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THE REMOVAL OF RADIOACTIVE CONTAMINANTS FROM DOE FUSRAP SOIL (HAZELWOOD-1987)

NUCLEAR TECHNICAL SERVICES

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TRUclean II - VORRP

THE REMOVAL OF RADIOACTIVE CONTAMINANTS FROM DOE FUSRAP SOIL*

(HAZELWOOD - 1987)

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Las Vegas, Nevada

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TABLES

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Norm Sunderland

Project Manager

ABSTRACT

This research was undertaken to determine if the TRUclean* process could effectively remove radioactive elements from soils other than derived coral.

This is an interim report prior to the project report and discusses the outcome of the tests of the United States Department of Energy's (DOE), Hazelwood Site. Bench tests were conducted on numerous DOE materials from other FUSRAP (Formerly Utilized Site Remedial Action Program) sites; however, weather and time were important factors in the Hazelwood site selection.

The soil tested contained radium and thorium particulates. Volume reduction and activity removal were accomplished with an overall efficiency of greater than 90 percent.

*Patent pending

INTRODUCTION

A soil decontamination pilot plant was developed starting in 1985 for the Field Command Defense Nuclear Agency to remove plutonium contamination from coral soil. The system was designed, fabricated and operated by AWC, Inc. a Las Vegas, Nevada nuclear services corporation. Subsequent to its fabrication, testing and operation, the plant, known as the TRUclean Process, was declared a successful coral/soil decontamination process.

The pilot tests conducted on Johnston Island during 1985 and 1986 by the TRUclean process opened avenues for large volume reduction and activity removal (Ayres 1987). The cost savings predicted for Johnston Island were based upon disposal costs of the contaminated soil at commercial sites. The tests demonstrated a somewhat greater than 90% volume reduction and activity removal from coral derived soil. This was such a significant reduction that the Department of Energy (DOE) was prompted to consider the cleanup of various materials under DOE jurisdiction (Delaney 1986). If similar in-situ volume reduction could be realized with the DOE materials, substantial savings would be realized even when considering the reduced burial costs at the Nevada Test Site (NTS).

Subsequent to the Johnston Island tests, agreement between the Department of Defense, Field Command Defense Nuclear Agency (DOD, FCDNA) and the DOE allowed the equipment, instrumentation and process to be tested at the NTS with various types of soil other than coral (Cody 1986).

The pilot plant was shipped from Johnston Island to the NTS and arrived at the Area 25 E-MAD facility the last week of August, 1986. The equipment and instrumentation were unpacked, inventoried and moved to the Engine Transport Maintenance Building (train shed) the second week in September, 1986 (Sunderland 1986).

The DOE Hazelwood site was the most accessible for the removal of sufficient test material for this phase of the project. A shipment of drummed soil arrived at the facility during the week ending March 28, 1987 for TRUclean processing and testing.

The testing and processing began on Monday, April 27, 1987. The detector system was modified and calibrated to thorium and radium sources. Test results indicated successful activity removal to levels of less than 2 picoCuries per gram (pCi/g) of radium-226 and less than 1 picoCurie per gram of thorium-228.

METHODS AND PROCEDURES

A total of 40 drums of soil were shipped from the Hazelwood, Missouri site and delivered to the TRUclean II test facility.

The soil was typically fine grained but in a heavy clay laden matrix. The deposition from suspension rate in untreated water was in excess of 180 minutes. Particle dynamics and the slow rate of deposition combined to present complex processing challenges which were met by system modifications and an increase in manual treatment of the soil.

Thirteen test runs were conducted to develop the optimum operating parameters for the TRUclean system with this soil type. The first thirty hours of testing involved the development of initial operational parameters, calibration of the detector system to radium and thorium isotopes and tests to determine the best methods of effluent and material handling.

During these initial tests the Hazelwood material, due to its clay matrix and moisture content, would roll up into 1.77 cm (0.5 in) to 2.54 cm (1.0 in) clay balls which would blind the shaker screen, clog the crusher and build up behind the weir in the separator bed and promptly force water into the cleated conveyor. A technique was developed to air dry the matrix and crush the clay balls. This technique allowed the processing to continue with minimal interruptions.

As the water slurry exited the TRUclean processing unit and entered the spiral classifier, the suspended soil particles dropped out and the water flowed over an adjustable weir gate. As the solids collected at the bottom of the spiral classifier they were continuously augered up and out onto a discharge conveyor. The water which went over the weir was collected in a tank and pumped to settling tanks or through a sub-micron filter system for

subsequent clarification and recycling. The small particle size and slow rate of deposition prevented sufficient collection of soil particles in the spiral classifier to allow classification to occur, thus long chain polymer flocculants were added to the slurry as it entered the classifier. This was an attempt to have the fine grain particles drop out of suspension in the classifier. The rate of deposition was increased, however, the major portion of the deposition still occurred in the settling tanks rather than the classifier.

The utilization of filtration techniques allowed the removal of particles from the liquid effluent. The filtration system removed particles down to and including 0.5 micron in size. Water sampling and analysis indicated that all system waters remained free of radium and thorium contaminants.

It was determined that background radiation was masking some of the spectra peaks. The addition of lead blankets and shot to the detector housings lowered the background. However, the very low level of thorium and radium isotope concentrations in the soil media made analysis by the Multichannel analyzer difficult. Pathway soil samples were then taken to determine that isotope collection was occurring in the hutch and that the filtration system was removing any residual contaminants.

RESULTS AND CONCLUSIONS

The test parameters are presented in Table 4. The set of data is preceded by an explanatory key.

Table 3 lists the Volume–Mass comparisons and Table 6 lists the picoCurie per gram comparisons for the test runs. These data were necessary to establish comparison points for each run and to enable determinations of activity removal and volume reduction.

Appendix A shows the spectra of the feed material as recorded by the multichannel analyzers (MCA). The Sample Data section lists the sample results as reported.

The research previously conducted on Johnston Island indicated that a number of modifications would be required to provide consistently high efficiency yields. Some of these modifications were made at the NTS and good yields were realized as the proper operational parameters were reached. However, the soil from the Hazelwood site must be preconditioned prior to processing because of the high clay content. Additional equipment needed to process high soil throughput would consist of screens, a drier and a macerator (a device to pulverize dry clay).

The reduction of a volume of contaminated material from an area is economically important due to the transportation and waste disposal costs. The removal of the radioactivity from soil can allow relatively free beneficial use of the soil for uncontrolled purposes. A review of the data indicates acceptable volume reduction and activity removal when optimum parameters are utilized and maintained.

Optimum conditions for the FUSRAP soil are met when the selective mineral separator's diaphragm stroke is set at 0.950 cm (3/8"), the fractional classification bed is made up of 3 layers of 0.95 cm (.38 in.) balls, there is a supply of 22 gallons per minute (gpm) of water to the TRUclean processor with 6 gpm to the sluice. These are reproducible parameters and they give reproducible results when there is a consistency in the soil media. The developed parameters are repeatedly successful in the indicated soil. The volume reduction and separation of the radioactive particulates from the soil matrix are predictable once proper operational parameters have been established.

Final soil sample analyses confirm that radium and thorium were removed at the reported levels from the FUSRAP samples. We can expect to be able to remove radioactivity down to levels <2.0 pCi/g of radium and thorium with a volume reduction of at least 90%. This equates to 90,000 cubic yards of clean soil returned from each 100,000 cubic yards of contaminated soil, with the 90,000 cubic yards of clean material capable of being released for "unrestricted use."

The Hazelwood soil presented many challenges. These challenges were met and the research accomplished good activity removal and volume reduction in this soil type. The TRUclean process should prove to be a valuable asset to the Department of Energy at FUSRAP and other sites.

Data Key I

OPERATIONAL PARAMETERS

Table 2 depicts the different parameters under which the TRUclean II Process operated. The parameters were changed to provide different configurations and results on the materials that were processed.

Run Number	Each change in the operating parameters during these experimental procedures was considered a "run" and each "run" was recorded separately for statistical analysis.
GPM	The water flow to the selective mineral separator is measured in gallons per minute.
Stroke	The length of the diaphram movement of the selective mineral separator is measured in inches.
Ball Size	The size of the balls used in the artificial bed of the selective mineral separator. This measurement is recorded in inches.
No. Balls	More than one layer of balls were used in the artificial bed of the selective mineral separator. The number of layers of balls are indicated in this column.
Weir Gate	A weir gate is used at the entrance to the selective mineral separator to force material down across the natural bed of the separator. The depth of the weir from the artifical bed is recorded in inches.

TABLE 1

OPERATIONAL PARAMETERS

RUN NUMBER	GPM WATER	STROKE	BALL SIZE	BALL LAYERS	WEIR DEPTH
1.00	25.0	0.25	3/16	6	2.0
2.00	15.0	0.25	3/16	6	2.0
3.00	15.0	0.25	3/16	3	2.5
4.00	25.0	0.38	3/8	3	N.A.
5.00	25.0	0.38	3/8	3	2.0
6.00	25.0	0.38	3/8	3	2.0
7.00	15.0	0.38	3/8	3	N.A.
8.00	20.0	0.38	3/8	3	N.A.
9.00	22.0	0.38	3/8	3	N.A.
10.00	23.0	0.38	3/8	3	N.A.
11.00	18.0	0.38	3/8	3	N.A.
12.00	16.0	0.38	3/8	3	N.A.
13.00	18.0	0.38	3/8	3	N.A.

TABLE 2

VOLUME - MASS COMPARISONS

RUN NUMBER	FEED		HUTCH		PRESS	
	cc	g	cc	g	cc	g
5	351,131	705,773	2,000	4,420	327,893	701,691
6	368,118	739,917	4,000	8,840	345,712	735,917
7	368,118	739,917	4,600	10,166	345,112	735,317
8	368,118	739,917	12,000	26,520	337,712	727,917
9	583,330	1,172,493	13,000	28,730	541,164	1,159,493
10	226,536	455,337	3,000	6,630	212,209	452,337
11	540,855	1,087,119	11,000	24,310	502,812	1,076,119
12	424,755	853,758	8,000	17,680	395,517	845,758
13	169,902	341,503	2,000	4,420	159,407	339,503

cc = Volume in cubic centimeter
g = Soil mass in grams

TABLE 3

PicoCurie Per Gram (pCi/g)
Comparisons

Run Number*	HUTCH		FILTER	
	Radium	Thorium	Radium	Thorium
5	8.7	0	1.8	0
6	5.7	7.6	1.4	0
7	2.1	1.3	1.6	0
8	no data	no data	1.4	7.5
9	no data	no data	0	0
10	2.9	0	0	0
11	4.1	2.1	1.2	1.1
12	4.2	1.3	1.4	1.2
13	3.3	0	1.7	1.2

TABLE 4

Note: *Average Feed Material =
4.1 pCi/g radium
5.2 pCi/g thorium

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DeLaney, E.G., Memorandum, "Volume Reduction R & D Project - Planning Meeting on July 7, 1986", U.S. DOE, Division of Facility and Site Decommissioning Projects, Office of Nuclear Emergency, Washington, D.C., June 27, 1986.

