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A COMPLETE SYSTEM FOR PORTABLE GAMMA SPECTROSCOPY

D. A. Fuess

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LAWRENCE LIVERMORE LABORATORY

University of California, Livermore, California, 94550

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ABSTRACT

This paper describes a system built around the Computing Gamma Spectrometer (PSA) LEA 74-008. The software primarily supports high-resolution gamma-ray spectroscopy using either a high-purity intrinsic germanium detector (HPGe) or a lithium-drifted germanium detector [Ge(Li)].

INTRODUCTION

The scientist in the field often needs a rapid, on-the-scene analysis of a sample (the most recent widely known example is Operation Morning Light in response to the inadvertent reentry of the Soviet satellite Cosmos-954). The Computing Gamma Spectrometer (PSA) LEA 74-008 fulfills such a

need. It is completely portable: the entire system fits in a vehicle and the multichannel analyzer (PSA) can be hand-carried. Thus, the data can either be analyzed on location or transmitted to a distant processing center via commercial telephone equipment.

SYSTEM OVERVIEW

The system is divided into two major blocks, data collection and data analysis, linked through data transmission. A detailed description of the interconnecting hardware can be found in Appendix A.

DATA COLLECTION

The data collection function is performed by the PSA and the various gamma detectors (see Refs. 1 and 2 for a complete description). Basically, it is a 1024 channel analyzer with built-in display, power supplies for detectors, single-region-of-interest integration, background subtraction, and a data output function. It has a volatile memory. However, a memory-protect function allows the main power to be turned off without data loss. In our experience, the internal batteries provide about six hours of full-on operation, and up to several months of memory protection.

The PSA may be used to collect data from numerous detector systems. A series of detectors have been designed specifically for use with the analyzer and are fully supported by it. These include a 7% resolution, 5-cm by 5-cm NAI detector, and side- and down-looking HPGe planar detectors with 11.4-cm² surface, by 1.3-cm-thickness active region.

DATA ANALYSIS

The heart of the data analysis function is the Tektronix 4051 Graphic Terminal. This is a Motorola 6800 microprocessor-based system with a resident-enhanced Basic interpretive language. In addition to data analysis, the 4051 receives transmitted data via the transmission link and stores and retrieves data from data library tapes. See Refs. 3, 4, and 5 for complete information on the operation and programming of the 4051. The operation of the 4051 with the spectroscopy software is described in a later section of this report.

DATA TRANSMISSION LINK

The data transmission link is provided by a Hewlett-Packard 59403A HP-1B/Common Carrier Interface and a Teledynamic 7202D Data Set. Both have been modified for compatibility with this system.

In this data transmission link, the data are converted from audio frequency shift keyed (FSK) to bit parallel, with an interim conversion to RS232C

bit serial. Each step will be detailed in a later section. Audio cassette tape recorders can store the data directly out of the PSA. The cassettes may be played directly into the 7202D Data Set to complete the data transmission.

Figure 1 is a block diagram of the overall system. The audio transmission link (PSA—modem) can consist of any combination of tape deck, telephone, radio, and hardwire, limited only by the amount of noise introduced into the system.

FIG. 1. Portable spectrum analyzer system.

FIG. 2. PSA transmission sequence.

THE SOFTWARE SYSTEM

The complete program listing appears in Appendix B. Flow charts for all programs except the primes appear in Appendix C.

PSA DATA TRANSMISSION FORMAT

The PSA transmits data in a bit-serial, audio FSK (frequency shift key), ASCII character format without parity or control characters. The entire transmission consists of 5440 characters arranged into 64 records (Fig. 2). Each record is further subdivided into 17 five-character words. The data output sequence is

two beginning-of-record characters (= <)
word 1 two digit record ID, octal
one front panel "LED" digit

+ 16 words of channel data.

A 5-sec carrier is transmitted before the data begins, followed by 64 cycles of the output sequence, followed by continuous carrier. The carrier is defined as the lower of the two FSK frequencies. If for some reason the transmission begins with the carrier on the high FSK tone (it has been known to do so), the transmit sequence must be reset by cycling the analyzer power off for about 30

sec (leaving memory protect on), and then on again. This cycling, should it be necessary, will result in the loss of the elapsed time indication and, for certain analyzers, the calibration information also.

DATA RECEIVING

The data receiving operation is performed by the I/O program (described in detail later). This is actually a dual function operation, data receiving and data decoding. The decoding function involves establishing the binary arrays of data and LED numbers, and filling the arrays with the proper numbers.

The ASCII characters are counted as they come in. End of transmission is signaled by a character count of 5440. This is not a highly efficient method for reliable data handling, but because of the absence of control characters, data count is the only available end-of-message indicator.

An interesting data redefinition occurs because of the defined qualities of numerical vs string variables in the 4051 and input of data via the GPIB. Data input via the GPIB is defined internally to the 4051 as numerical; conversely, the data being presented to the input port is ASCII (string). What we end up with is the numerical value of the ASCII digit. This situation forces a double conversion of the data. Table 1 describes this conversion process.

TABLE 1. How to input the number 25 from the PSA.

Step	Conditions			Remarks
	Digit numerical value	ASCII string	Numerical value	
1	50			2 is received
2		2		1st conversion of 2
3	53			5 is received
4		5		1st conversion of 5
5		25		Conversion of 2 and 5
6			25_{10} 00011001 ₂	Final conversion of 25

FIG. 3. (a) Data receiving, (b) data receiving (continued). This process takes about 3 min at 300 baud.

