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EXTRACTION OF POINT SOURCE GAMMA SIGNALS FROM AERIAL SURVEY DATA TAKEN OVER A LAS VEGAS, NEVADA, RESIDENTIAL AREA

(SANDS Test - 12 March 1975)

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INTRODUCTION

Detection of point-source gamma signals from aerial measurements is complicated by widely varying terrestrial gamma backgrounds, since these variations frequently resemble signals from point-sources. Spectral stripping techniques have been very useful in separating man-made and natural radiation contributions which exist on Energy Research and Development Administration (ERDA) plant sites and other like facilities. However, these facilities are generally situated in desert areas or otherwise flat terrain with few man-made structures to disturb the natural background. It is of great interest to determine if the stripping technique can be successfully applied in populated areas where numerous man-made disturbances (houses, streets, yards, vehicles, etc.) exist.

EXPERIMENT

To determine the applicability of spectral stripping for identifying low-energy point-sources in a populated area, a helicopter overflight was made in the Las Vegas metropolitan area on 12 March 1975. The standard SANDS data acquisition system utilizing forty 5-inch by 2-inch NaI gamma detectors was utilized. Nominal altitude was 150 ft; nominal velocity was 100 ft/sec.

At one point in the survey, a Barium source was placed at ground level in a two-story frame house. One pass was made near the house at ~400 ft altitude, and three passes were made at ~150 ft.

DETERMINATION OF STRIPPING PARAMETERS

To determine appropriate spectral windows for stripping, data were examined to find a part of the survey which showed large count rate extremes. The area chosen was a stretch of Eastern Avenue between Russell and Natalie, fig. 1. The average count rate was 7363 ± 1114 cps. (If only counting statistics were involved, an approximate deviation of $\pm \sqrt{7363}$ or ± 86 cps would have been observed). Spectral data were extracted from 'lo' and 'hi' gross count regions of this area (see fig. 2 & 3). The 'hi' spectrum was divided channel by channel by the 'lo' spectrum (see fig. 4). With the low-energy Barium source, virtually all source counts will occur below 400 keV. Thus, the window 60 keV through 390 keV (channels 6 thru 39) was selected as the 'source' window. It is observed from fig. 4 that the window from 400 keV to 730 keV shows the same approximate ratio as does the source window. Since virtually no Barium counts will fall in this window, it may be used as a background window to indicate background counts present in the source window. The constant which relates the counts in the source and background window is

$$K = \frac{S_B}{B_B} = \frac{\Sigma \text{ cts from 60 thru 390 keV}}{\Sigma \text{ cts from 400 thru 730 keV}}$$

(S_B & B_B from bkg only spec)

Fig. 5 shows a plot of K for the calibration line chosen. Using this K value (5.668), net counts will be

$$N = S_s - KB_s$$

Fig. 6 shows net counts for the calibration line. Average is nominally zero (-7 cps) with a standard deviation of ± 126 cps, considerably smaller than the ±1114 cps standard deviation observed in gross count data for the same line.

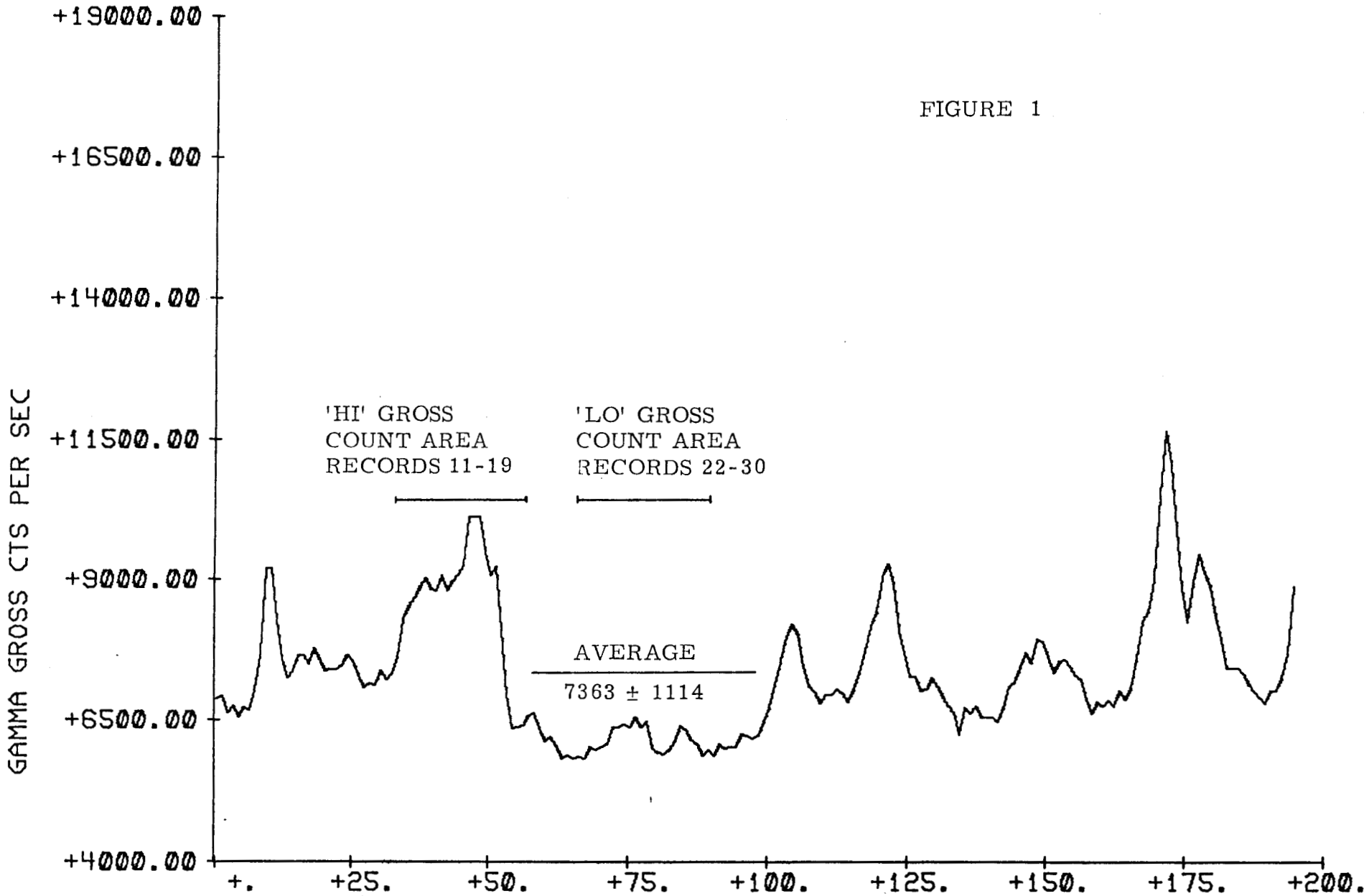
DATA OVER SOURCE IN HOUSE

Four passes were made over the house. The first pass was made at 400 ft; the remaining passes were made at 150 ft. Lateral displacement of the helo relative to the source was ~70 ft for the first three passes, and ~ 20 ft for the last pass. Fig. 7 shows the gross count data collected during the period of time which included the four passes. Source passes (annotated by 'hacks' on x axis) were not easily seen in the midst of other variations. Fig. 8 shows net count data extracted as described in the preceding section. Detection of source passes was much improved. Since the background variations between source passes show a nominally statistical behavior, further improvement of signal-to-background discrimination may be obtained by applying a sliding average to the data. Fig. 9 shows net counts with a 9-sec average applied (near the optimum for 400 ft altitude at v = 100 ft/sec). Spectral data were also extracted in the regions indicated in fig. 9. Fig. 10, 11, and 12 show respectively 1) background, 2) background + source, and 3) source (background removed).