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APPENDIX A

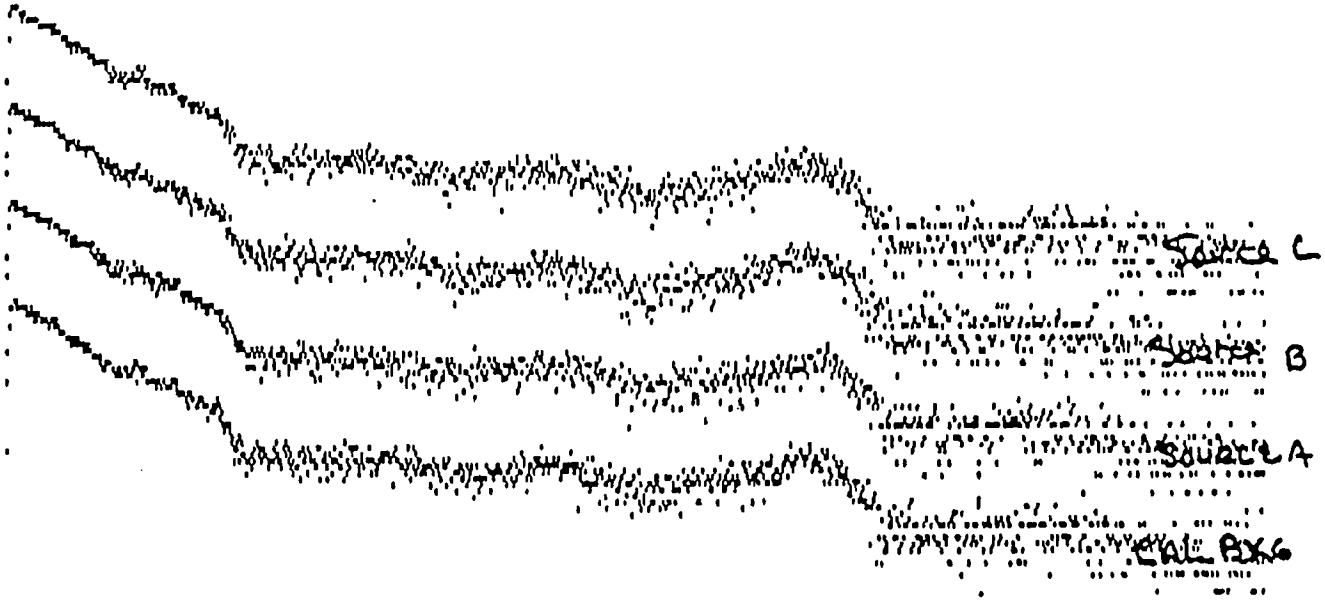
TEST RUN PRINTOUTS

MAY 12 1987 11:36:11 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00

GROUP: 01 VS: LOG CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: CAL BKG

FUNCTION KEY

F1 MORE	F2 IDENT
F3 STORE	F4 LOAD
F5 I/O	F6 USER
F7 CTRD	F8 FWHM
F9 DOS	F10 MAIN



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PK #: 00 CTRD: 0.00000 CHL FWHM: 0.00000 CHL GROSS: 000000000 NET: 000000000

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MAY 12 1987 11:36:11 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00

GROUP: F VS: LOG CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: CAL BKG

FUNCTION KEY

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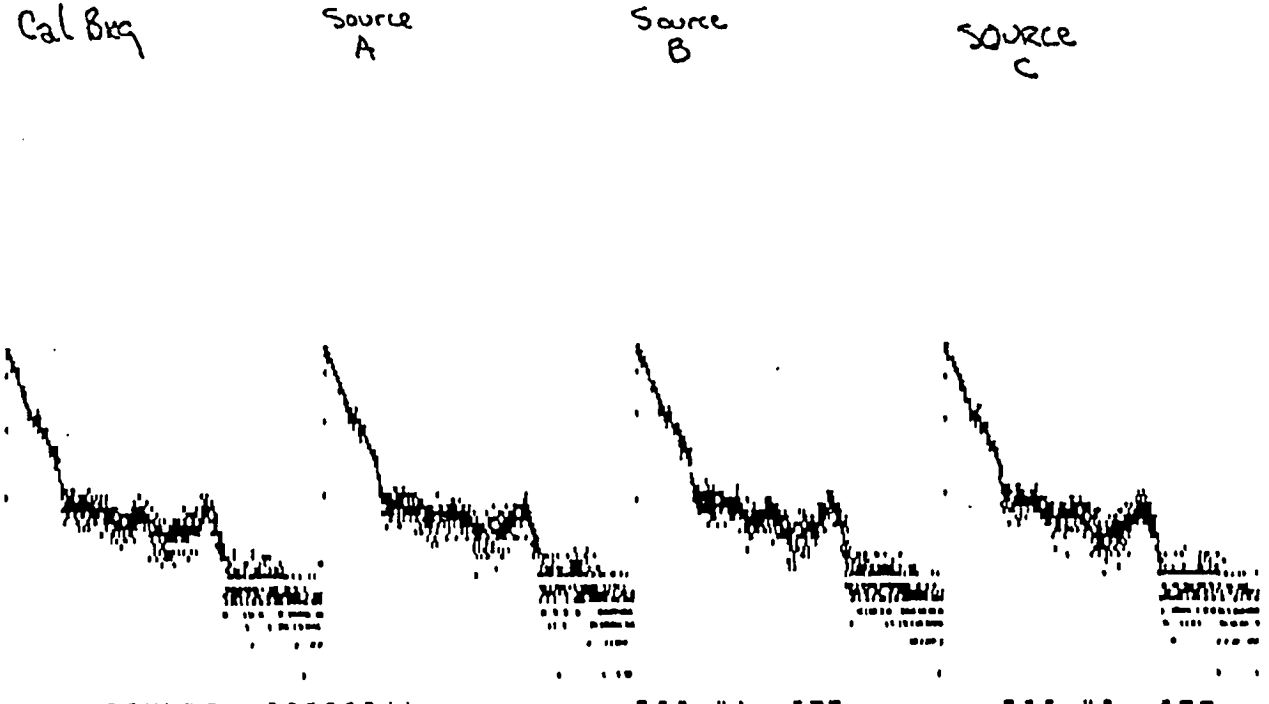
F3 STORE	F4 LOAD
F5 IZO:	F6 USER
F7 CTRD:	F8 FWHM:
F9 DOS	F10 MAIN



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TIME LIVE PRESET: 000000 ELAPSED: 000226 REMAINING: ∞ SECONDS

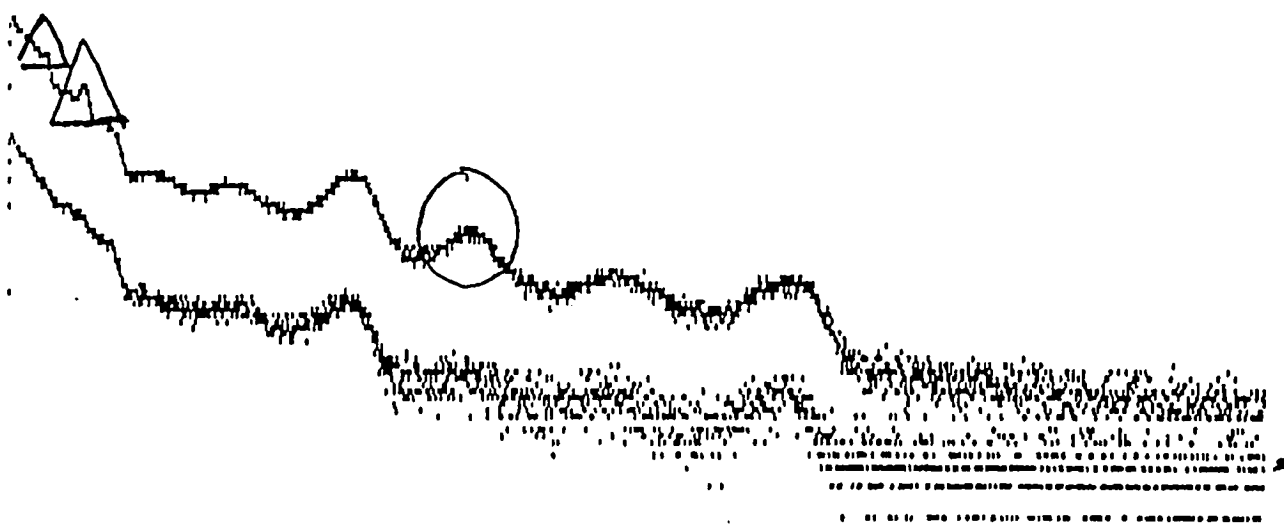
APR 28 1987 11:08:26 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00

GROUP: H1 VS LOC CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID:

Comparison

FUNCTION KEY

F1 MORE	F2 IDENT
F3 STORE	F4 LOAD
F5 I/O	F6 USER
F7 CTRD	F8 FWHM
F9 DOS	F10 MAIN



ENERGY: 457.965 KEV COUNTS: 00016528 ROI #1: OFF ROI #2: OFF

PK #: 00 CTRD: 0.00000 KEV FWHM: 0.00000 KEV GROSS: 000000000 NET: 000000000

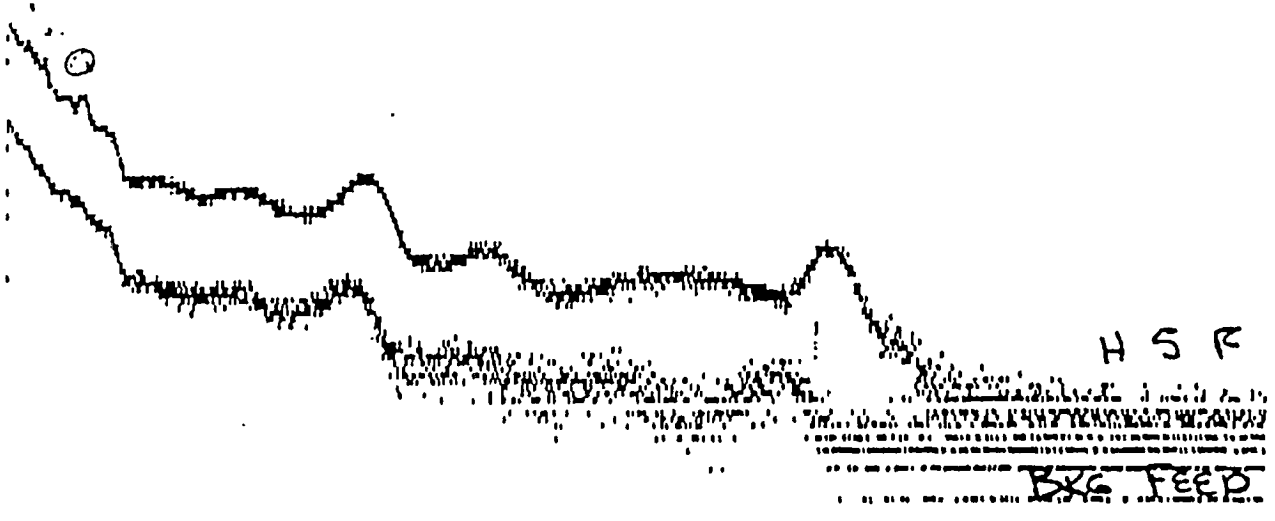
TIME LIVE PRESET: 000000 ELAPSED: 00~~42~~15 REMAINING: ∞ SECONDS

