 → 2082

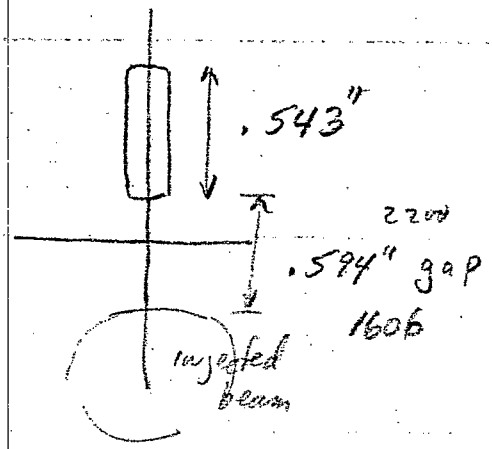


FIGURE 15

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BY _____ DATE 12/20 SUBJECT B Line Low Losses SHEET No. 3 OF _____

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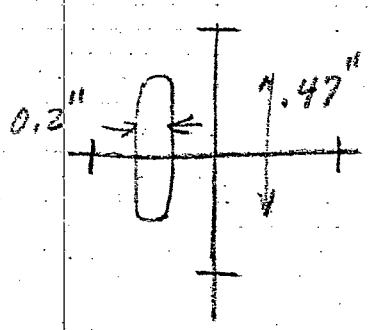
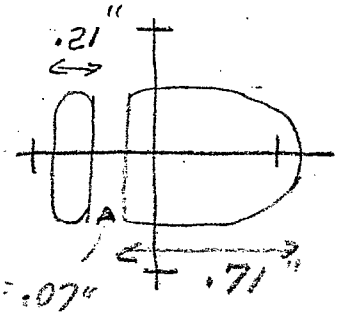
CF100



The Swic at C100 does not work --- it reds back zero but it appears to go in.

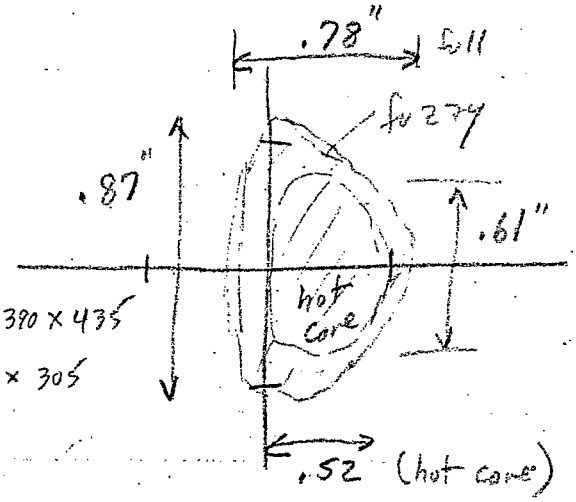


HS B = 105 x 235

gap: .07"

Total beam
560 x 235

CF039

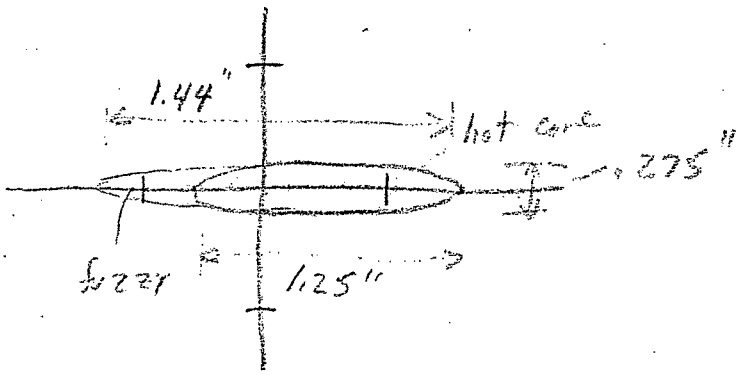


HS B = 390 x 435

Hot core - 260 x 305

CF040 Swic does not work

CF011



HS = 720 x 137
or 625 x 137

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FIGURE 16

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BY _____ DATE 12/20/80 SUBJECT B Line SHEET No. 2 OF _____