CONCLUSIONS

Spectral stripping appears to improve low-energy point-source detection in populated areas. Surveys under other real-life situations should be done to further validate the technique.

FIGURE 1


+19000.00
+16500.00
+14000.00
+11500.00
+9000.00
+6500.00
+4000.00
GAMMA GROSS CTS PER SEC
'HI' GROSS
COUNT AREA
RECORDS 11-19
'LO' GROSS
COUNT AREA
RECORDS 22-30
AVERAGE
7363 ± 1114
+.
+25.
+50.
+75.
+100.
+125.
+150.
+175.
+200.
SANDS, 3-12-75, EASTERN (RUSSELL > NATALIE), 308(1,65), SEC

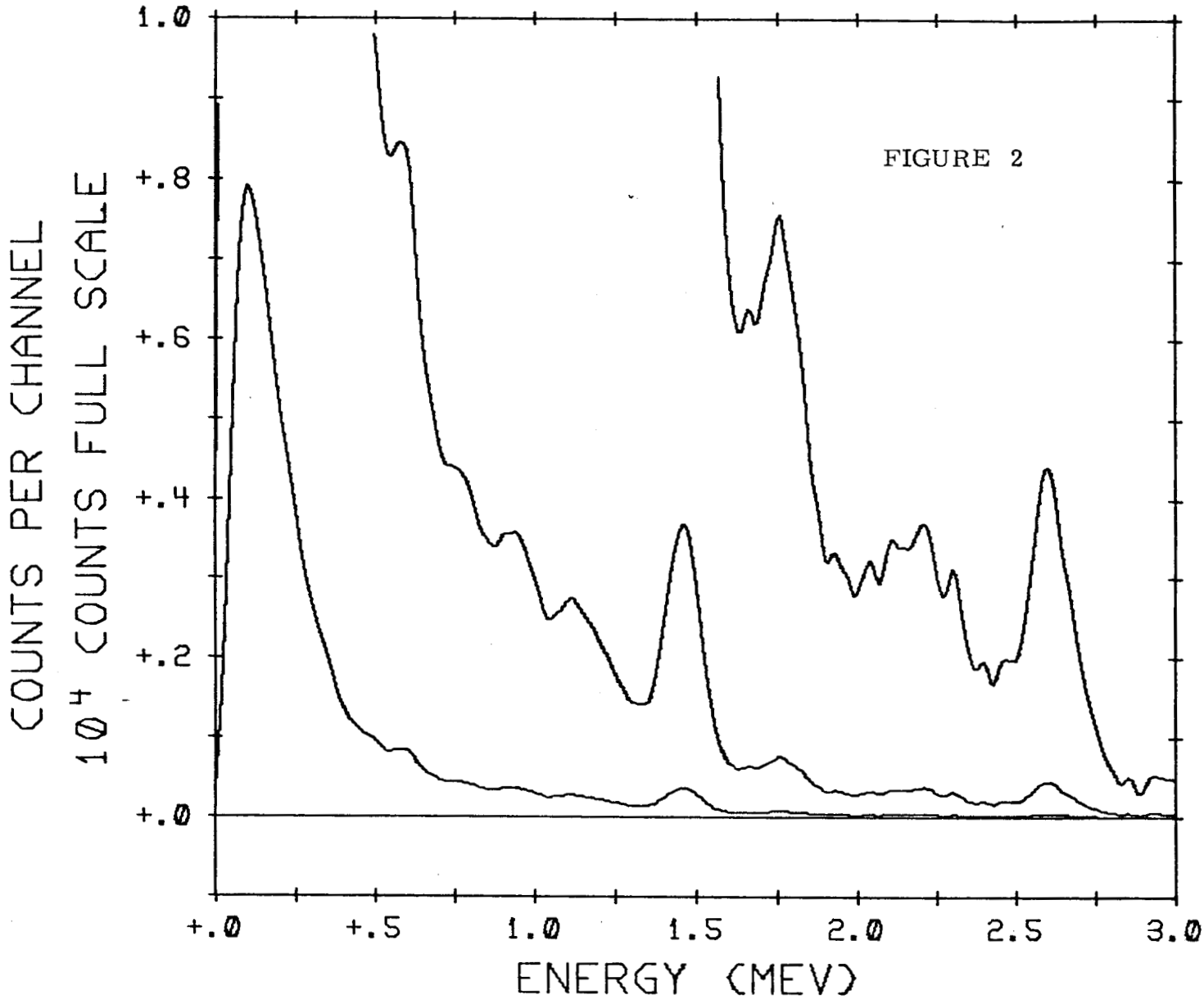


FIGURE 2

SPECTRUM NO. 308(11,19)
DATE 3-12-75
LIVE TIME (MIN) +.430
INTEGRATED CT. +.2256622E+06
TYPE EASTERN, 'HI' GAMMA GROSS CPS
ALTITUDE 150'
AIRCRAFT UH1N