APR 27 1987 08:33:44 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00

GROUP: H2 VS: LOG CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: BKG FEED

FUNCTION KEY

F1 MORE	F2 IDENT
F3 STORE	F4 LOAD
F5 [ZOOM]	F6 USER
F7 [CTRD]	F8 [FWHM]
F9 DOS	F10 MAIN



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PK #: 00 CTRD: 0.00000 CHL FWHM: 0.00000 CHL GROSS: 000000000 NET: 000000000

TIME LIVE PRESET: 000000 ELAPSED: 000600 REMAINING: ∞ SECONDS

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GROUP: H1 VS: LOG CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: SSFBA

FUNCTION KEY

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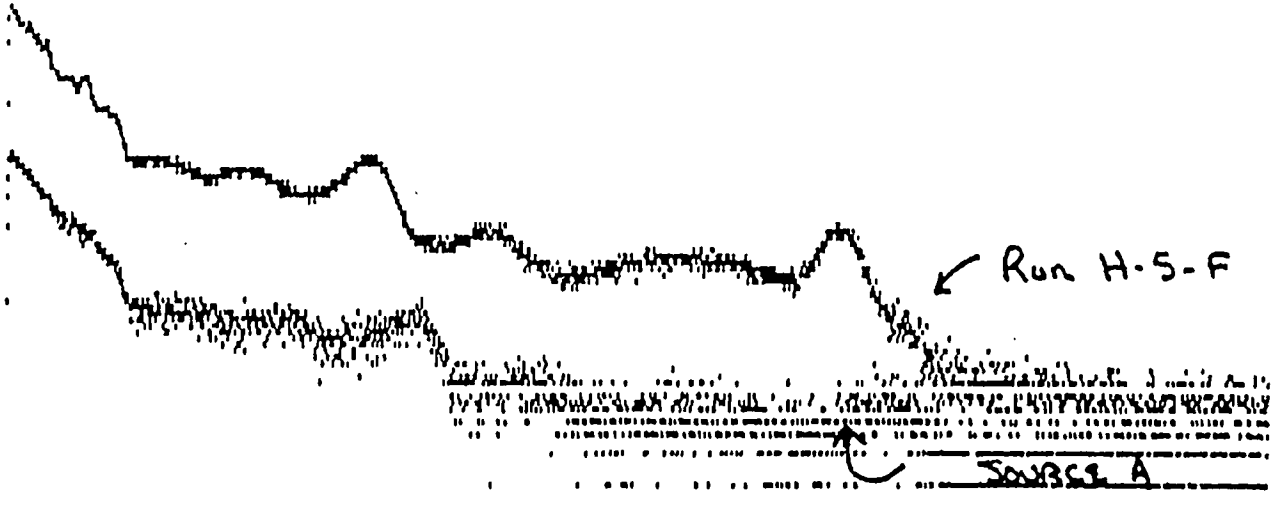
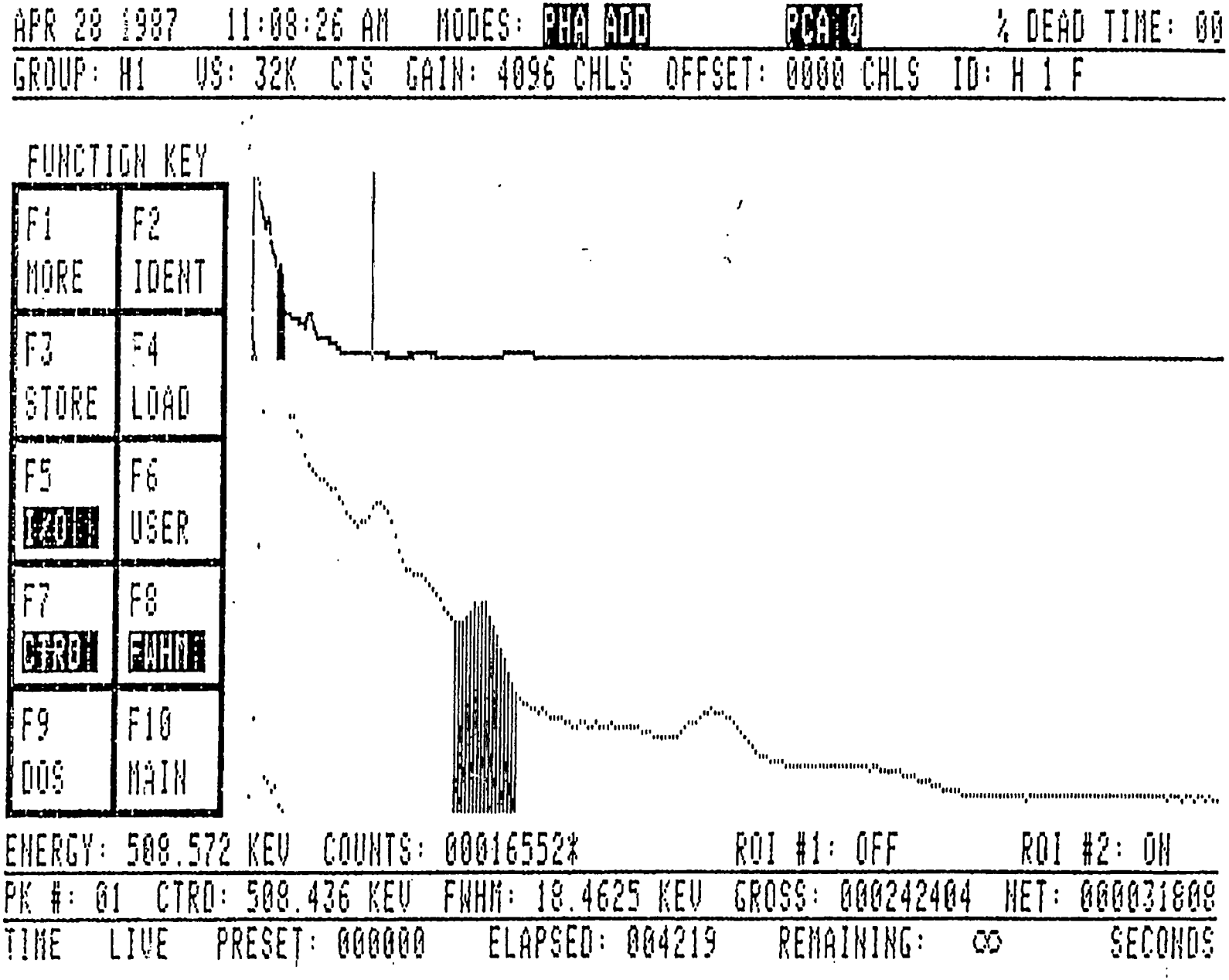
F5 I/O:	F6 USER
F7 CTRD:	F8 FWHM:
F9 DOS	F10 MAIN



ENERGY: 622.600 KEV COUNTS: 00004797 ROI #1: OFF ROI #2: ON

PK #: 00 CTRD: 0.00000 KEV FWHM: 0.00000 KEV GROSS: 000000000 NET: 000000000

TIME LIVE PRESET: 000000 ELAPSED: 000226 REMAINING: ∞ SECONDS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FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 M2 ON
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 508.572 KEV COUNTS: 00016552 ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 508.436 KEV FWHM: 18.4625 KEV GROSS: 000242404 NET: 000031808
TIME LIVE PRESET: 000000 ELAPSED: 004219 REMAINING: ∞ SECONDS

APR 28 1987 11:08:26 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00

GROUP: H1 VS: 2K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 1 F

FUNCTION KEY

F1 MORE	F2 IDENT
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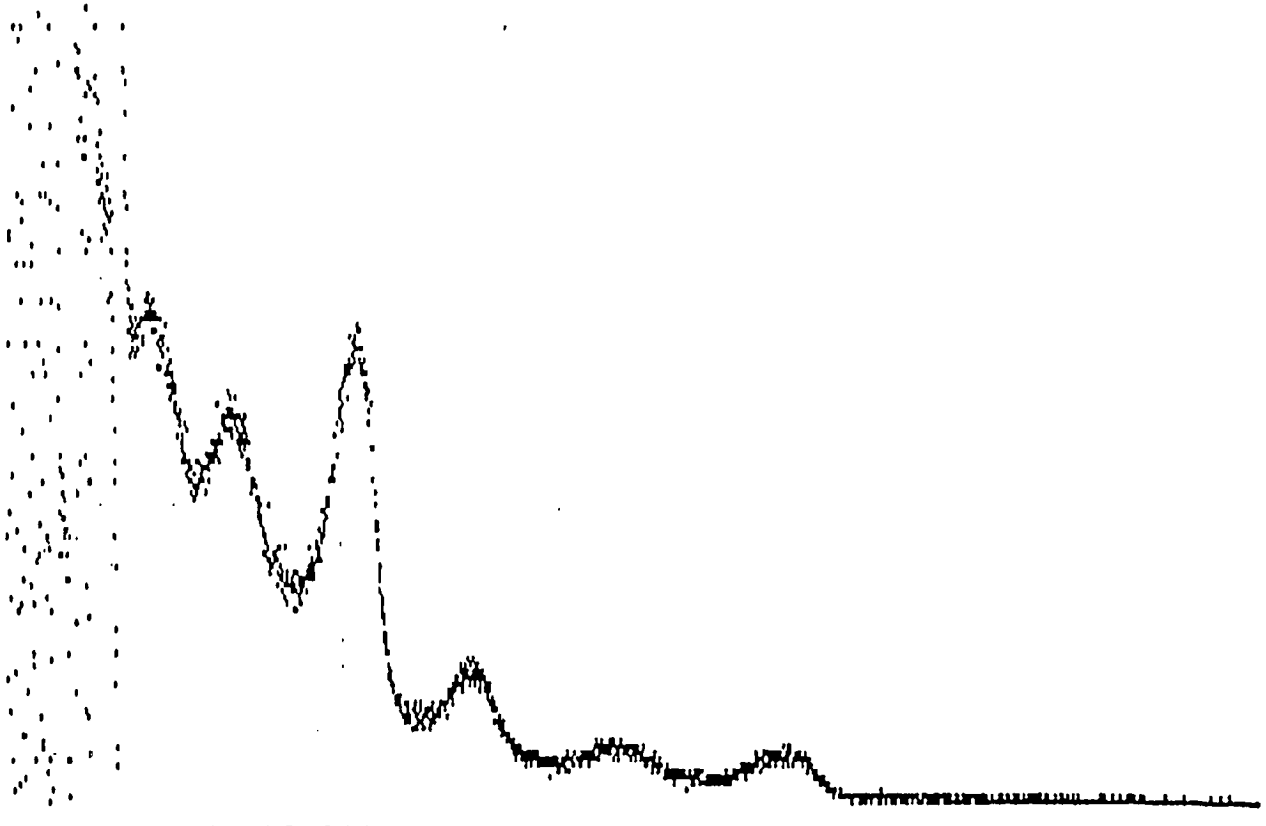
F5 [ZOOM]	F6 USER
F7 [CTRD]	F8 [FWHM]
F9 DOS	F10 MAIN



