

## SEB Size Comparison

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December 1980

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**U.S. Department of Energy**

USDOE Office of Science (SC)

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Date 12/10-20/80 Time \_\_\_\_\_ Experimenters J.F. RyanSubject SEB Sizes Compared with Calculated SizesOBSERVATIONS AND CONCLUSIONPurpose:

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 measurements 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 calculated 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.

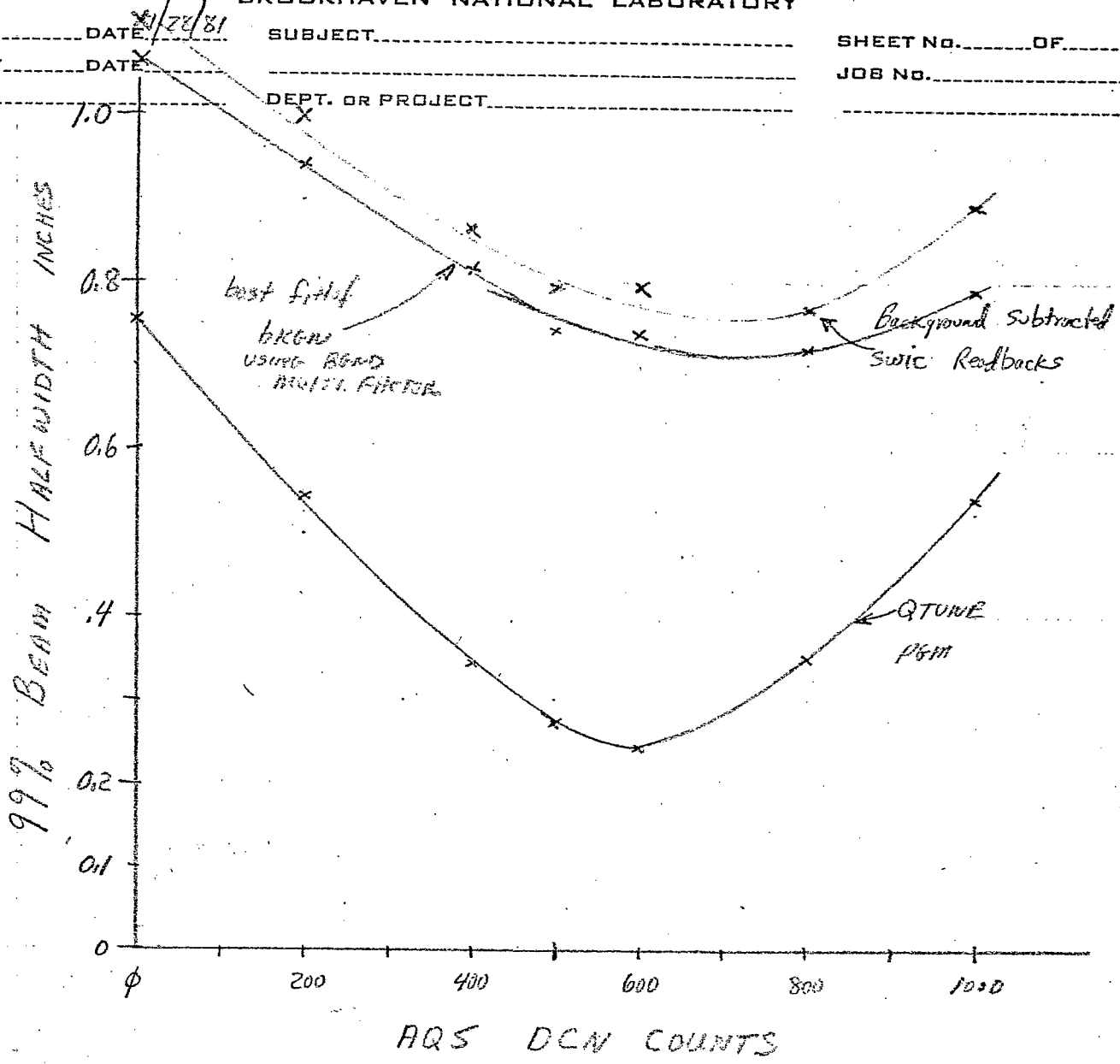
The plunging SWIC CW223 was inserted and the 'B' and 'C' beams were observed with AD2 and 3 on and off. Figure 13 shows that the beam moved horizontally to the left when AD2 and 3 was turned off corresponding to a move to the east or away from the 'B' line. The CW223 wire spacing is 50 mils. By observing 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.



VERTICAL

outsized of minimum - average difference = 4/12 inches  
 RMS Assumed emittance of F13 --  $\alpha, \beta, \epsilon = 0.8708, 0.1279, .0095$  (inch-mrad)  
 99% emittance = 0.08750 (inch-mrad)  
 WIDTH =  $K \sqrt{\beta \epsilon} = K \sqrt{\epsilon}$   
 $W_Q = 542$      $\epsilon = .08750$   
 $W_S = 1000$      $\epsilon_x = \epsilon_x = 0.2978$  (inch-mrad)

SEB INFO - 12-Dec 1980 4 AM  
 A = 0.73 TP    T/E = 80.5  
 B = 0 TP    PLS = 6.9  
 C = 5.26 TP    LLS = 6.4  
 XEFF = 98.6%    M/P = 12.0  
 XIEFF = 5%

$\frac{\epsilon_x}{\epsilon} = 3.40$   
 B. With beam fitting (green curve)  
 $\frac{\epsilon_x}{\epsilon} = 3.0$      $\begin{cases} W_Q = 542 \\ W_S = 942 \end{cases}$