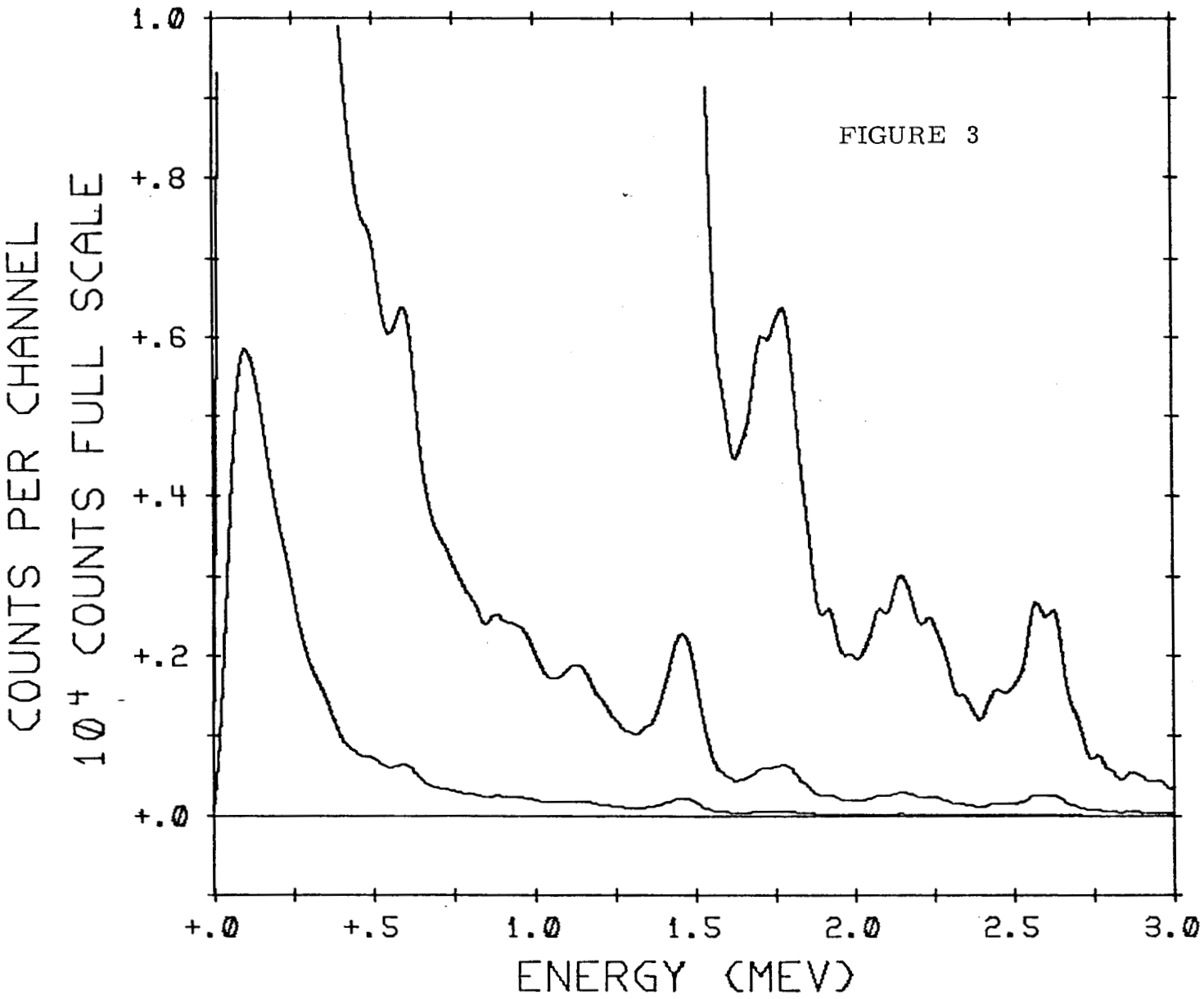


FIGURE 3

SPECTRUM NO. 308(22,30)
DATE 3-12-75
LIVE TIME (MIN) +.435
INTEGRATED CT. +.1647698E+06
TYPE EASTERN, 'LO' GAMMA GROSS CPS
ALTITUDE 150'
AIRCRAFT UH1N

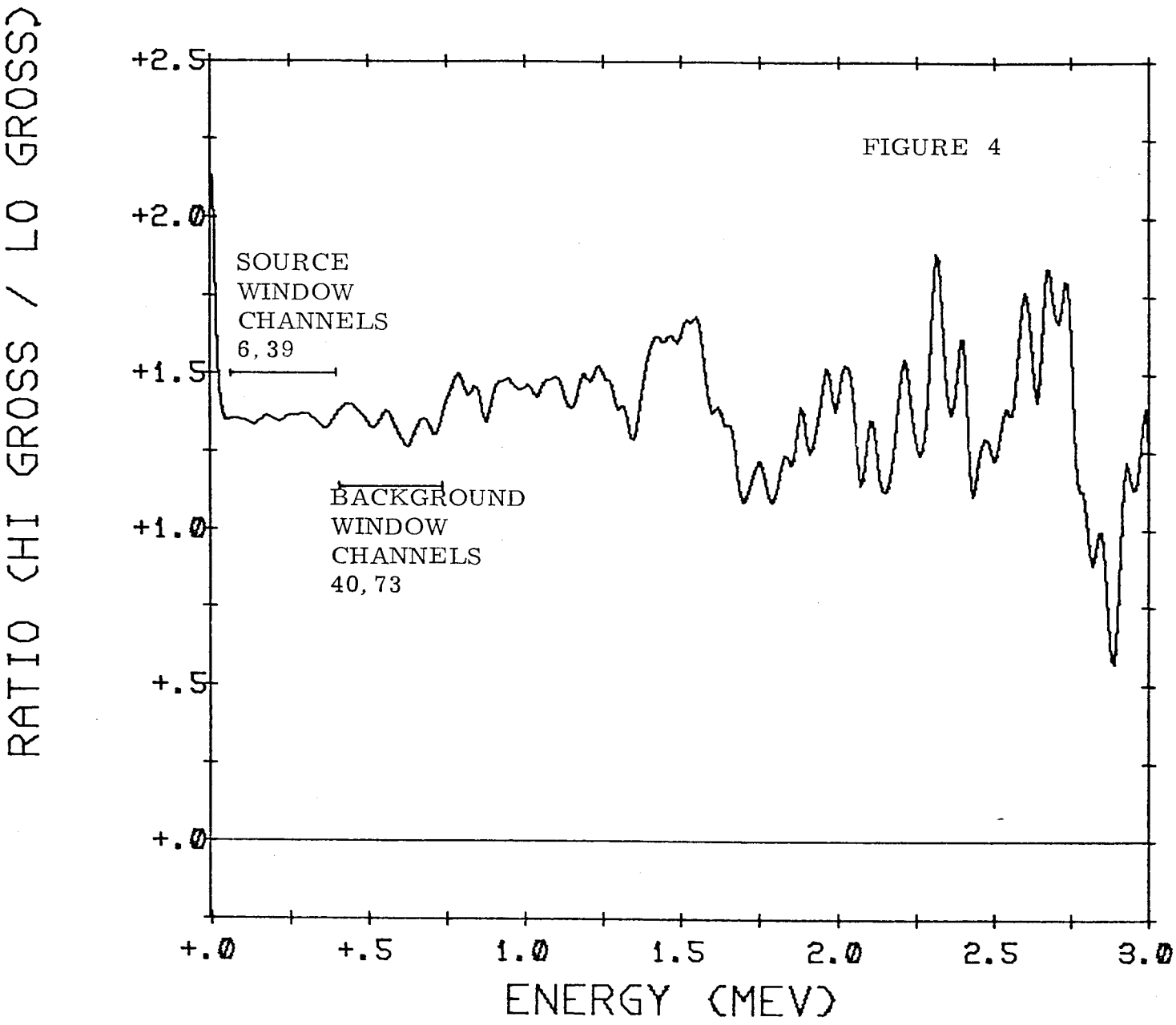


FIGURE 4

SPECTRUM NO. 308(11,19 / 22,30)
DATE 3-12-75
LIVE TIME (MIN) +.430
INTEGRATED CT. +.1647698E+06
TYPE EASTERN
ALTITUDE 150'
AIRCRAFT UH1N