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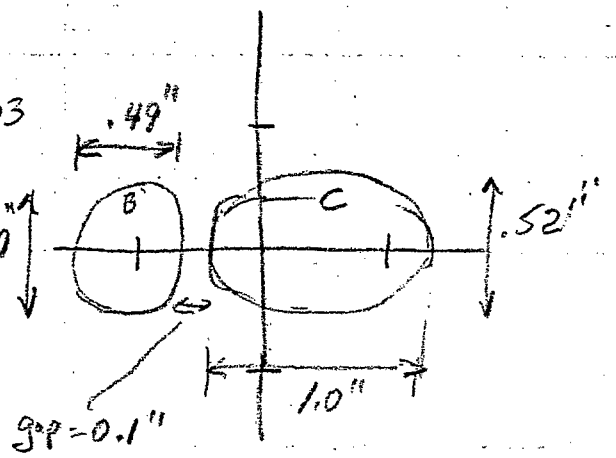
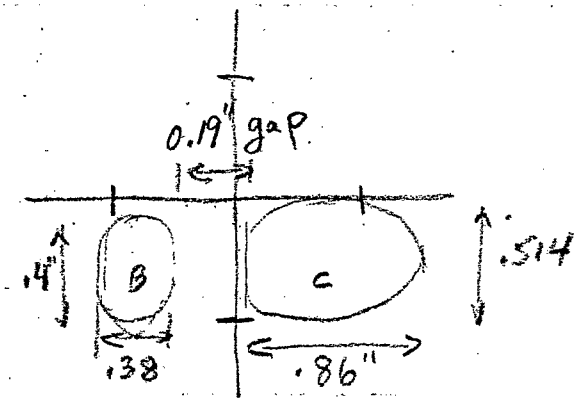
CF 223

HS = 245 x 203



CF 157



B HS = 190 x 200

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FIGURE 17

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BY_____ DATE 12/2/82 SUBJECT B Line flags SHEET No. 1 OF_____

CHKD. BY_____ DATE_____ JOB No._____

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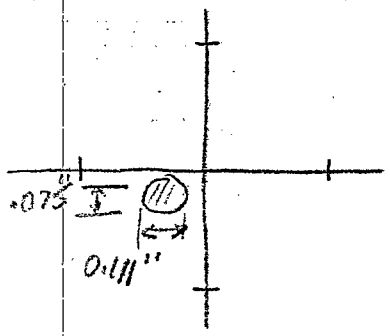
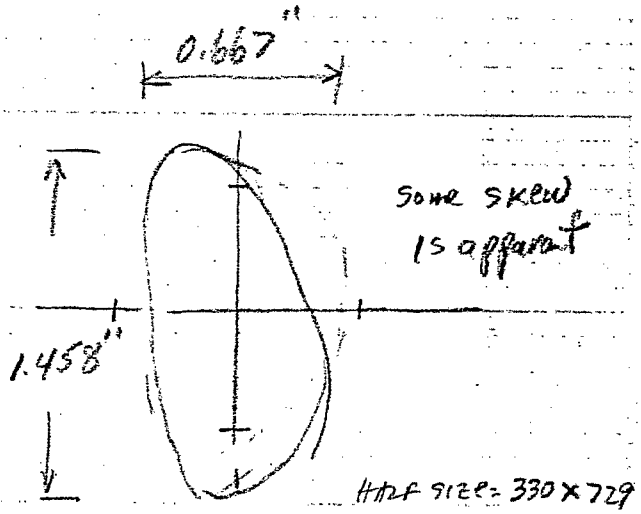
B TGT A = 0.25 C = 5.16 TP BF448
B = 1.68

beam moved for good picture

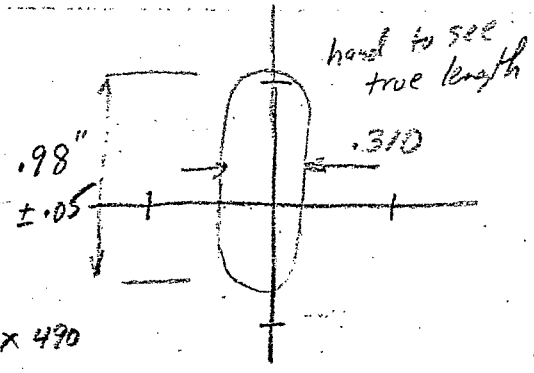


Half size – 55 x 37



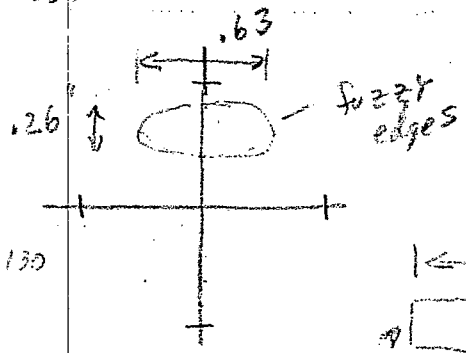
Half size = 330 x 729

BF329



H.S = 155 x 490

CF255



H.S = 315 x 130

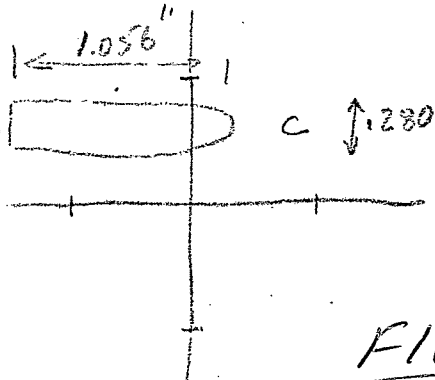


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FIGURE 18