FIGURE 1

BROOKHAVEN NATIONAL LABORATORY

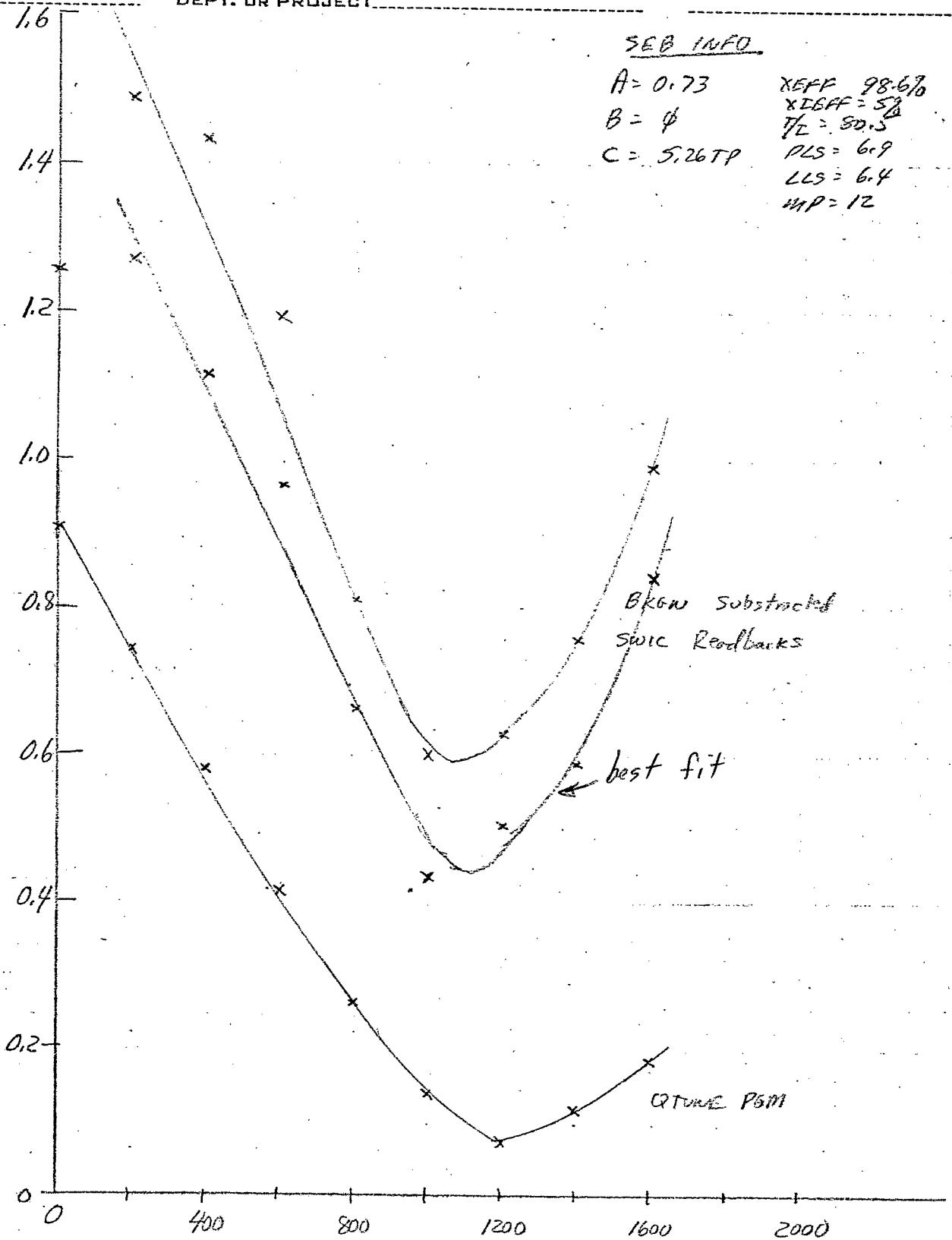
BY \_\_\_\_\_ DATE 1/28/81  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

SUBJECT \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
 JOB NO. \_\_\_\_\_

DEPT. OR PROJECT \_\_\_\_\_

99% BEAM HALF WIDTH -- INCHES



SEB INFO  
 A = 0.73      XEFF 98.67  
 B = φ          XIBAF = 52  
 C = 5.26TP      TL = 50.5  
                  PLS = 6.9  