FIGURE 5

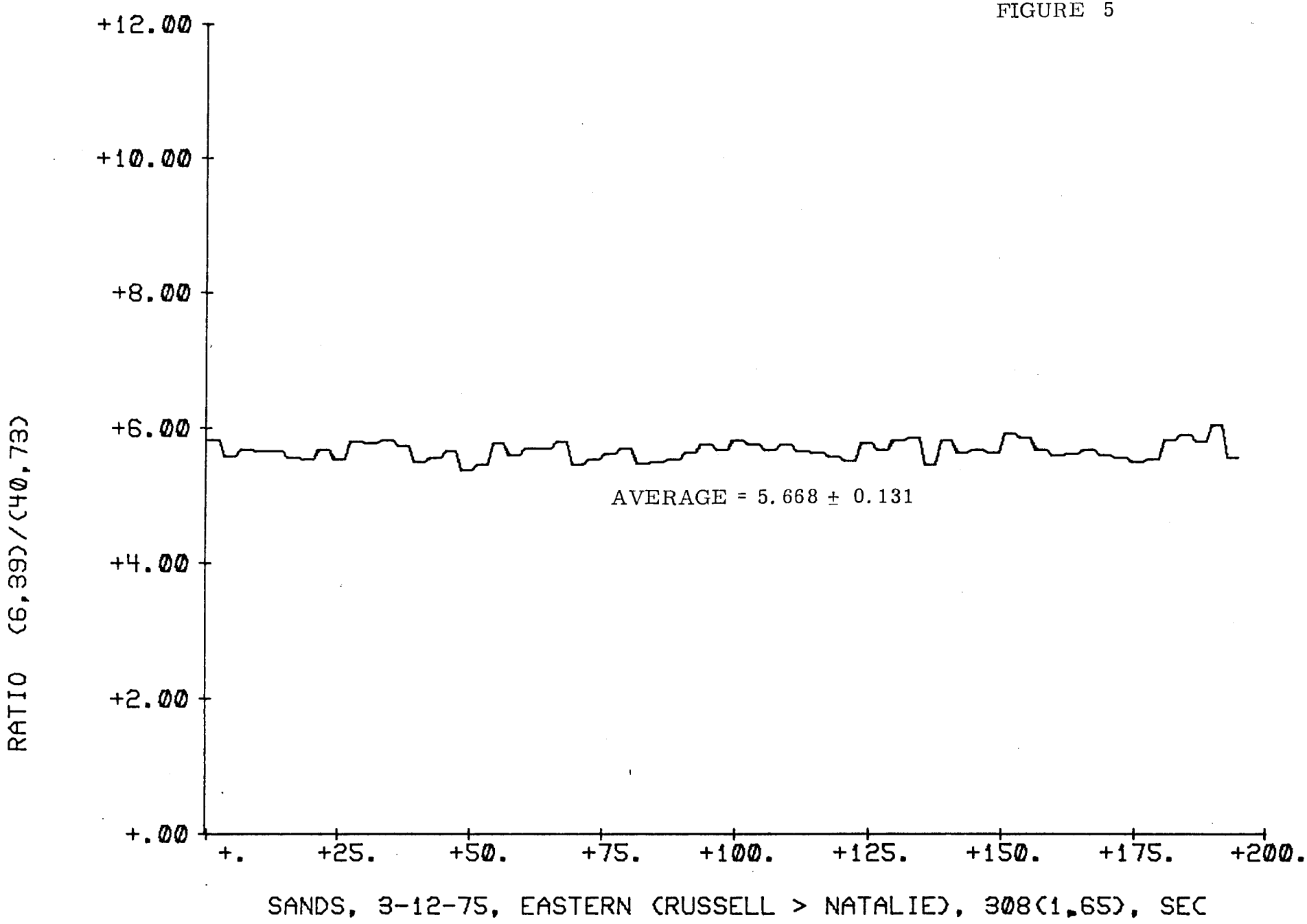

+12.00
+10.00
+8.00
+6.00
+4.00
+2.00
+.00
RATIO (6,39)/(40,73)
AVERAGE = 5.668 ± 0.131
+.
+25.
+50.
+75.
+100.
+125.
+150.
+175.
+200.
SANDS, 3-12-75, EASTERN (RUSSELL > NATALIE), 308(1,65), SEC

FIGURE 6

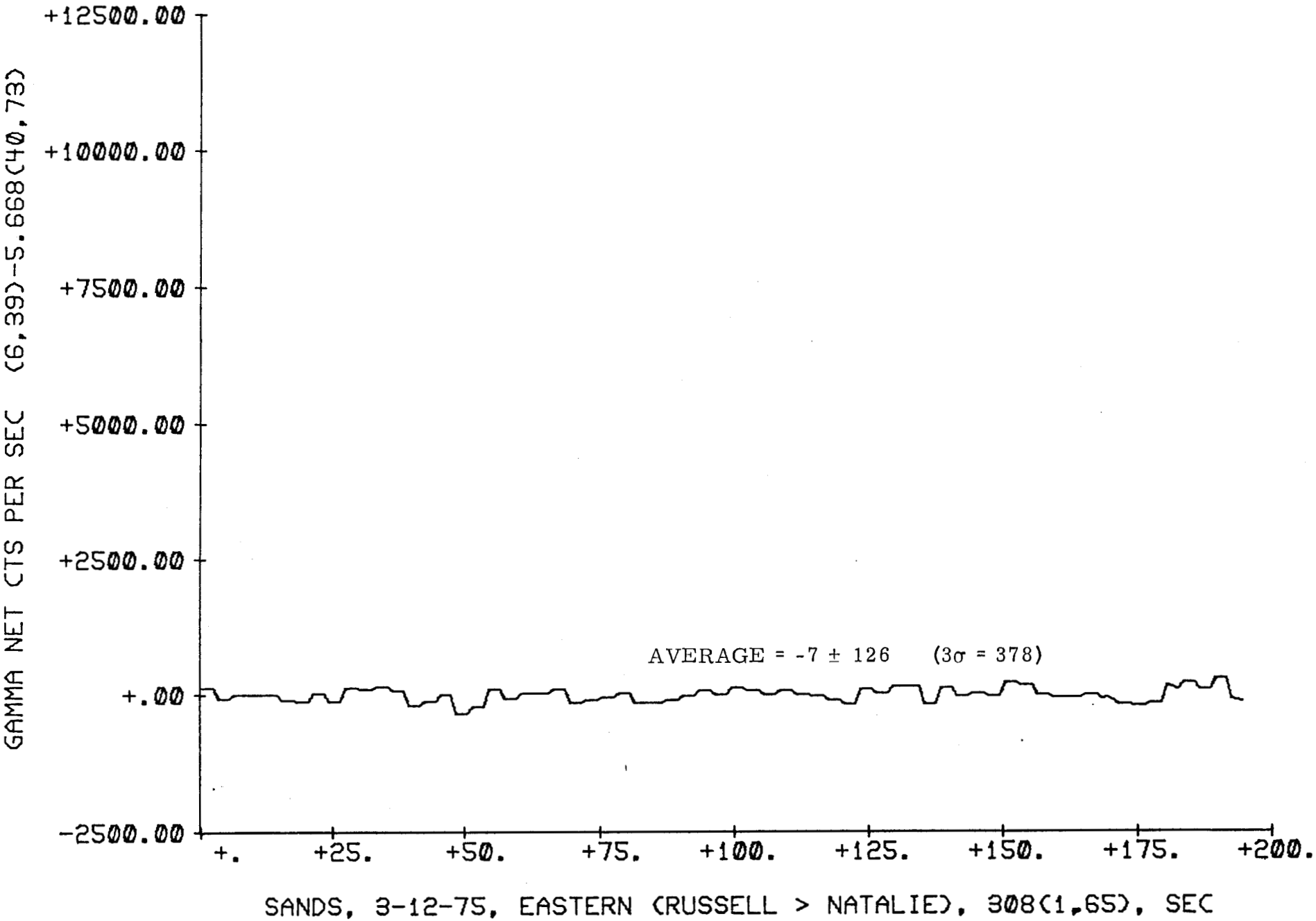

+12500.00
+10000.00
+7500.00
+5000.00
+2500.00
+.00
-2500.00
GAMMA NET CTS PER SEC (6,39)-5.668(40,73)
AVERAGE = -7 ± 126 (3σ = 378)
+.
+25.
+50.
+75.
+100.
+125.
+150.
+175.
+200.
SANDS, 3-12-75, EASTERN (RUSSELL > NATALIE), 308(1,65), SEC