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PK #: 00 CTRD: 0.00000 CHL FWHM: 0.00000 CHL GROSS: 000000000 NET: 000000000

TIME LIVE PRESET: 000000 ELAPSED: 004219 REMAINING: ∞ SECONDS

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GROUP: H1 VS: 4K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H1FSTRIP

FUNCTION KEY

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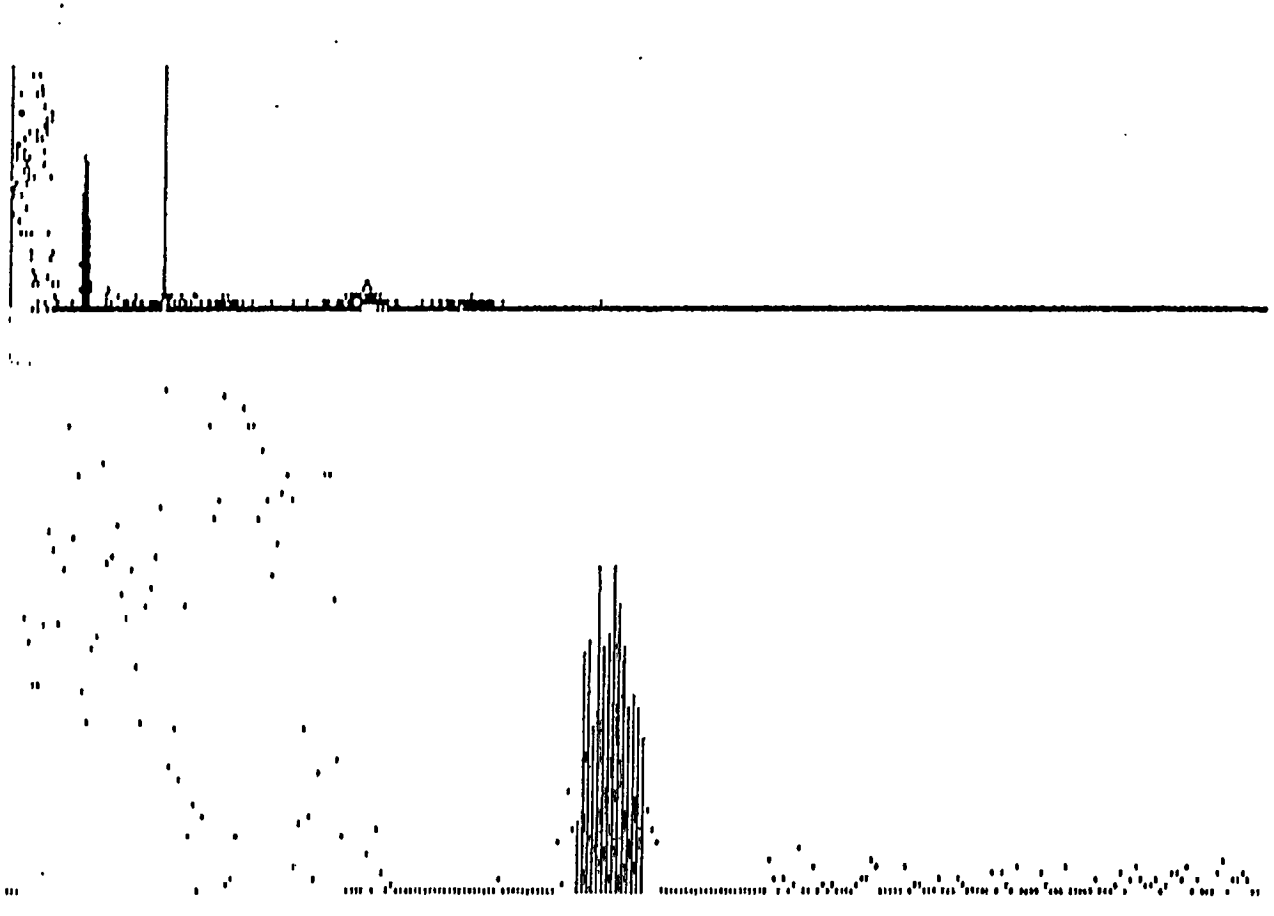
F5 I/O	F6 USER
F7 CTRD	F8 FWHM
F9 DOS	F10 MAIN



ENERGY: 594.793 KEV COUNTS: 00002012* ROI #1: ON ROI #2: OFF

PK #: 01 CTRD: 0.00000 KEV FWHM: 0.00000 KEV GROSS: 000024211 NET: 000016077

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FUNCTION KEY

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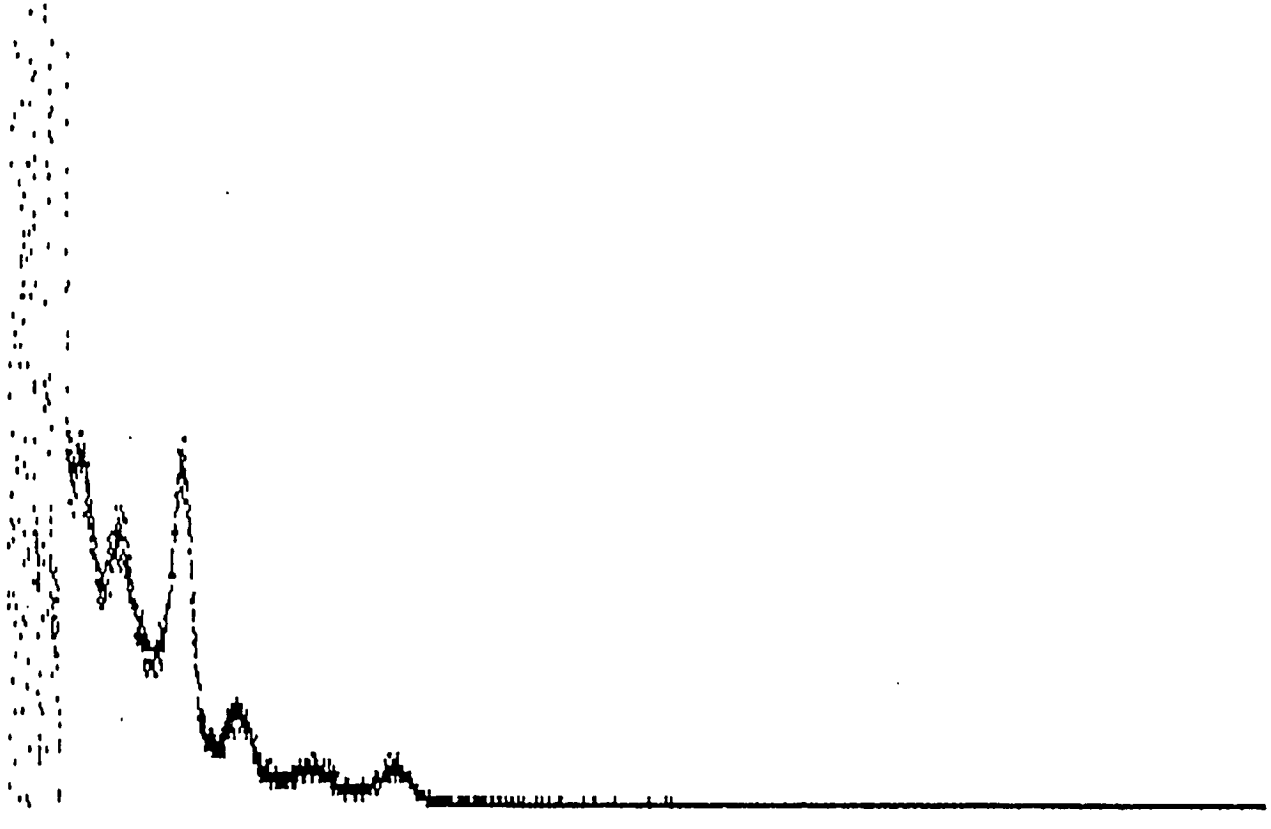
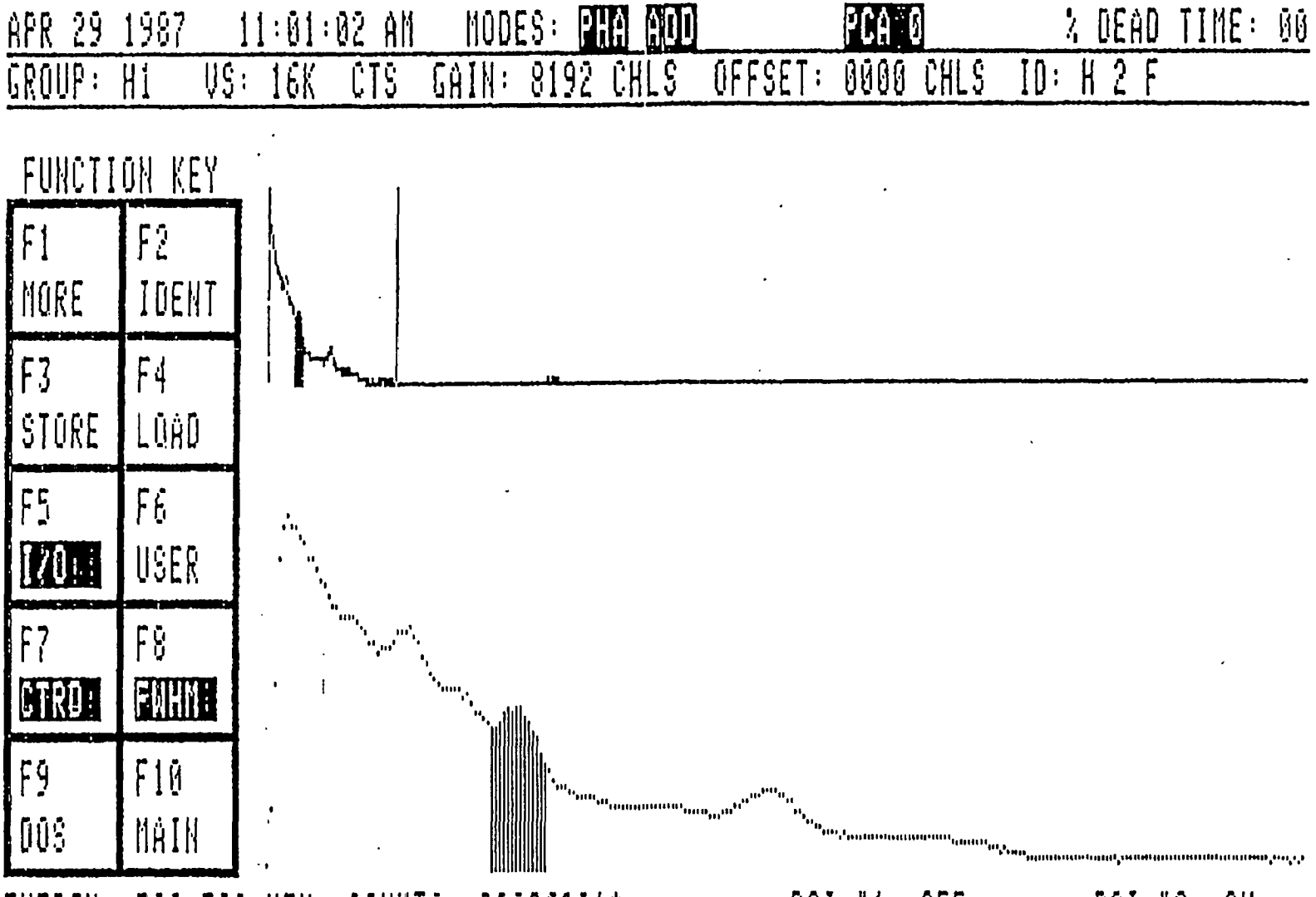
F5 I/O	F6 USER
F7 CTRD	F8 FWHM
F9 DOS	F10 MAIN