                  LLS = 6.4  
                  MP = 12

AQ6. DCN COUNTS  
 HORIZONTAL

FIGURE 2

Q-TUNE Assume emittance at F13 - 0078 (uv-mrad rms) = 0.0718 (uv-mrad) 99% beam  
 measured emittance =  $(\frac{1.8}{1.27})^2 = 8.8$  times E-Q-TUNE

General effects 14' A' of varying AQS & AQB

# "A" LINE F13 TO TGT

AQS  
AQB

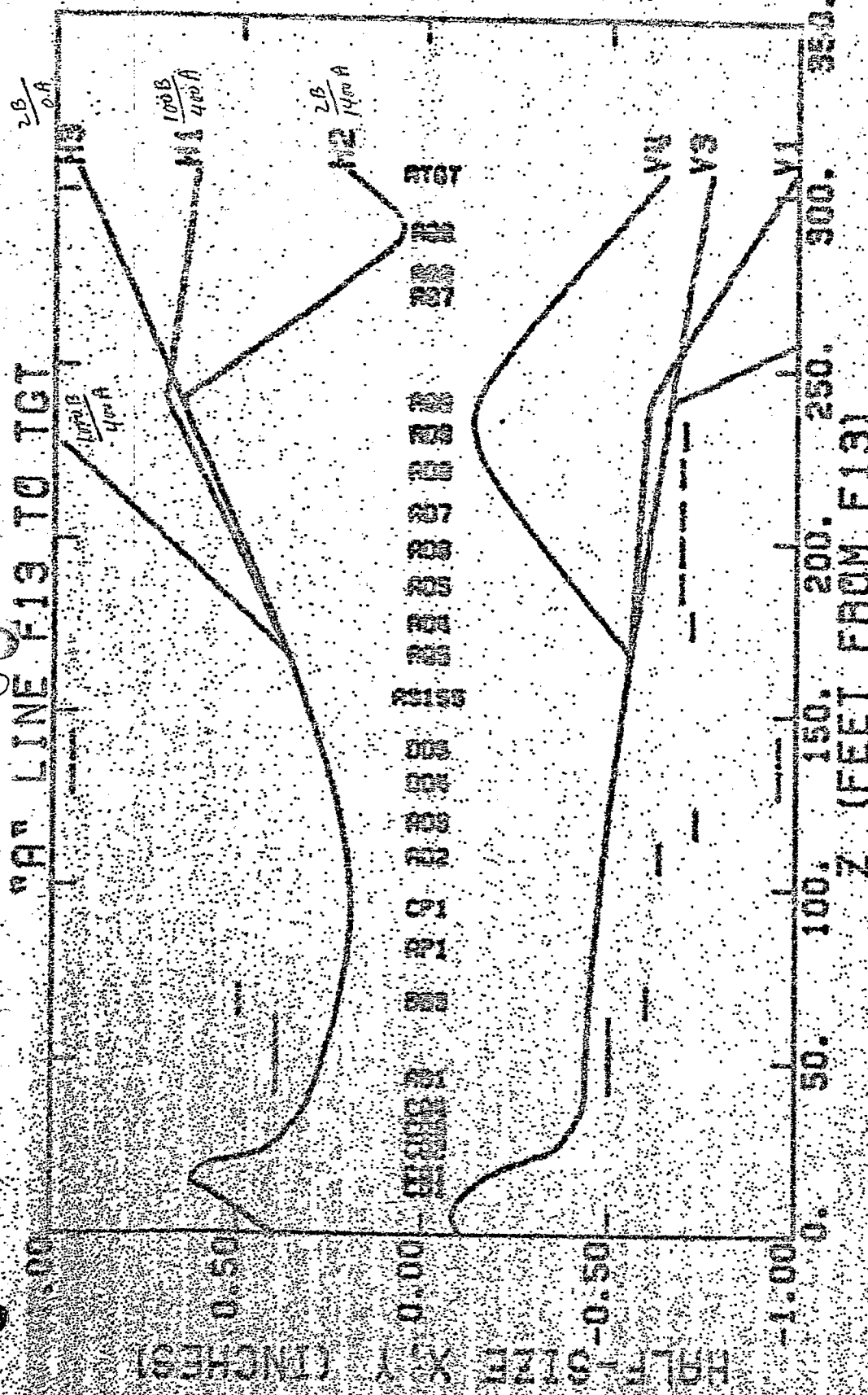
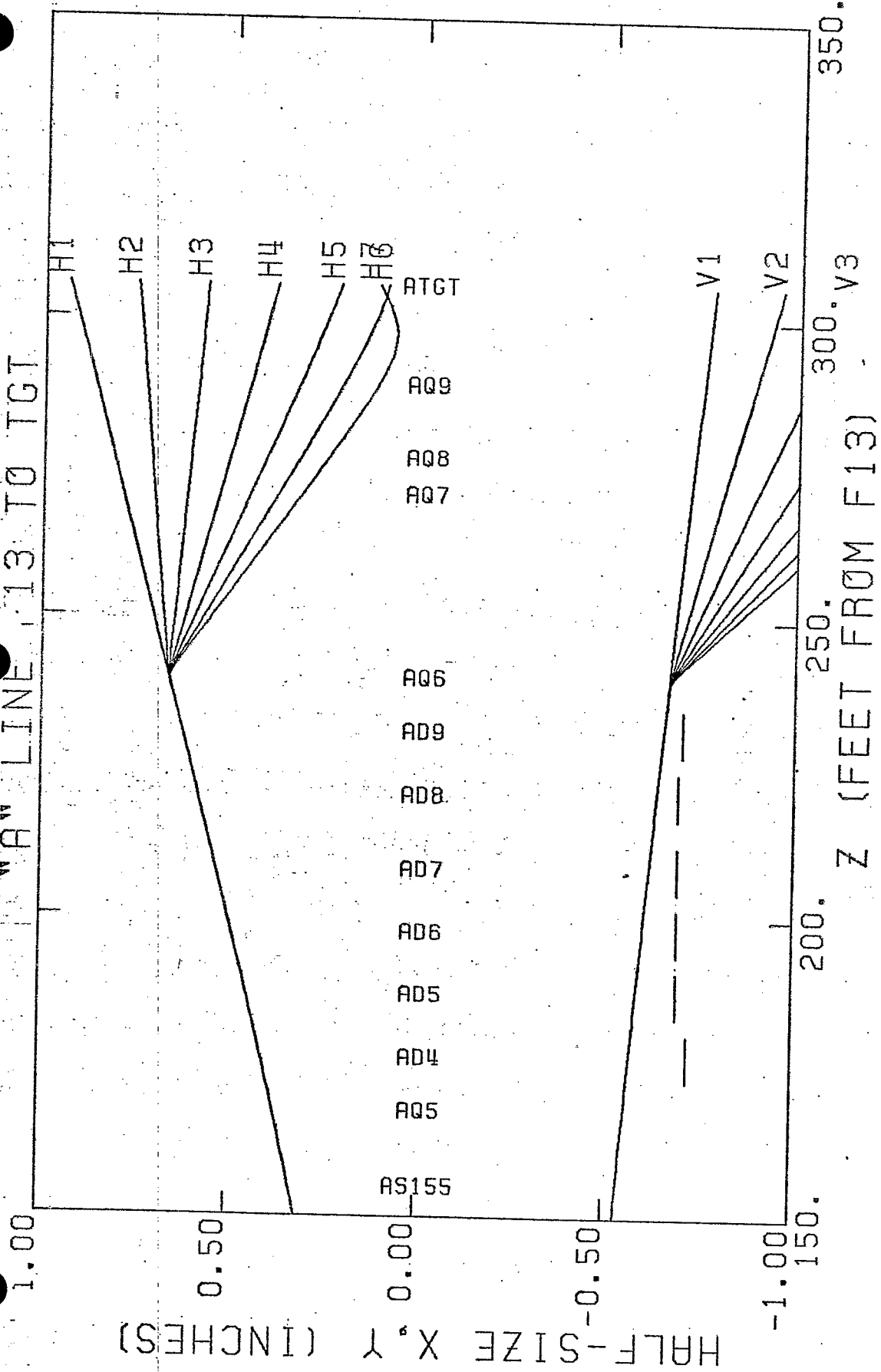