FIGURE 7

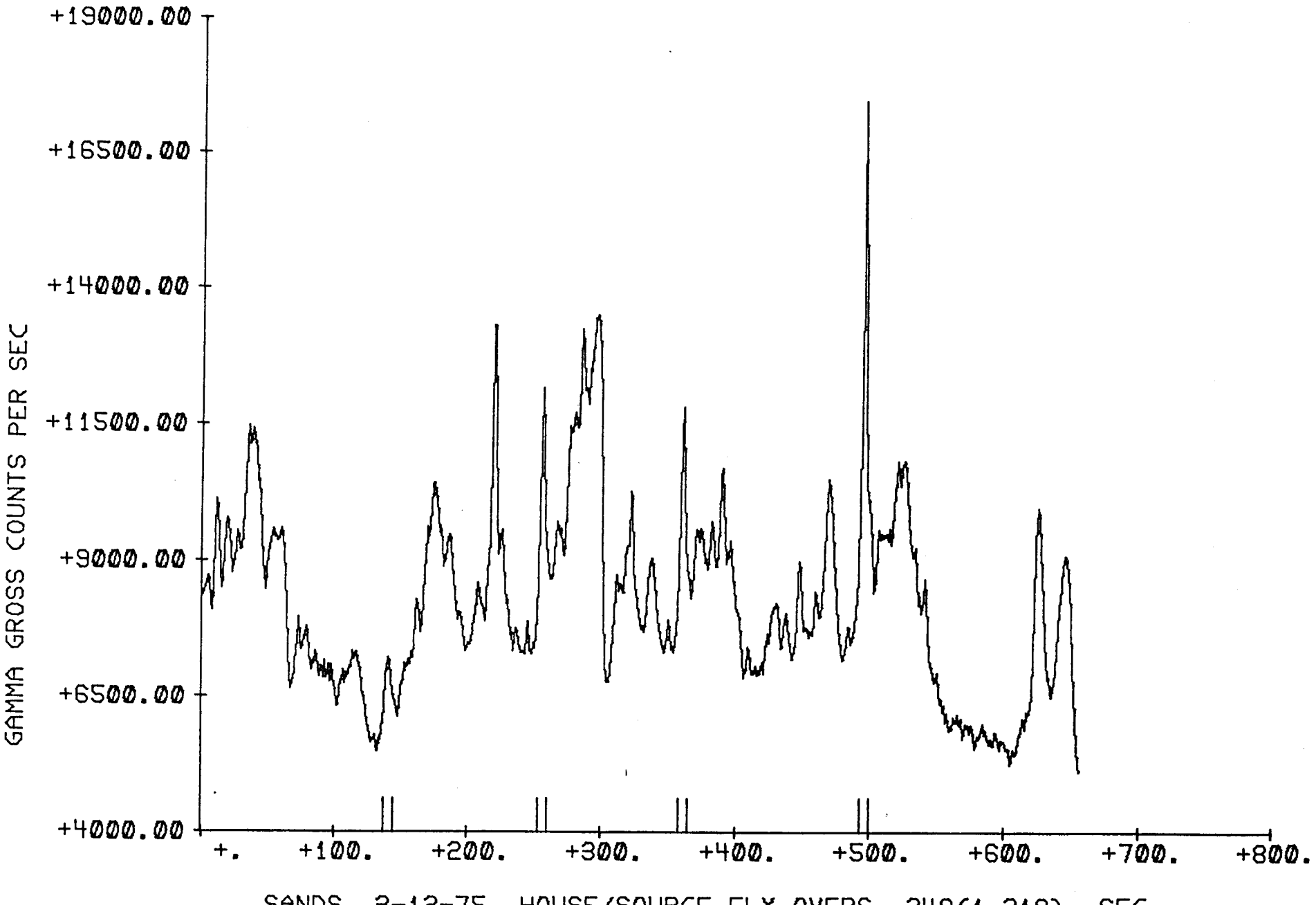

+19000.00
+16500.00
+14000.00
+11500.00
+9000.00
+6500.00
+4000.00
GAMMA GROSS COUNTS PER SEC
+.
+100.
+200.
+300.
+400.
+500.
+600.
+700.
+800.
SANDS, 3-12-75, HOUSE/SOURCE FLY-OVERS, 349(1,219), SEC