ENERGY: 1331.99 KEV COUNTS: 00000260 ROI #1: OFF ROI #2: OFF

PK #: 00 CTRD: 0.00000 KEV FWHM: 0.00000 KEV GROSS: 000000000 NET: 000000000

TIME LIVE PRESET: 000000 ELAPSED: 001333 REMAINING: ∞ SECONDS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FUNCTION KEY
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F2 IDENT
F3 STORE
F4 LOAD
F5 I/O:
F6 USER
F7 CTRD:
F8 FWHM:
F9 DOS
F10 MAIN
ENERGY: 508.529 KEV COUNTS: 00006021* ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 509.724 KEV FWHM: 13.8595 KEV GROSS: 000075646 NET: 000011610
TIME LIVE PRESET: 000000 ELAPSED: 001333 REMAINING: ∞ SECONDS

APR 29 1987 03:19:27 PM MODES: PHA ADD PCA:0 % DEAD TIME: 00

GROUP: H1 VS: 32K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 3 F

FUNCTION KEY

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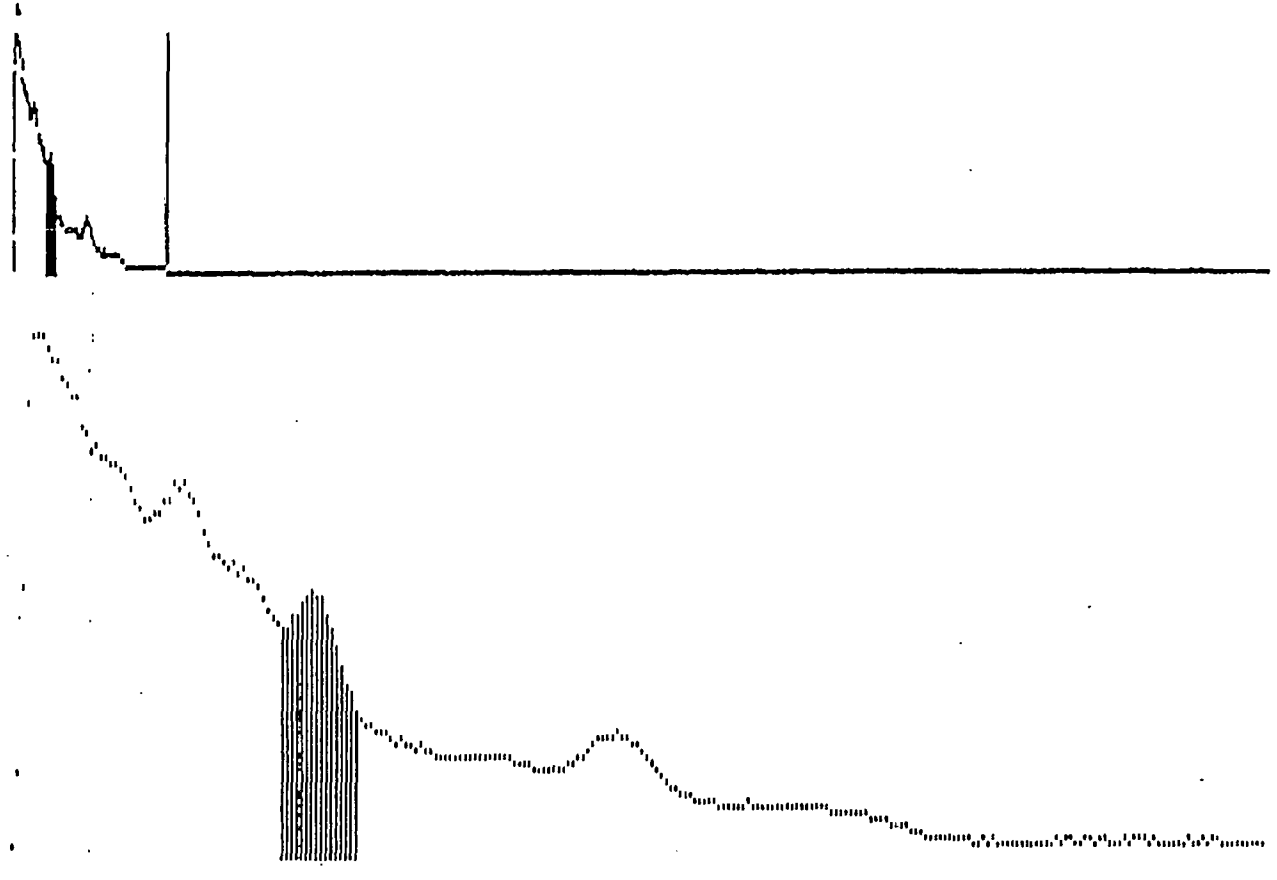
F5 [ZOOM]	F6 USER
F7 CTRD:	F8 FWHM:
F9 DOS	F10 MAIN