FIGURE 3



"A" LINE F13 TO TGT



V4  
V5  
V6  
V7

FIGURE 4

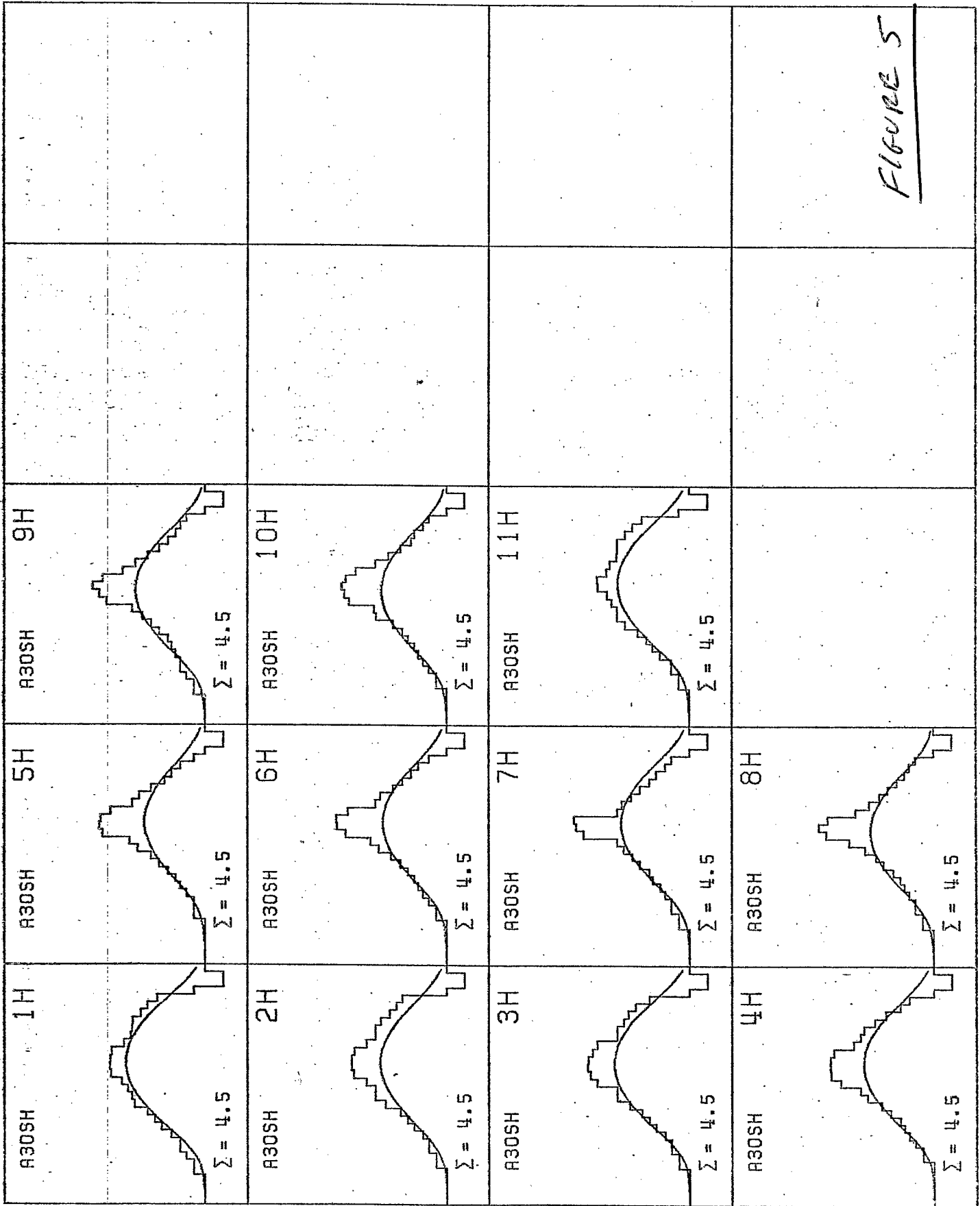


FIGURE 5

VARYING A306 - Best fit using Bkou Filter

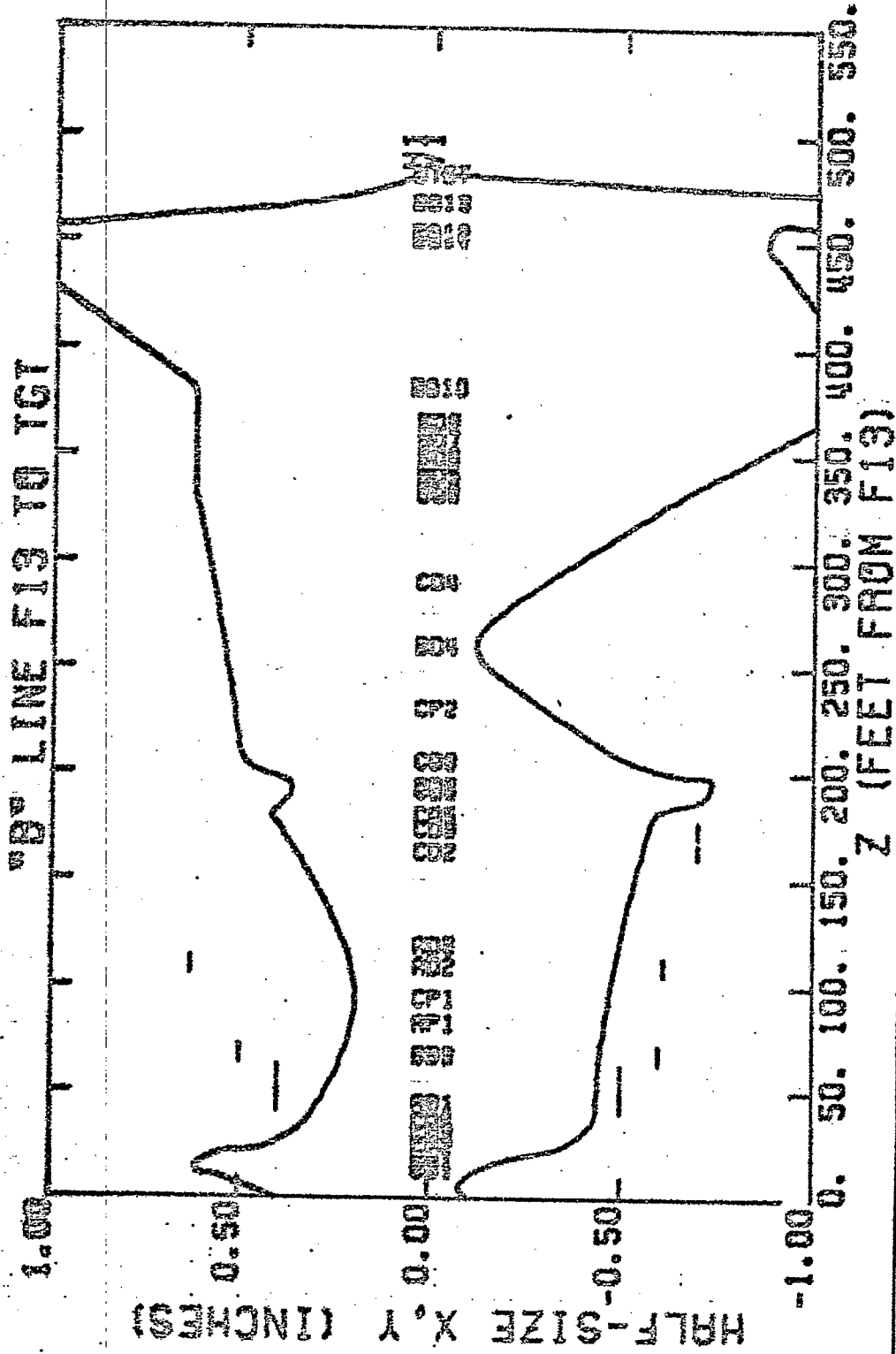
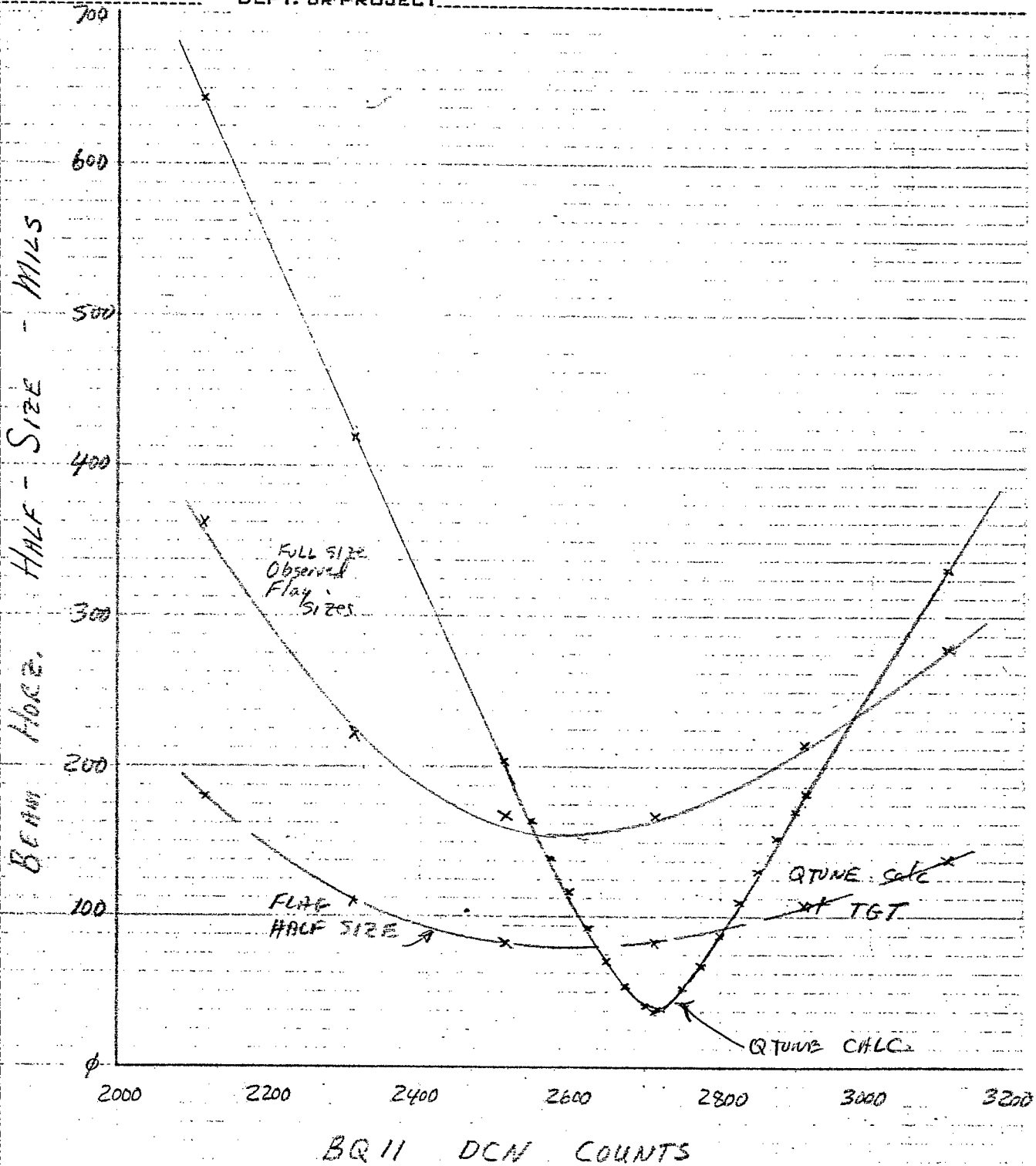