FIGURE 8

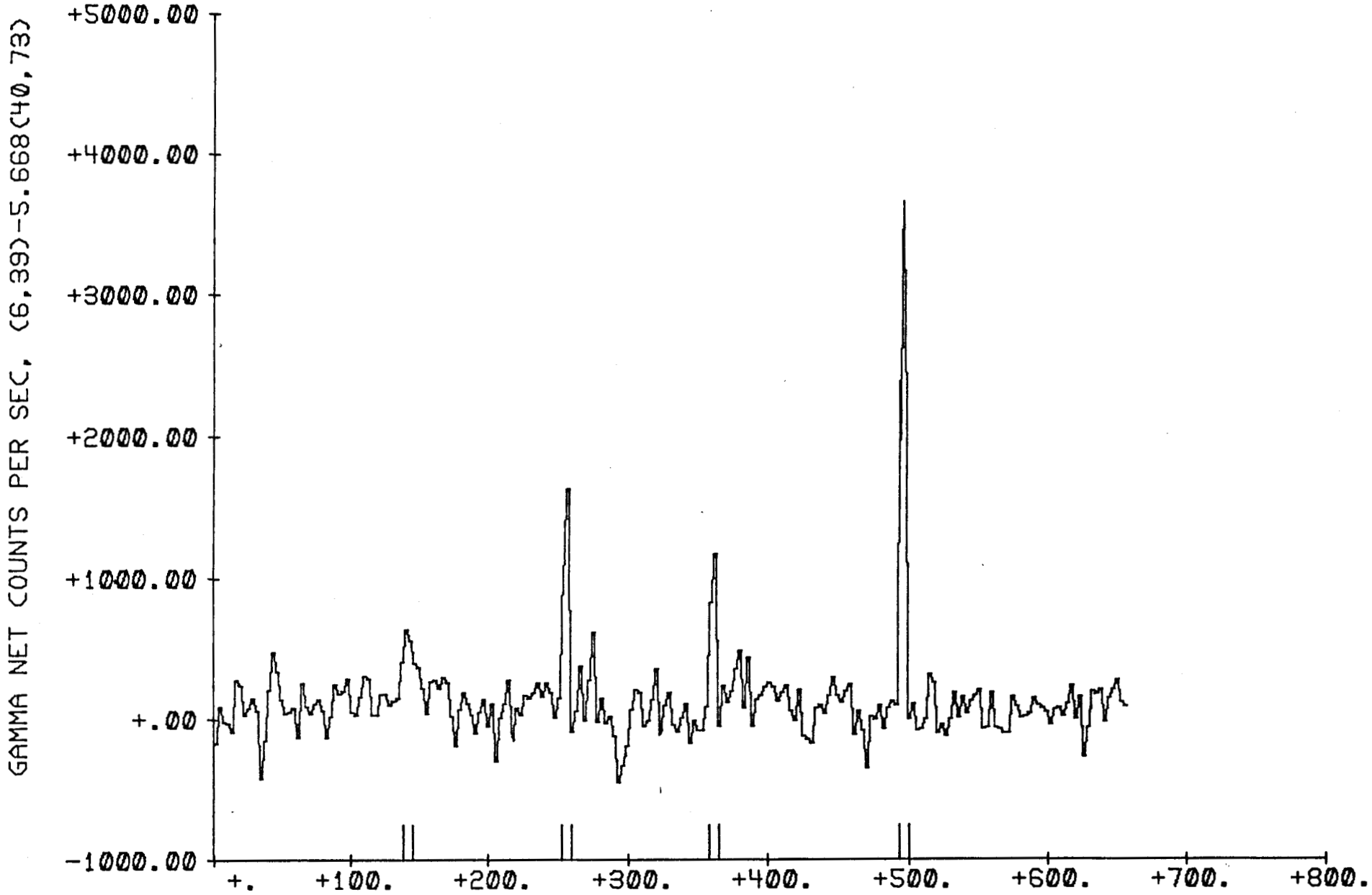
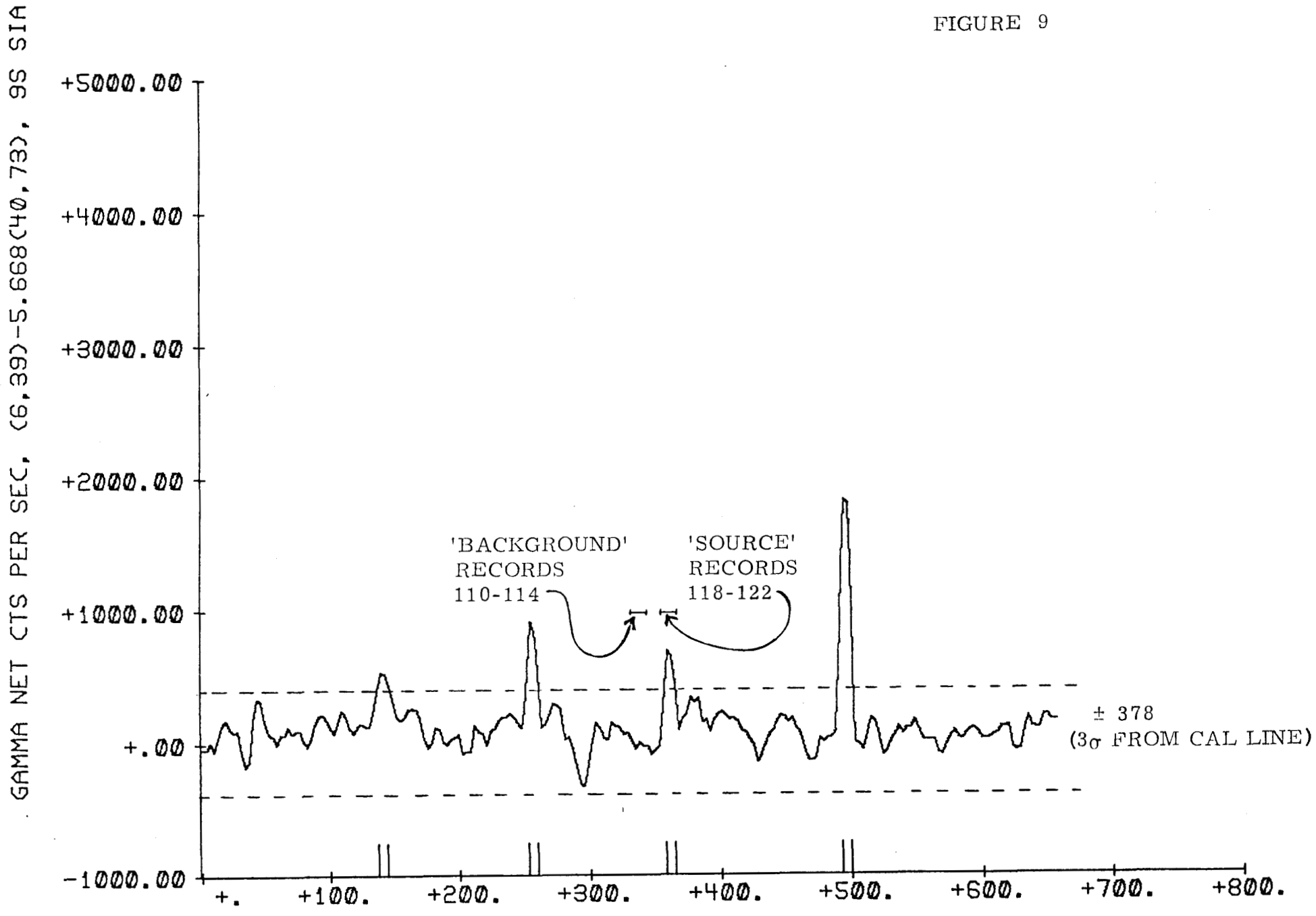

+5000.00
+4000.00
+3000.00
+2000.00
+1000.00
+.00
-1000.00
GAMMA NET COUNTS PER SEC, (6,39)-5.668(40,73)
+.
+100.
+200.
+300.
+400.
+500.
+600.
+700.
+800.
SANDS, 3-12-75, HOUSE/SOURCE FLY-OVERS, 349(1,219), SEC

FIGURE 9


GAMMA NET CTS PER SEC, (6,39)-5.668(40,73), 9S SIA
+5000.00
+4000.00
+3000.00
+2000.00
+1000.00
+.00
-1000.00
'BACKGROUND' RECORDS 110-114
'SOURCE' RECORDS 118-122
± 378
(3σ FROM CAL LINE)
+.
+100.
+200.
+300.
+400.
+500.
+600.
+700.
+800.
SANDS, 3-12-75, HOUSE/SOURCE FLY-OVERS, 349(1,219), SEC