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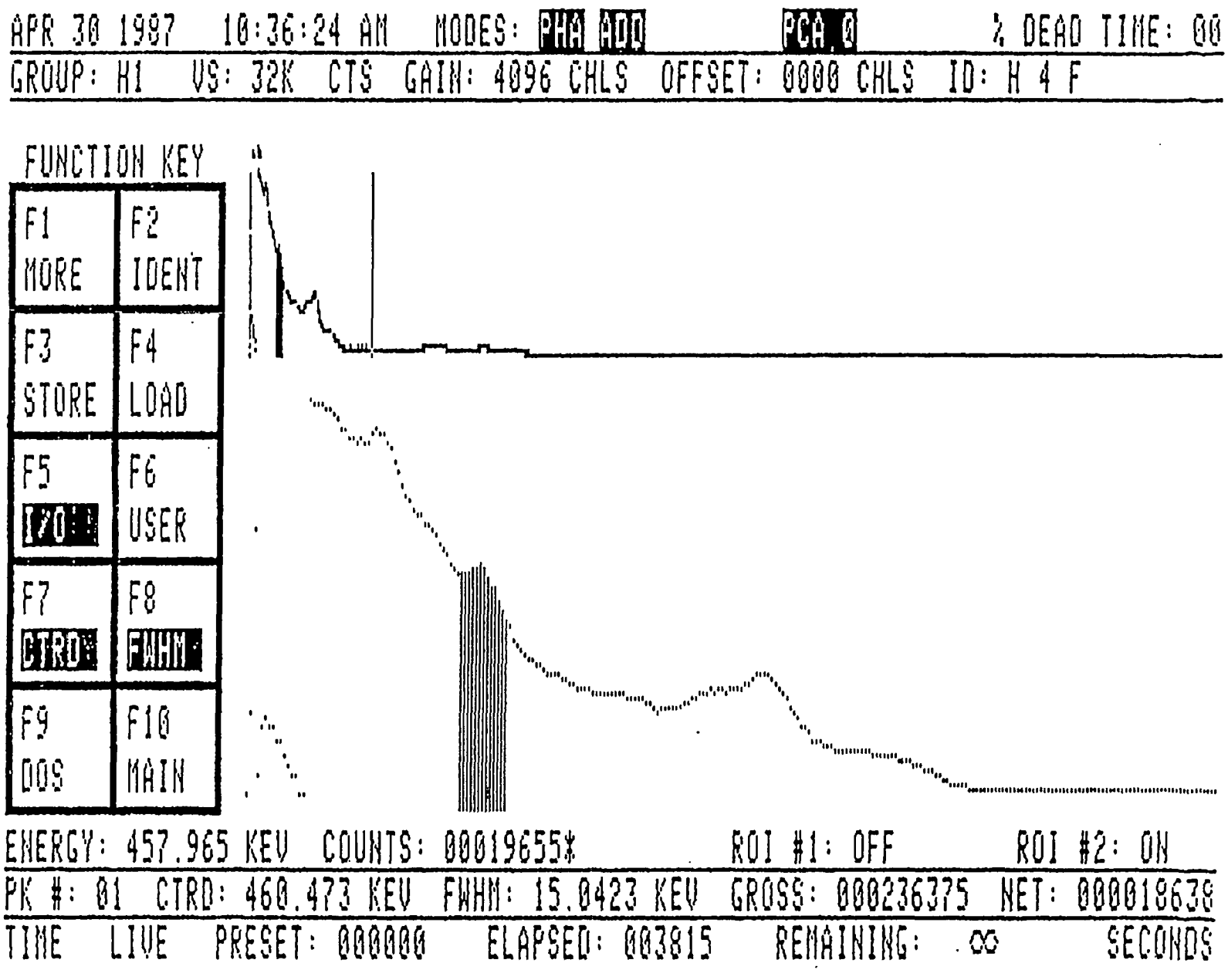
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F3 STORE
F4 LOAD
F5 [ZOOM]
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 457.965 KEV COUNTS: 00019655* ROI #1: OFF ROI #2: ON
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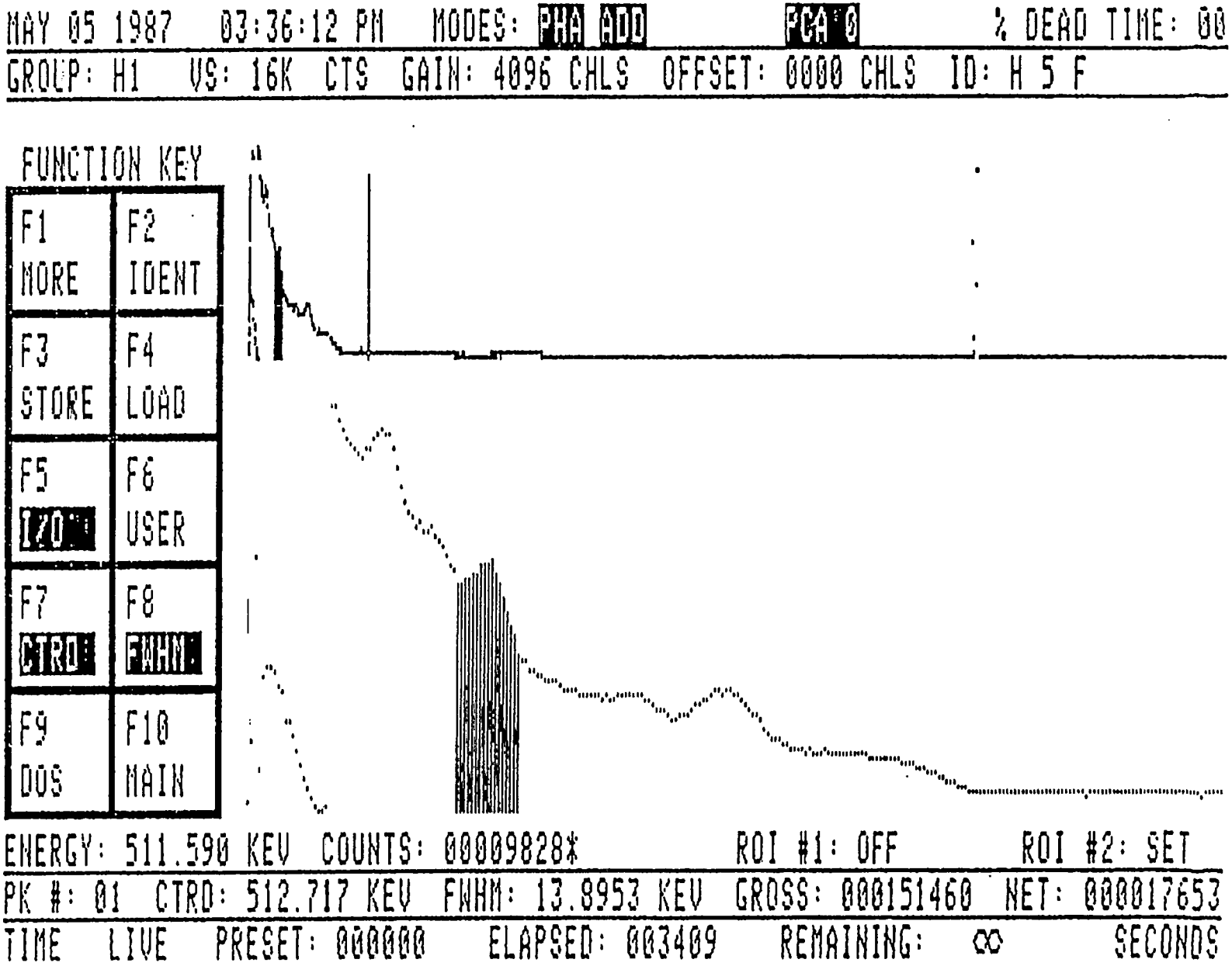
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F2 IDENT
F3 STORE
F4 LOAD
F5 I/O
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 511.590 KEV COUNTS: 00009828* ROI #1: OFF ROI #2: SET
PK #: 01 CTRD: 512.717 KEV FWHM: 13.8953 KEV GROSS: 000151460 NET: 000017653