Figure 6

BROOKHAVEN NATIONAL LABORATORY

BY \_\_\_\_\_ DATE \_\_\_\_\_ SUBJECT \_\_\_\_\_ SHEET No. \_\_\_\_\_ OF \_\_\_\_\_  
 CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_ DEPT. OR PROJECT \_\_\_\_\_ JOB No. \_\_\_\_\_



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

Note: The operation point is 2712, the minimum calc occurs at 2713.5  
 very good data

FIGURE 7

"B" LINE F13 TO TGT

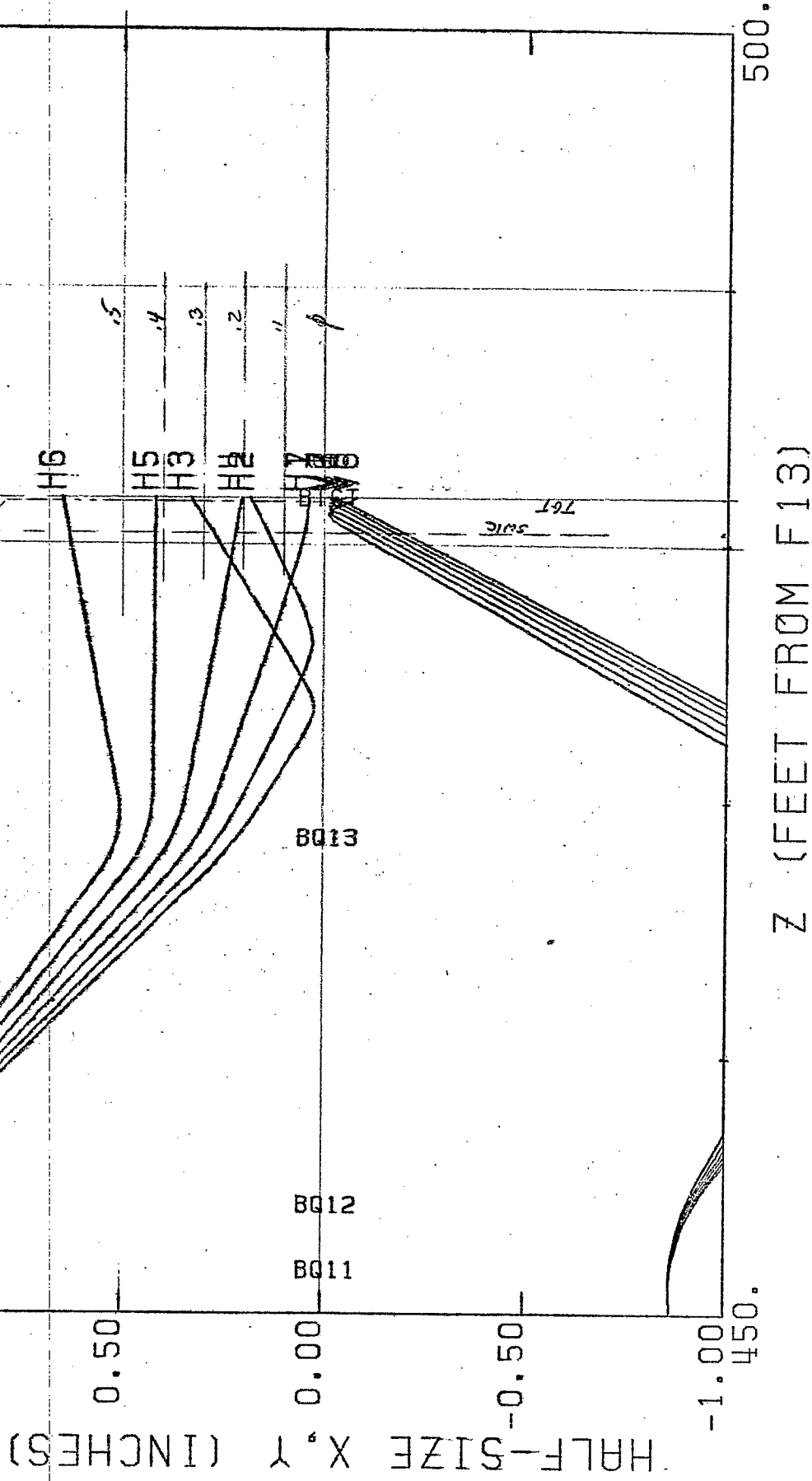


FIGURE 8

<p>1H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>5H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>2V AS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>6V AS8TB</p> <p><math>\Sigma = 6.0</math></p>
<p>2H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>6H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>3V AS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>7V AS8TB</p> <p><math>\Sigma = 6.0</math></p>
<p>3H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>7H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>4V AS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>8V AS8TB</p> <p><math>\Sigma = 6.0</math></p>
<p>4H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>8H HS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>5V AS8TB</p> <p><math>\Sigma = 6.0</math></p>	<p>9V AS8TB</p> <p><math>\Sigma = 6.0</math></p>