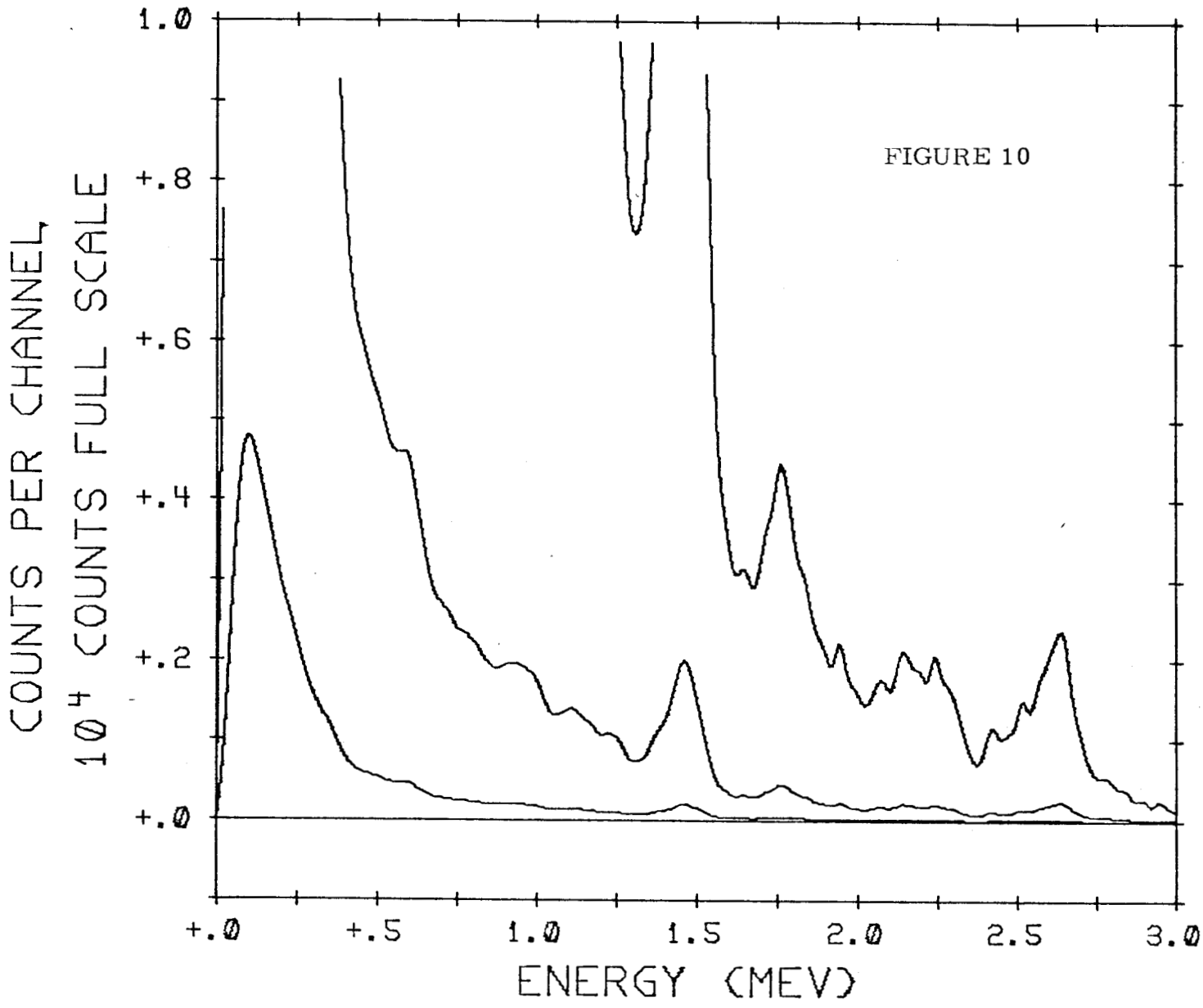


FIGURE 10

SPECTRUM NO. 349(118,122)
DATE 3-12-75
LIVE TIME (MIN) +.238
INTEGRATED CT. +.1313607E+06
TYPE SOURCE + BKG
ALTITUDE 150'
AIRCRAFT UH1N

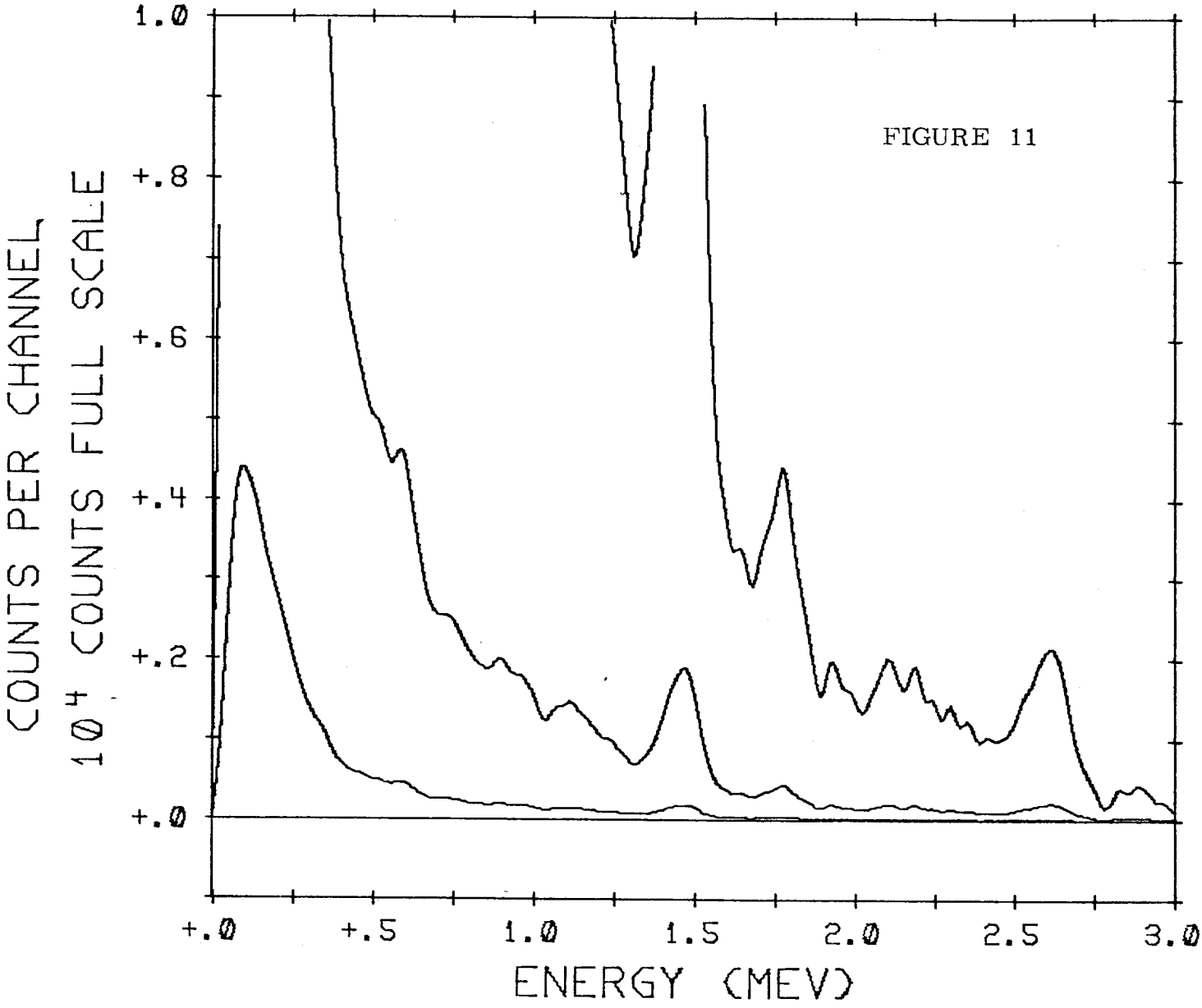


FIGURE 11

SPECTRUM NO. 349(110,114)
DATE 3-12-75
LIVE TIME (MIN) +.239
INTEGRATED CT. +.1228884E+06
TYPE BKG NEAR SOURCE
ALTITUDE 150'
AIRCRAFT UH1N