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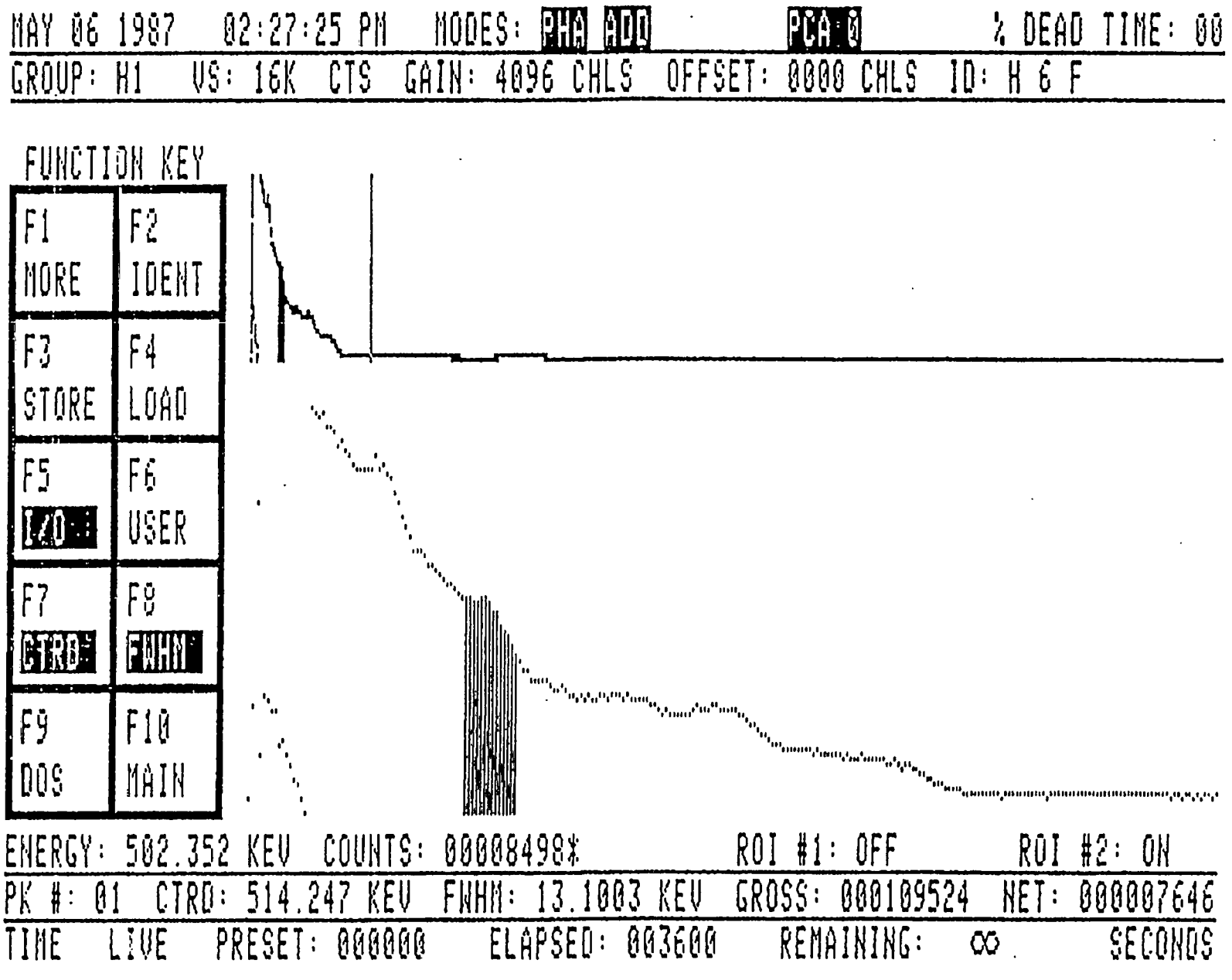
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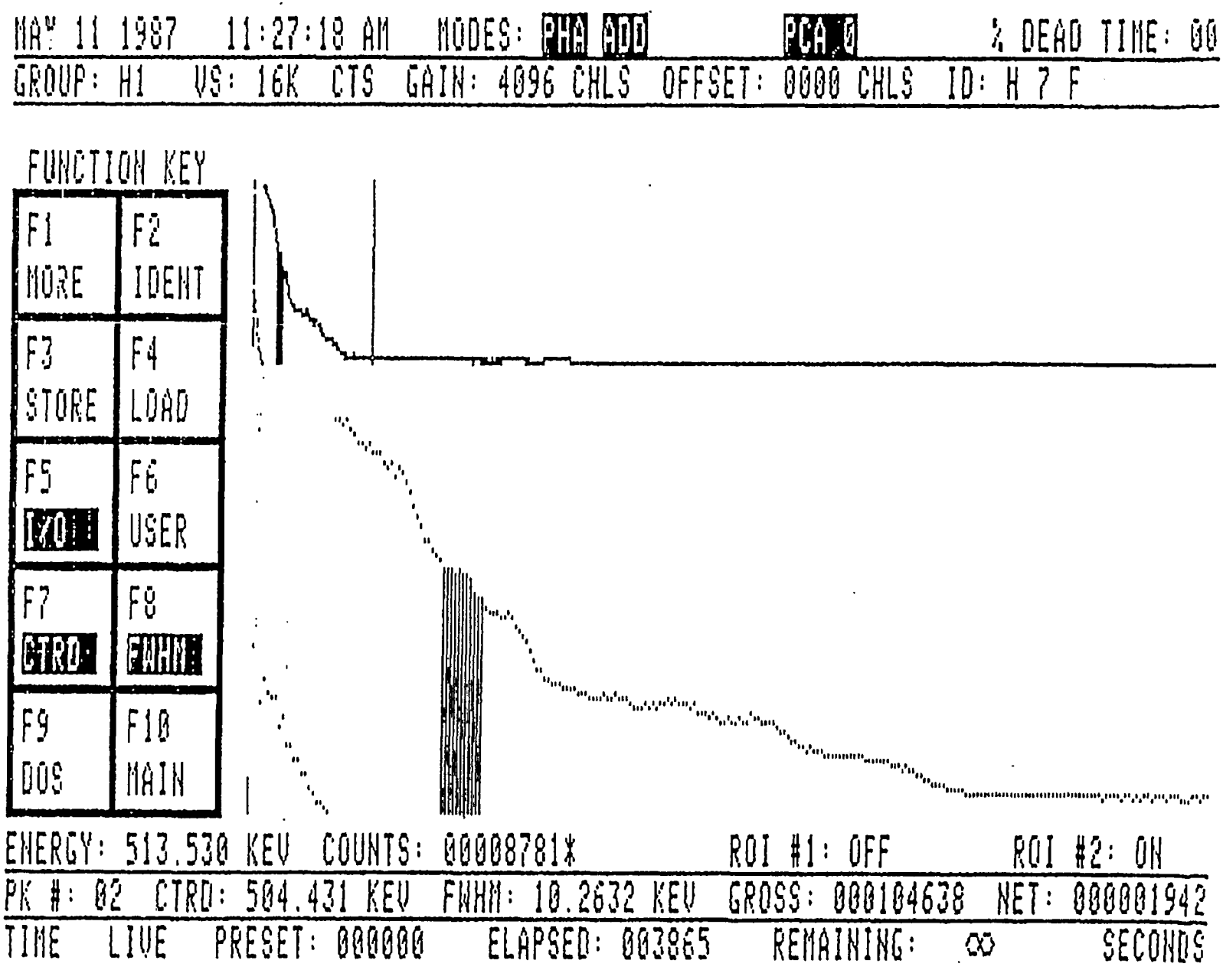
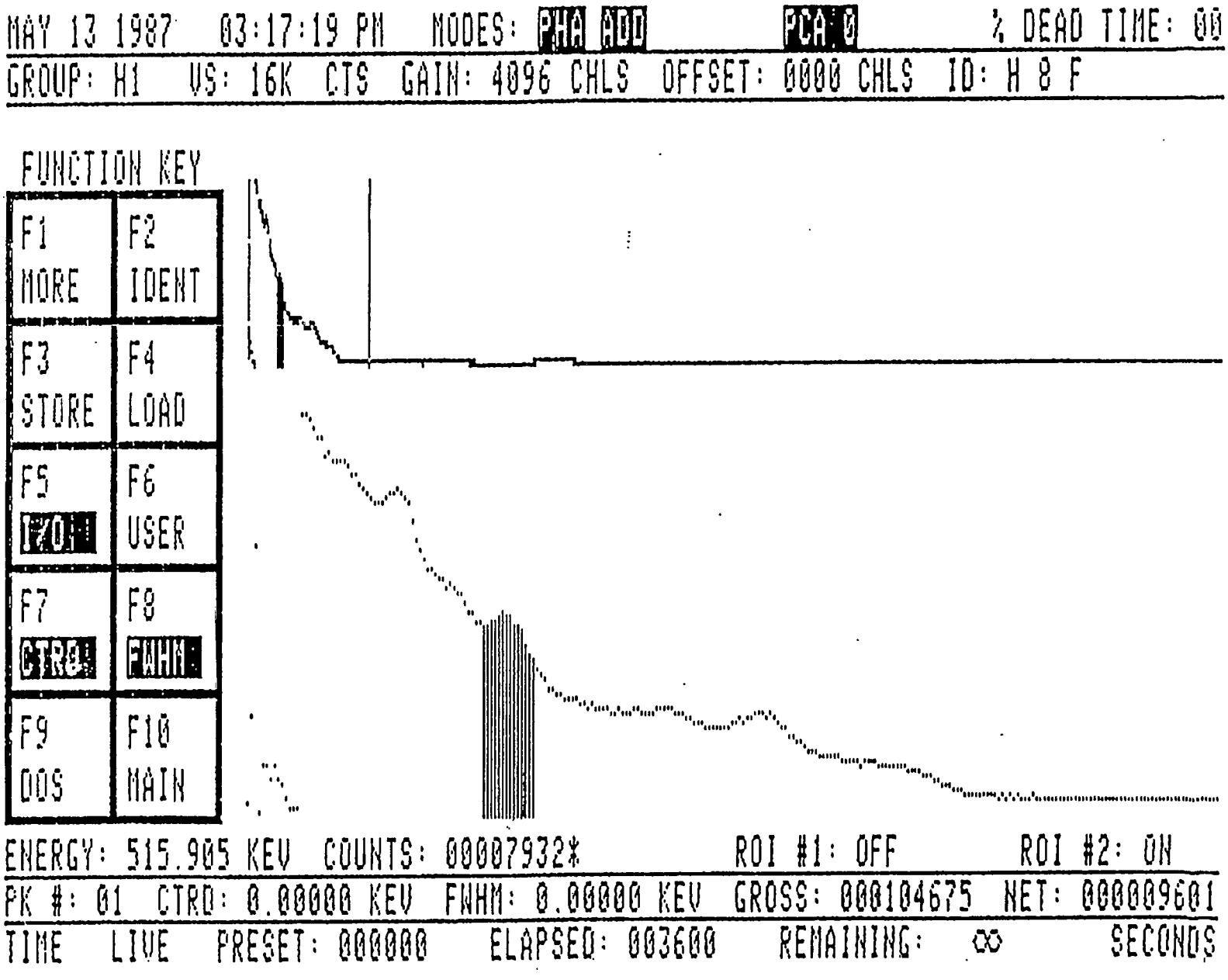
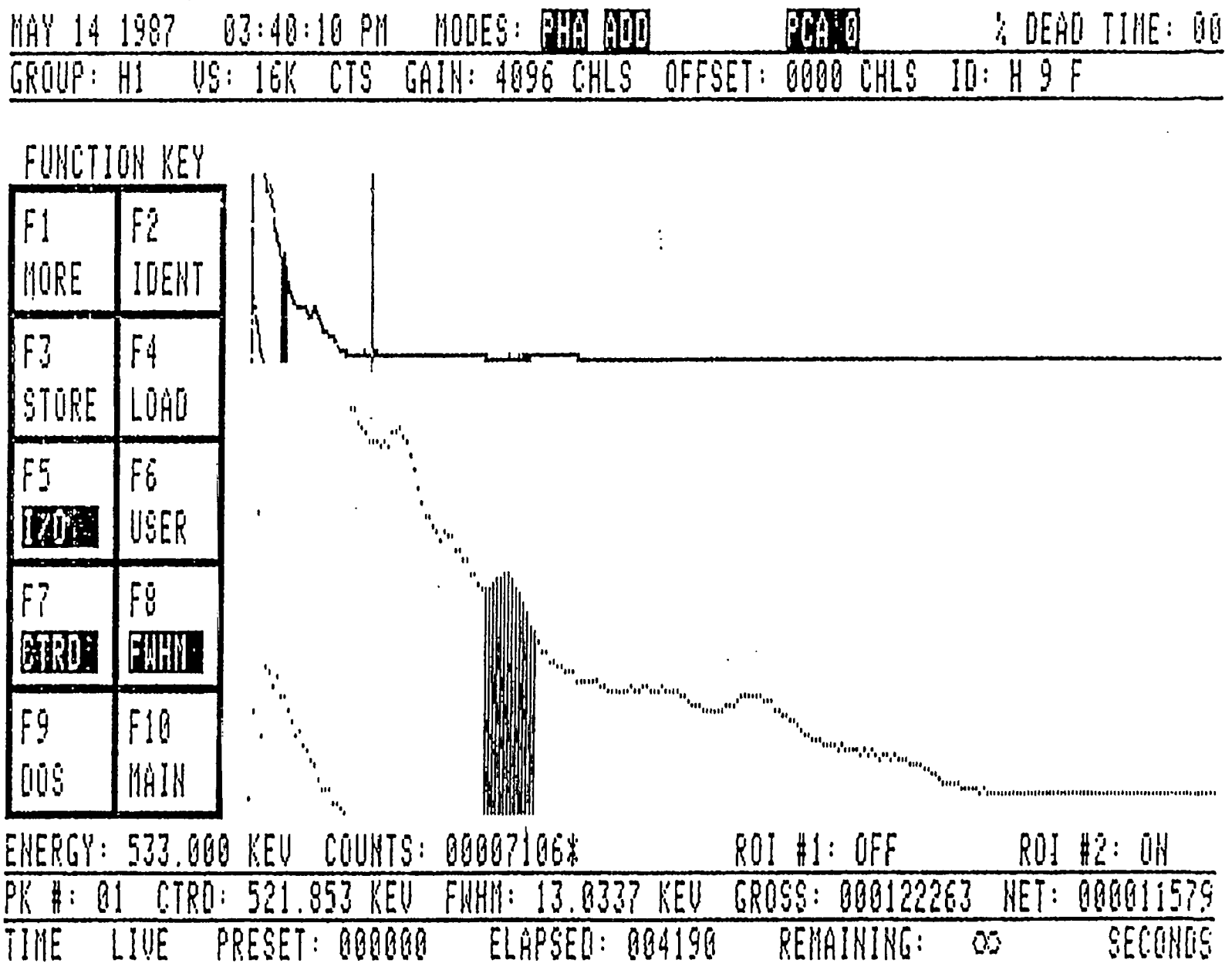
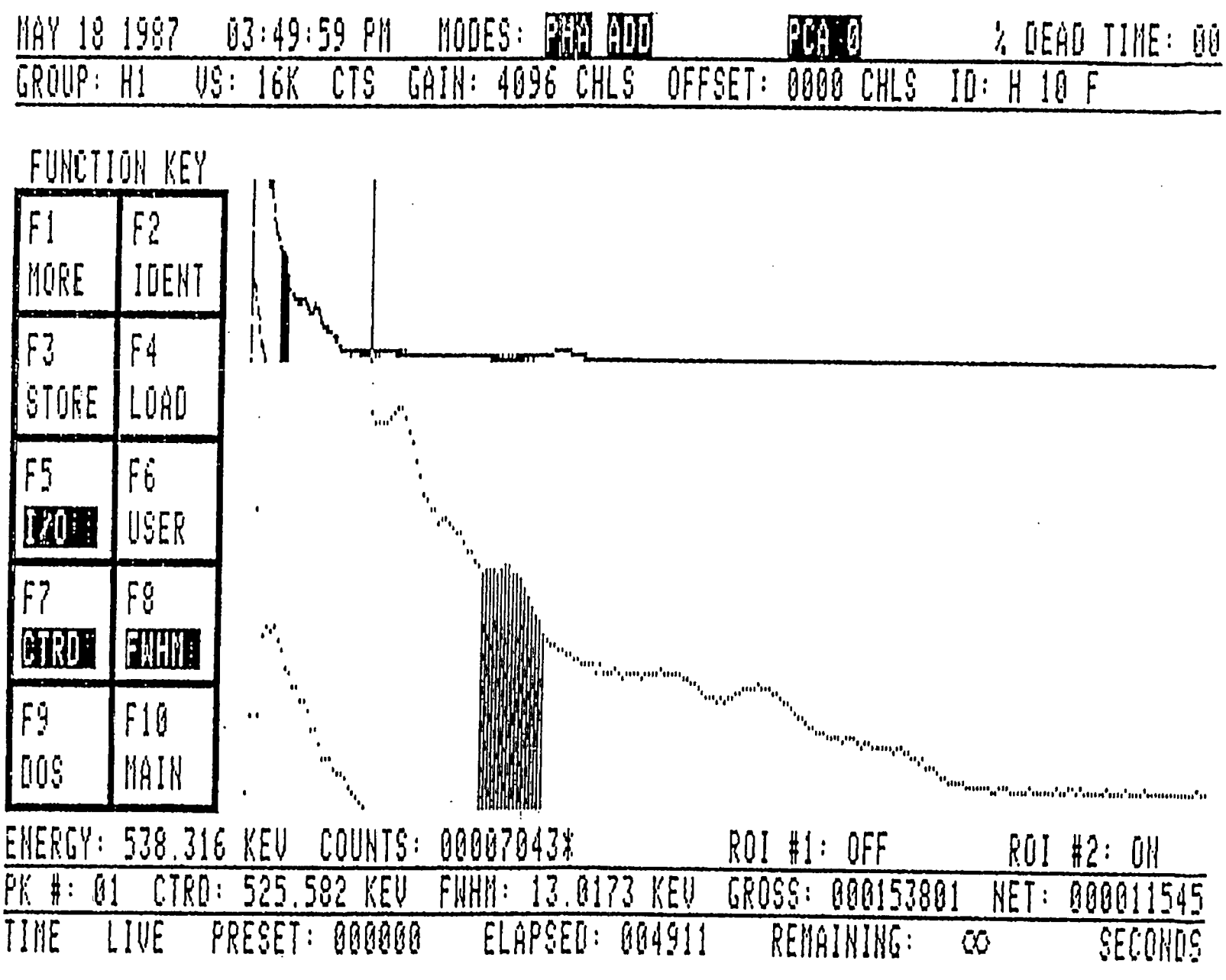
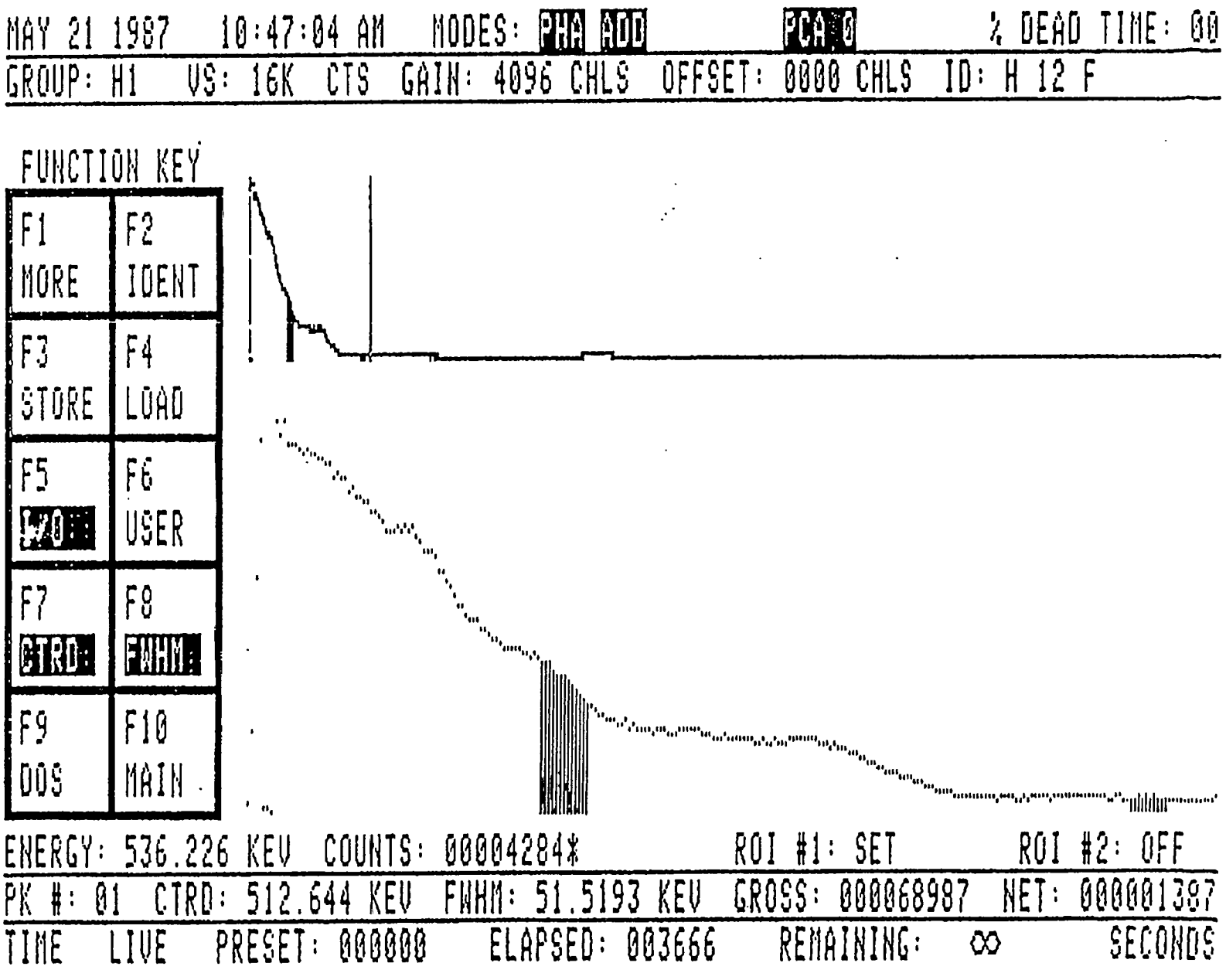
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 6 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 I/O
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 502.352 KEV COUNTS: 00008498* ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 514.247 KEV FWHM: 13.1003 KEV GROSS: 000109524 NET: 000007646
TIME LIVE PRESET: 000000 ELAPSED: 003600 REMAINING: ∞ SECONDS