FIGURE 9

NOTE: SIZE CAN NOT BE INTERPRET

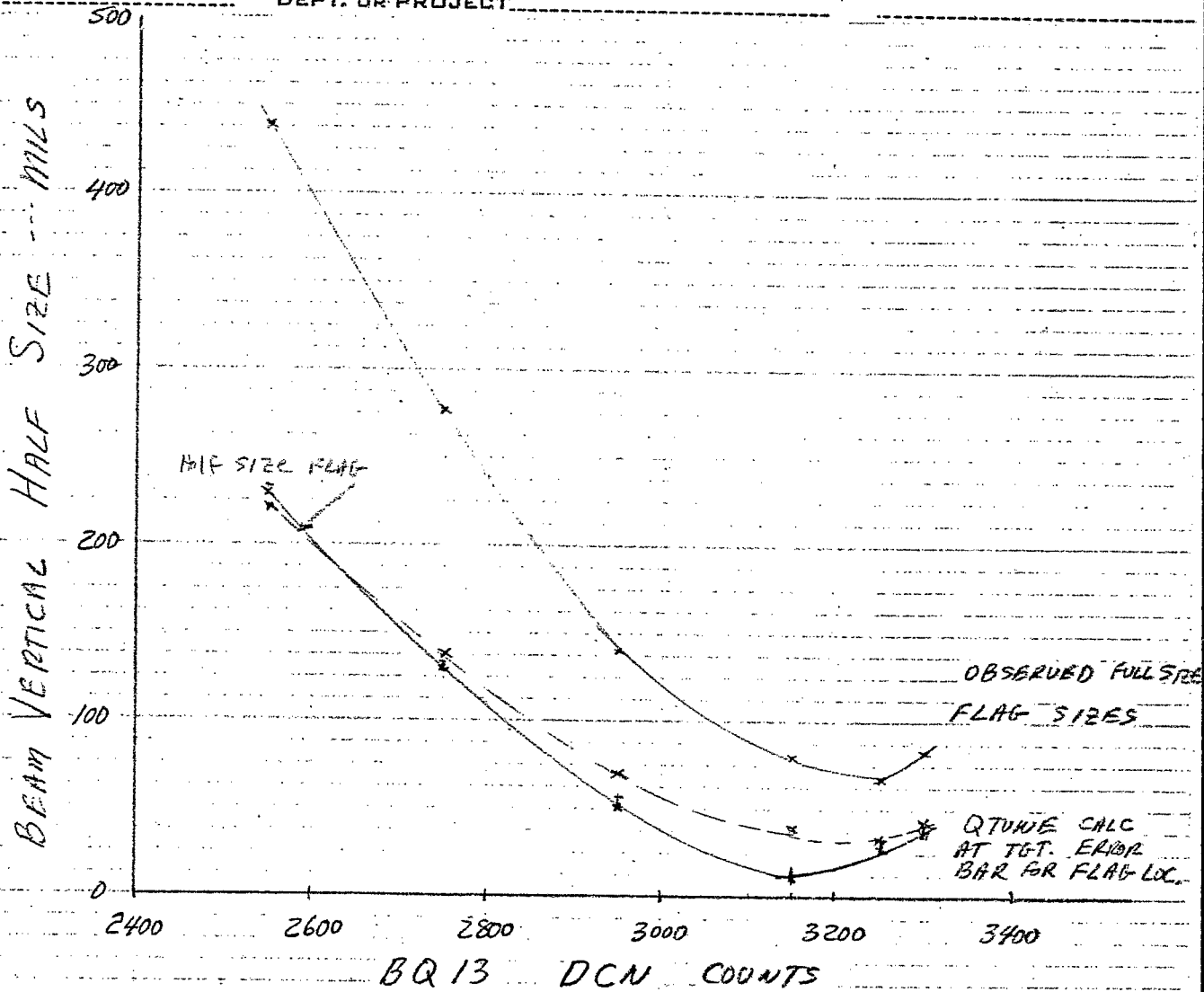
BY \_\_\_\_\_ DATE \_\_\_\_\_ SUBJECT \_\_\_\_\_

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

JOB NO. \_\_\_\_\_

DEPT. OR PROJECT \_\_\_\_\_



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

FIGURE 10

WB LINE F13 TO TGT

HALF-SIZE X, Y (INCHES)

Z (FEET FROM F13)

1.00

0.50

0.00

-0.50

-1.00

450.

500.

BQ13

BQ12

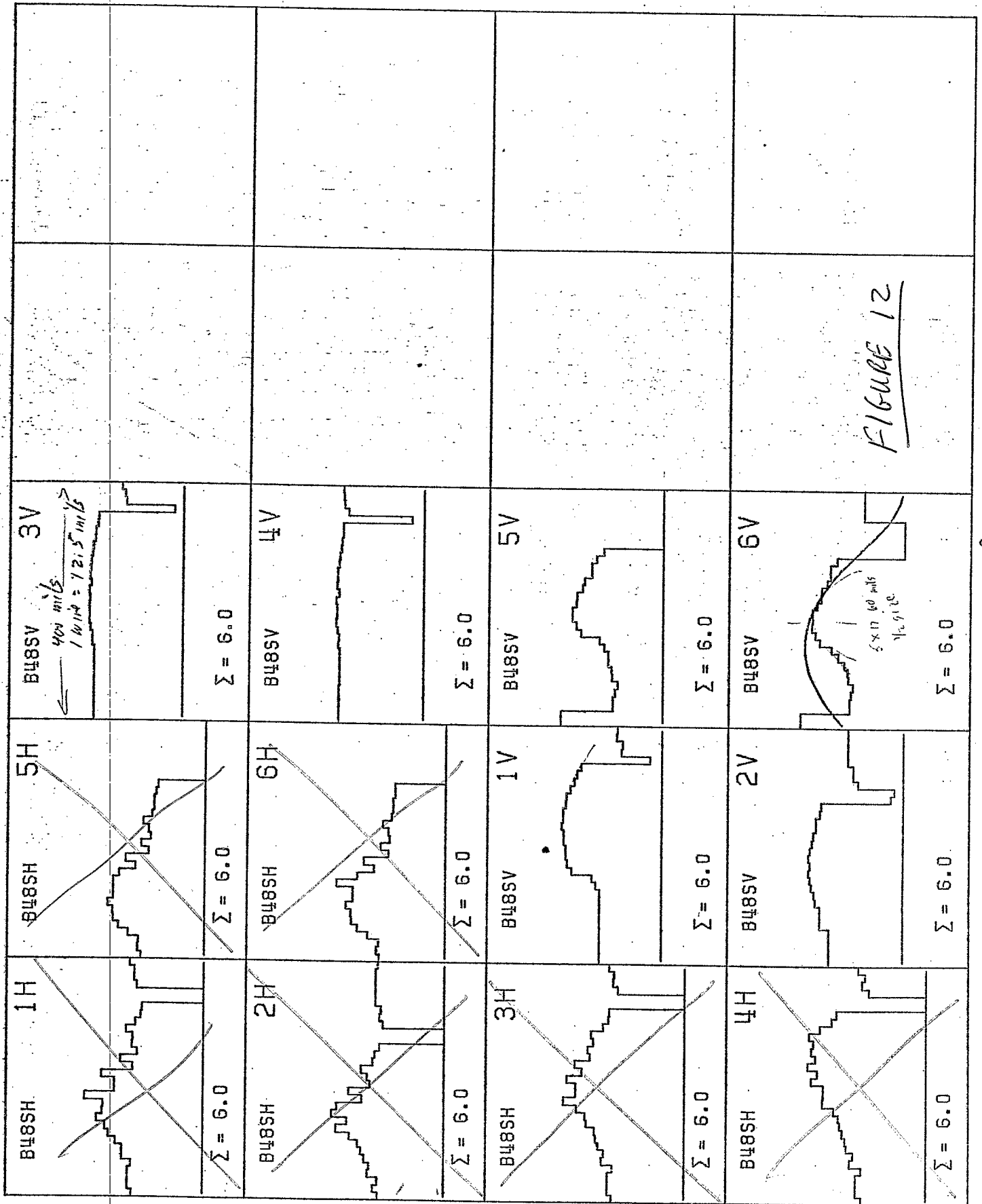
BQ11

SWIC  
FLAG  
TGT

1  
2  
3  
4  
5

FIGURE 11





Do not interpret the vertical patterns.