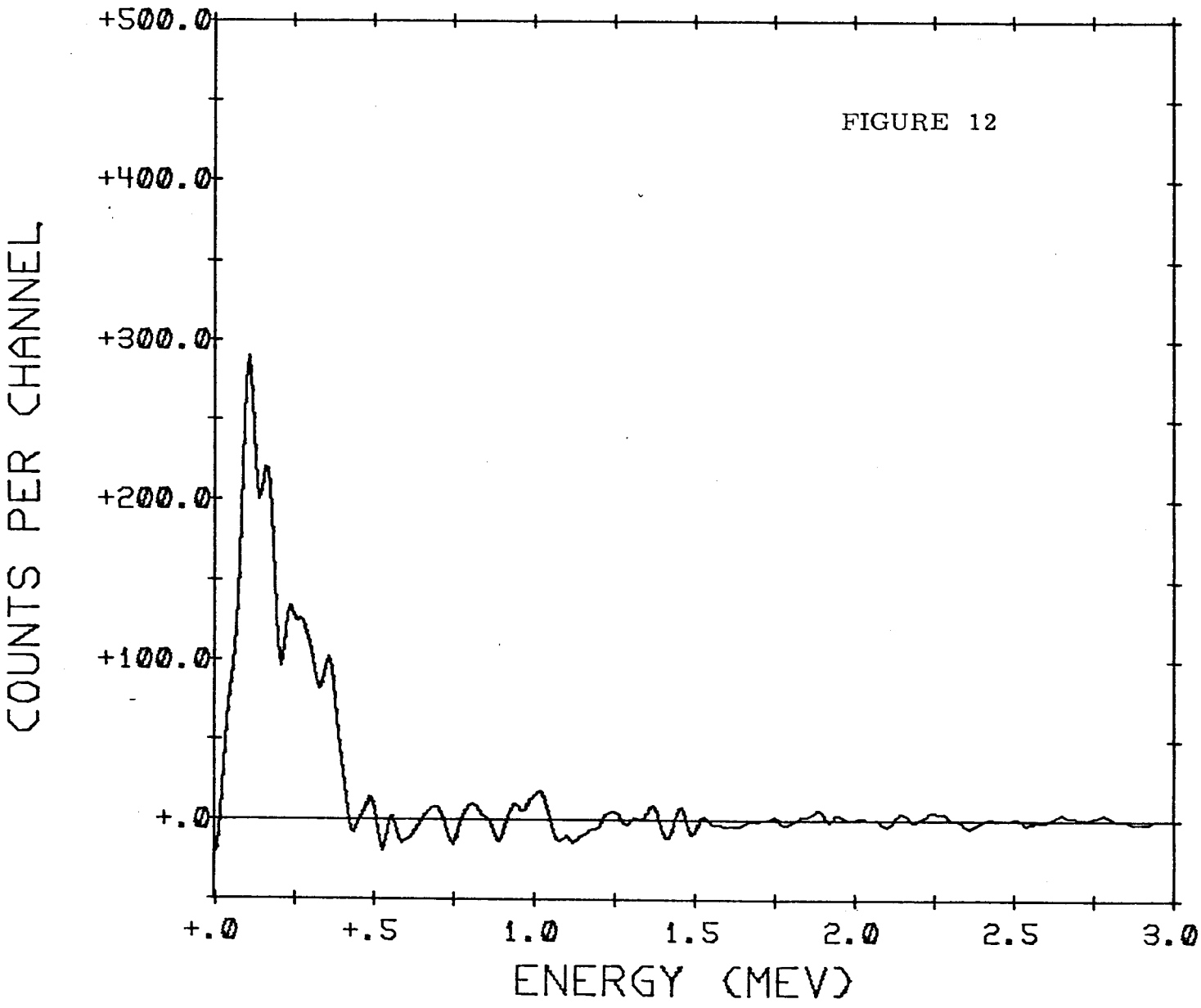
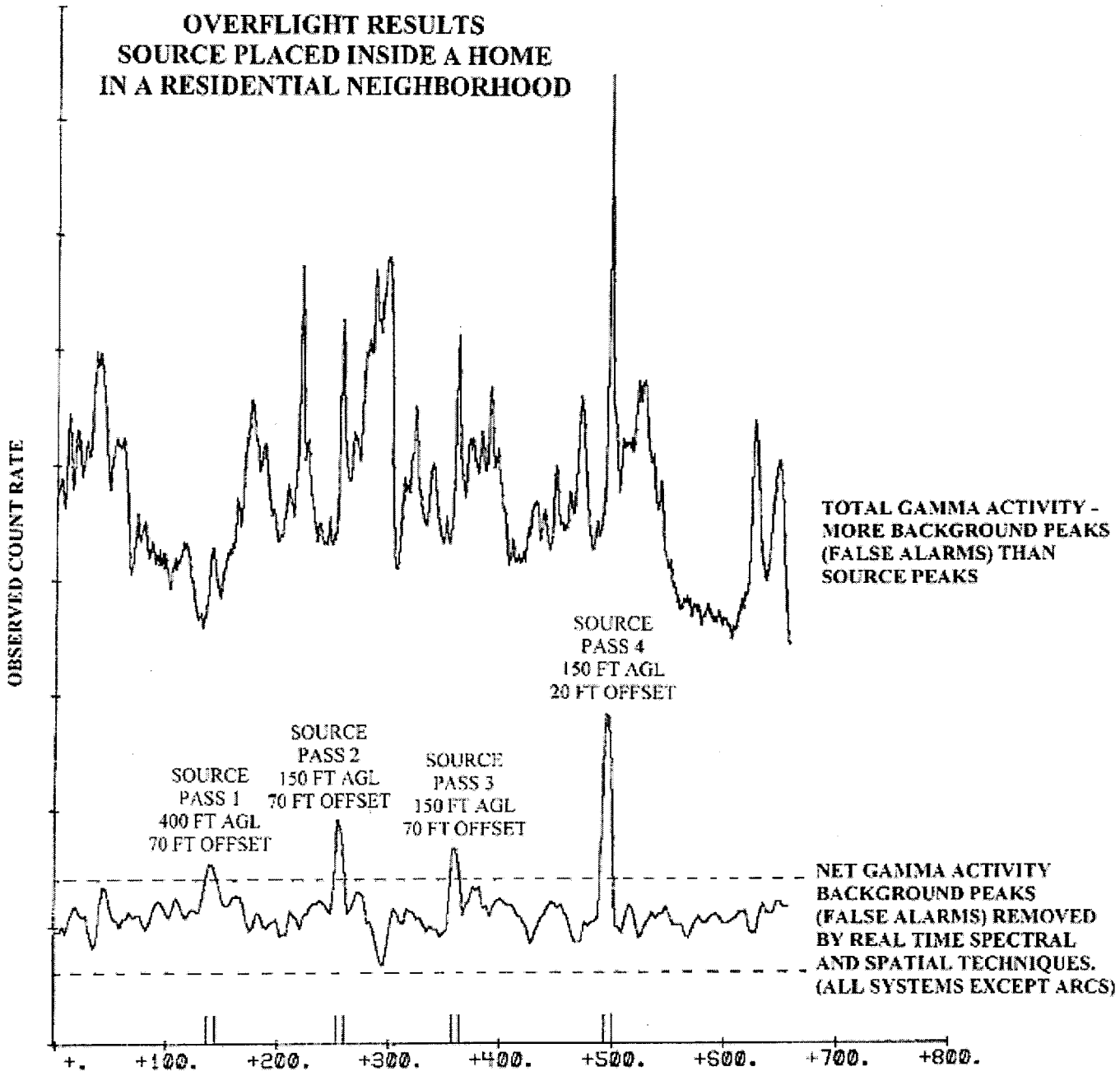


FIGURE 12

SPECTRUM NO. 349 (118,122)-K(110,114
DATE 3-12-75
LIVE TIME (MIN) +.238
INTEGRATED CT. +.5031383E+04
TYPE SOURCE (BKG REMOVED)
ALTITUDE 150'
AIRCRAFT UH1N


OVERFLIGHT RESULTS
SOURCE PLACED INSIDE A HOME
IN A RESIDENTIAL NEIGHBORHOOD
OBSERVED COUNT RATE
TOTAL GAMMA ACTIVITY - MORE BACKGROUND PEAKS (FALSE ALARMS) THAN SOURCE PEAKS
SOURCE PASS 4 150 FT AGL 20 FT OFFSET
SOURCE PASS 2 150 FT AGL 70 FT OFFSET
SOURCE PASS 1 400 FT AGL 70 FT OFFSET
SOURCE PASS 3 150 FT AGL 70 FT OFFSET
NET GAMMA ACTIVITY BACKGROUND PEAKS (FALSE ALARMS) REMOVED BY REAL TIME SPECTRAL AND SPATIAL TECHNIQUES. (ALL SYSTEMS EXCEPT ARCS)
+.
+100.
+200.
+300.
+400.
+500.
+600.
+700.
+800.