MAY 11 1987 11:27:18 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 7 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 [X0]
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 513.530 KEV COUNTS: 00008781* ROI #1: OFF ROI #2: ON
PK #: 02 CTRD: 504.431 KEV FWHM: 10.2632 KEV GROSS: 000104638 NET: 000001942
TIME LIVE PRESET: 000000 ELAPSED: 003865 REMAINING: ∞ SECONDS


MAY 13 1987 03:17:19 PM MODES: PHA ADD PCA 0 % DEAD TIME: 00
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 8 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 ROI
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 515.905 KEV COUNTS: 00007932* ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 0.00000 KEV FWHM: 0.00000 KEV GROSS: 000104675 NET: 000009601
TIME LIVE PRESET: 000000 ELAPSED: 003600 REMAINING: ∞ SECONDS


MAY 14 1987 03:40:10 PM MODES: PHA ADD PCA:0 % DEAD TIME: 00
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 9 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 I/O
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 533.000 KEV COUNTS: 00007106 ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 521.853 KEV FWHM: 13.0337 KEV GROSS: 000122263 NET: 000011579
TIME LIVE PRESET: 000000 ELAPSED: 004190 REMAINING: SECONDS


MAY 18 1987 03:49:59 PM MODES: PHA ADD PCA 0 % DEAD TIME: 00
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 10 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 I/O
F6 USER
F7 CTRD
F8 FWHM
F9 DOS
F10 MAIN
ENERGY: 538.316 KEV COUNTS: 00007043* ROI #1: OFF ROI #2: ON
PK #: 01 CTRD: 525.582 KEV FWHM: 13.0173 KEV GROSS: 000153801 NET: 000011545
TIME LIVE PRESET: 000000 ELAPSED: 004911 REMAINING: ∞ SECONDS


MAY 21 1987 10:47:04 AM MODES: PHA ADD PCA 0 % DEAD TIME: 00
GROUP: H1 VS: 16K CTS GAIN: 4096 CHLS OFFSET: 0000 CHLS ID: H 12 F
FUNCTION KEY
F1 MORE
F2 IDENT
F3 STORE
F4 LOAD
F5 ZOOM
F6 USER
F7 CTRD:
F8 FWHM:
F9 DOS
F10 MAIN
ENERGY: 536.226 KEV COUNTS: 00004284* ROI #1: SET ROI #2: OFF
PK #: 01 CTRD: 512.644 KEV FWHM: 51.5193 KEV GROSS: 00006898? NET: 00001387
TIME LIVE PRESET: 000000 ELAPSED: 003666 REMAINING: ∞ SECONDS

SAMPLE DATA

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ±% Error
66234	AWC018	RA226	1.01E-05 +- 11.1 Mic.Ci/g

Run 2:

KeV	CPM
695.1	2.0
84.7	12.3
143.8	6.3
92.8	13.5
329.4	5.5
582.0	5.5
1181.3	1.0

Gamma Count Time: 20 min
513 Sample Size: 892.00G
Count Fact = 1.000

66235	AWC019	RA226	6.45E-06 +- 12.4 Mic.Ci/g
		TH228	2.18E-06 +- 20.0 Mic.Ci/g

Run 4:

KeV	CPM
423.7	2.3
527.9	.8
846.6	.8
403.0	2.2
143.8	5.3
92.8	7.2
1164.0	.6
66.1	8.0

Gamma Count Time: 20 min
513 Sample Size: 957.00G
Count Fact = 1.000

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ±% Error
66236	AWC020	RA226	1.80E-06 +- 24.1 Mic.Ci/g

Run 5: Press

Units:

KeV	CPM
238.6	2.4
142.2	1.5
106.1	1.2
1460.5	.8

Gamma Count Time: 20 min
612 Sample Size: 444.00G
Count Fact = 1.000

66293	AWC022	RA226	1.41E-06 +- 29.4 Mic.Ci/g

Run 6: Press

Units:

KeV	CPM
338.7	1.1
88.0	1.9
1460.5	1.0
910.0	.8

Gamma Count Time: 20 min
612 Sample Size: 389.00G
Count Fact = 1.000

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ±% Error
66294	AWC023	RA226	1.64E-06 +— 25.7 Mic.Ci/g

Run 7: Press

Units:

KeV	CPM
1460.5	1.2
92.8	2.1
238.6	2.5

Gamma Count Time: 20 min
612 Sample Size: 343.00G
Count Fact. = 1.000

66329	AWC024	RA226	8.71E-06 +— 13.6 Mic.Ci/g

Run 5: Hutch

Units:

KeV	CPM
563.2	1.4
67.6	3.4
768.5	2.0
143.8	3.6
92.8	5.7
84.7	7.1
860.4	.9
270.2	5.0
256.5	3.3

Gamma Count Time: 20 min
612 Sample Size: 917.00G
Count Fact = 1.00

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ± % Error
66450	AWC035	RA226	1.35E-06 +- 20.9 Mic.Ci/g
		TH228	7.49E-07 +- 25.1 Mic.Ci/g

Run 8: Press

KeV	Units: CPM
67.6	3.3
209.5	1.9
92.8	3.1
255.0	2.5
1766.3	.5

Gamma Count Time: 20 min
513 Sample Size: 442.00G
Count Fact = 1.000

66451 AWC036

Run 9: Press

KeV	Units: CPM
610.3	2.1
176.4	1.8
241.0	3.7
1460.5	1.1
92.8	2.3
1120.3	.5
295.2	3.0
270.2	1.0
257.0	.9

Gamma Count Time: 20 min
612 Sample Size: 405.00G
Count Fact = 1.000

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ±% Error
66510	AWC041	RA226	4.14E-06 +- 16.0 Mic.Ci/g
		TH228	2.06E-06 +- 21.7 Mic.Ci/g

Run 11: Hutch

KeV	Units: CPM
67.6	4.6
338.7	2.7
910.3	2.9
512.0	1.4
711.7	1.0

Gamma Count Time: 20 min
712 Sample Size: 971.00G
Count Fact = 1.000

66628	AWC042	RA226	4.20E-06 +- 18.1 Mic.Ci/g
		TH228	1.34E-06 +- 35.0 Mic.Ci/g

Run 12: Hutch

KeV	Units: CPM
401.3	1.0
1175.4	.8
288.4	2.1
1460.5	1.4
143.8	3.3
1332.5	.6
463.3	1.5
255.0	1.8
910.0	1.0
573.7	.9

Gamma Count Time: 20 min
612 Sample Size: 833.00G
Count Fact = 1.000

HAZELWOOD SOIL SAMPLE

Sample Number	ID	Isotope	Activity ±% Error
66631	AWC045	RA226	1.66E-06 +- 26.6 Mic.Ci/g
		TH228	1.21E-06 +- 27.7 Mic.Ci/g

Run 13: Press

KeV	Units: CPM
270.2	1.8

Gamma Count Time: 20 min
612 Sample Size: 566.00G
Count Fact = 1.000