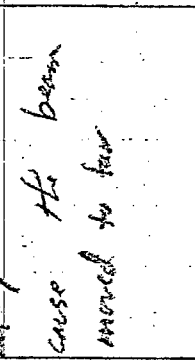
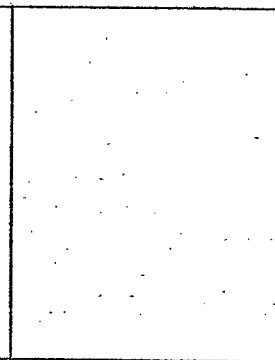
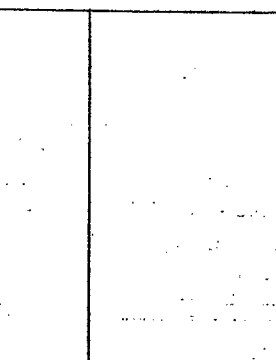
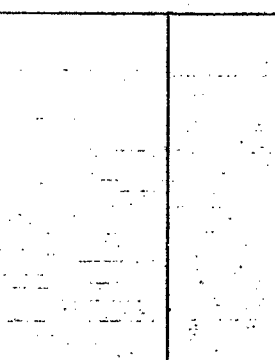
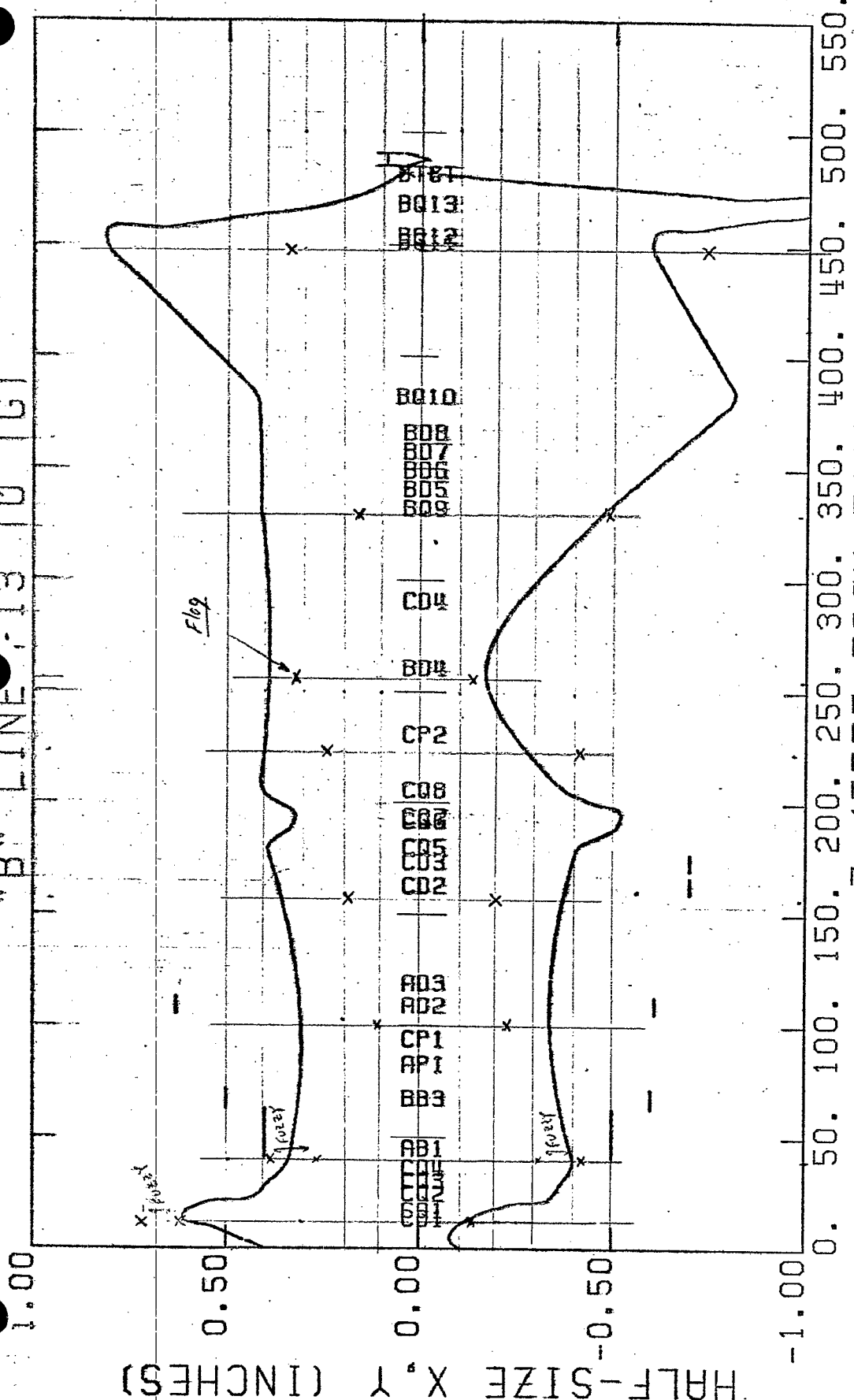
<p>C225H HS22C</p> <p>1H ADL-30W</p>  <p>Σ = 12:0</p>	<p>This program can not accurately determine the horiz. centroid movement because the beam is cut off on the swich. It is moved to far to the left on the swich.</p>		
<p>C225H HS22C</p> <p>2H ADL-30W</p>  <p>Σ = 12:0</p>			
<p>C225V AS22C</p> <p>1V ADL-30W</p>  <p>Σ = 8:0</p>			
<p>C225V AS22C</p> <p>2V ADL-30W</p>  <p>Σ = 8:0</p>			

FIGURE 13

"B" LINE F13 TO TGT



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

FIGURE 14

BY J. Ryan DATE 12/20

SUBJECT B Line

SHEET No. 4 OF

CHKD. BY DATE

JOB No.

DEPT. OR PROJECT

F10 1549 → 2082

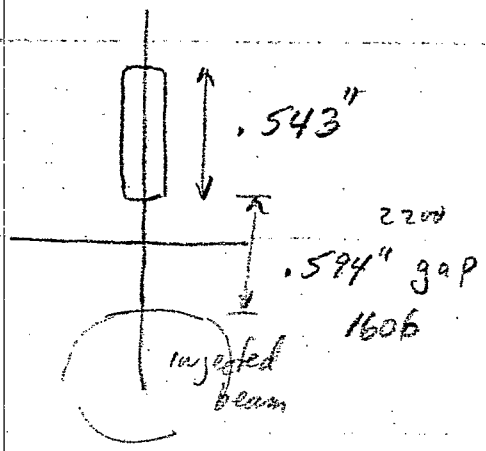


FIGURE 15

BY \_\_\_\_\_ DATE 12/20

SUBJECT B Line

SHEET NO. 3 OF

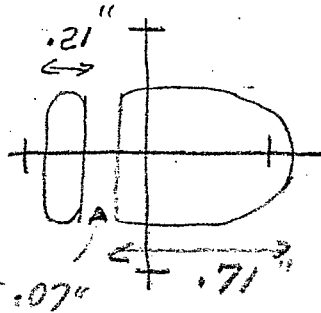
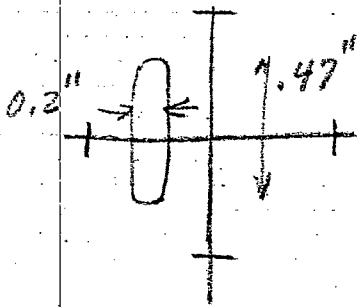
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

Low losses

JOB NO. \_\_\_\_\_

DEPT. OR PROJECT \_\_\_\_\_

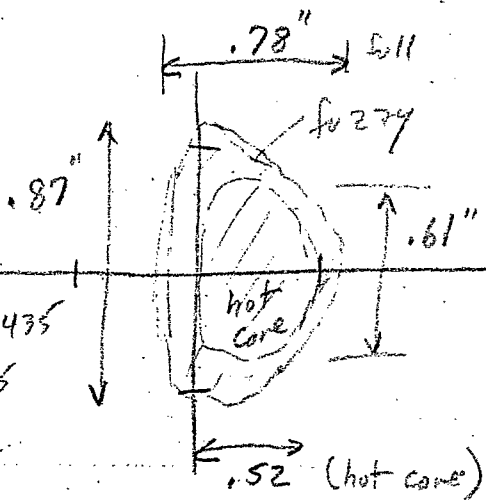
CF100



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

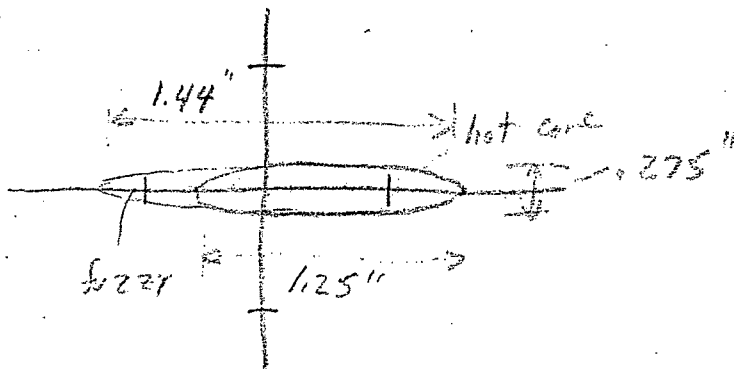
Total beam 560 x 235

CF039



CF040 swic does not work

CF011



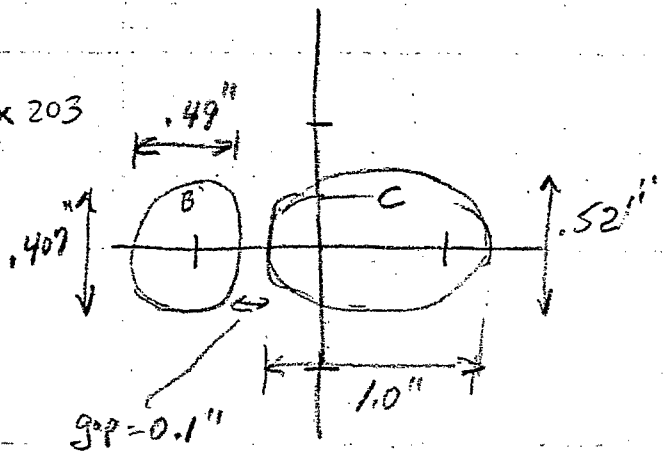
HS = 720 x 137  
of 625 x 137

BY \_\_\_\_\_ DATE 12/24/80 SUBJECT B Level  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_  
DEPT. OR PROJECT \_\_\_\_\_

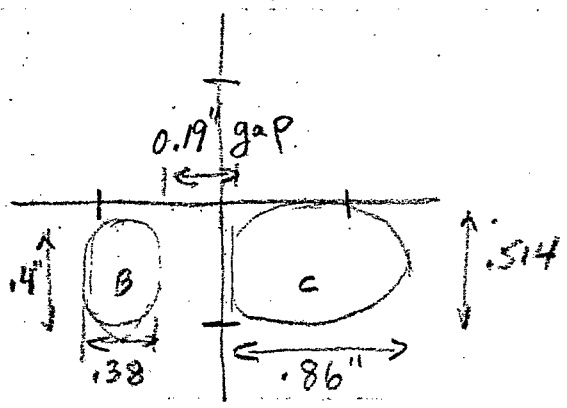
SHEET NO. 2 OF \_\_\_\_\_  
JOB NO. \_\_\_\_\_

CF 223

HS = 245 x 203



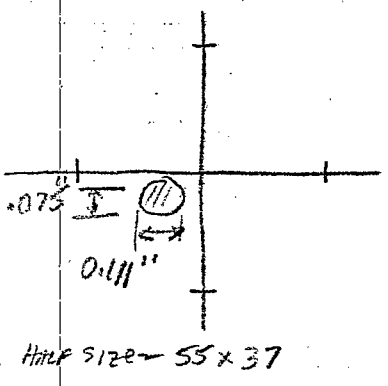
CF 157



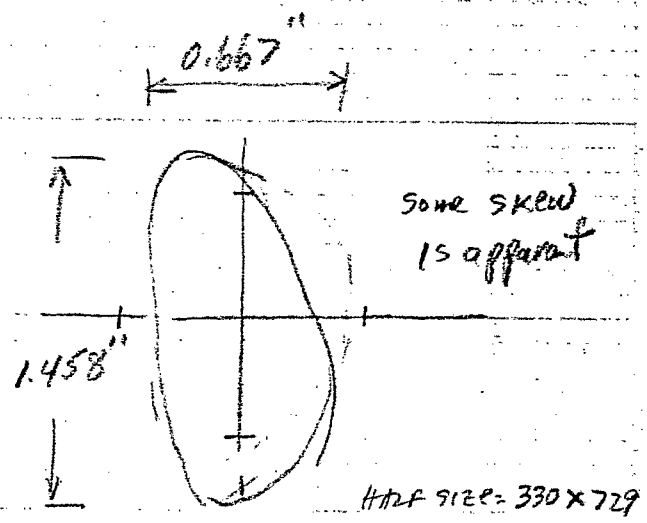
B HS = 190 x 200

B T&T       $A = 0.25$     $C = 5.16 TP$       BF448  
 $B = 1.68$

beam moved for good picture

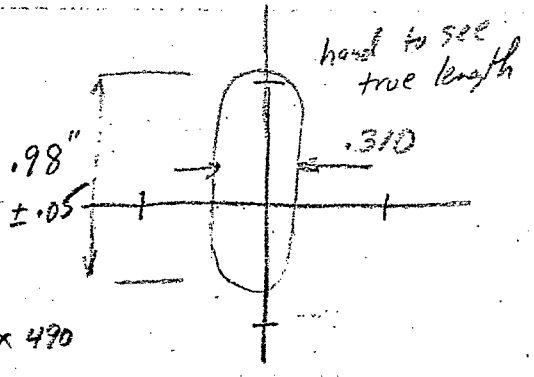


Half size - 55 x 37



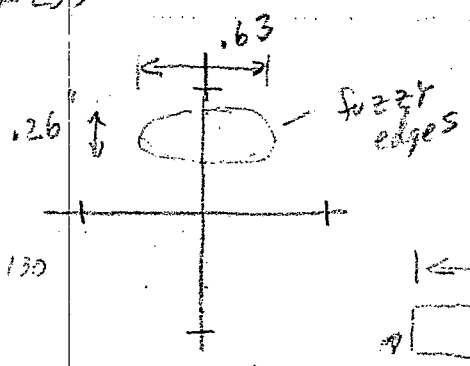
Half size - 330 x 729

BF329



H.S. - 155 x 490

CF255



H.S. - 715 x 130

Sharp edges