DATA INPUT/DECODE ALGORITHM

The data input/decode algorithm was written for highest efficiency using the BASIC language. This is done by processing the data as completely as possible as the data are received, leaving very little post-processing. Specifically, the first four characters of each record are discarded, the LED digit is stored as ASCII for later conversion, and the 16 words of count data are double-converted and stored in the data array.

The algorithm is implemented in a series of nested FOR ... NEXT (DO) loops, and the rate is controlled by the incoming data (see Figs. 2 and 3 and Table 2). Thus,

$$E(ch) = E1^* \cdot C1 + E0^*$$

where ch = channel No.,

$$E0^* = E1 \cdot C1 + E0^*,$$

Then

$$E0^* = E0 \text{ if } 0 < E0 < x \text{ or}$$

$$E0^* = 9\text{'s complement of } E0 \text{ if } x < E0 < 9999.$$

E0 is the contents of a four-digit energy offset register whose maximum value is 4096. If E0 is negative, its 9's complement is sent. Therefore, I have set x at 5000 to allow for adequate offset in both directions.

TABLE 2. Transmitted constants (LED digits).

Digits in LED array			Variable name in program	Name
From	To	No. digits		
1	4	4	P0	P mark energy
5	7	3	F9	Julian day number
8	8	1	Q0	Quadrant number ^a
9	10	2	O9	Sample I.d. number
11	18	8	S9	Summation A to B
19	20	2	J9 ^b	Hours (clock time)
22	23	2	K9 ^b	Minutes (clock time)
24	28	5	B0	B mark counts
29	32	4	B1	B mark energy
33	37	5	L9	Elapsed time (seconds)
38	42	5	A0	A mark counts
43	46	4	A1	A mark energy
49	51	3	E1 ^c	Energy calibration constant (slope)
52	55	4	E0 ^c	Energy calibration constant (intercept)
56	57	2	C2 ^c	Analyzer constant

^aQuadrant number (Q0) indicates the status of the memory pushbuttons at the time of transmission. A 1, 2, 3, or 4 means that a single quadrant was selected, and an 8 means that all quadrants were selected. The quadrant number may or may not be a valid indicator of switch positions during acquisition. The entire contents of memory are transmitted every time, regardless of the position of the memory switches.

^bTimes (J9, K9) signifies that the clock time is the time of day that the data were transmitted, not the time of day the data were acquired. If the same data are transmitted twice, two different times of day will be listed.

^cEnergy calibration and analyzer constants (E0, E1, C2): The meaning of C2 is somewhat nebulous and is not useful. E0 and E1 are used as constants in the linear energy calibration equation.

DATA STORAGE LIBRARIES

The IO program stores data for later analysis or historical purposes. These libraries are maintained separately from the program tape. The following definitions apply throughout the remainder of this document:

- Library tape: A tap (scotch 500A or equivalent) on which data are stored.
- Data library: Refers to all of the information stored on a library tape.
- File: A physical file on the library tape.
- Data set: The data stored on tape or in the 4051 from one specific spectrum and its parameters.
- Data file: A file in which a data set is stored.
- Library i.d.: A unique designation/name for a library tape.

- Data set i.d.: A unique name for a data set.

- Index: A listing of data set i.d.'s for this library tape.

- Index file: The first file, it contains the library i.d. and the index.

The library tape format was established to meet the following criteria:

- Machine recognizable as a library tape.
- Avoid data set i.d. duplications.
- Facilitate automatic data storage, i.e., the 4051 can figure out where to write the data set.
- Protect the data against inadvertent loss or destruction (as much as possible).

The tape is structured by files. The first file contains the word "DATA," followed by the library i.d., followed by the index. The remainder of the files contain the data sets referred to in the index.

FIG. 4. Sample spectrum.

The library creation operation sets up File 1, and writes the word "DATA" and the library i.d. Thereafter, the user conducts only read and write operations on the library tape.

INITIAL DATA DISPLAY

The I/O program plots the incoming data after receipt and decoding. The plotting format duplicates the PSA display in log mode to allow the sender and receiver to compare readings. A dashed line is drawn across the lower portion of the screen, and energy calibration calculations are made and displayed below the dashed line (see Fig. 4). This display can be called manually to display data retrieved from a data library tape.

DATA ANALYSIS PROGRAM PHILOSOPHY

There is no established technique for gamma spectrum analysis. Generally, those involved in this area have devised their own specific techniques. The analysis functions provided in this program are intended to complement all the various techniques by carrying out the computations common to them. That is, the functions provide the physicist with the necessary baseline data upon which he may apply his analysis technique. These functions include:

- Plotting the data.
- Energy calibration.
- Peak location.
- Peak net area integration.
- Background determination.
- Listing of photo peaks with their properties.
- Listing of the raw data.

These functions are presented in a variety of fashions, ranging from nearly fully automatic processing of the entire spectrum to a fully manual processing controlled entirely by the operator.

A functional description of the program is given later in the program listing; only the calculational methods will be discussed here.

ENERGY CALIBRATION

The calibration procedure employed assumes that energy is a perfectly linear function of the chan-

nel numbers and can be fully defined on the basis of two points.

Given two-channel energy pairs $P_1(C_1, E_1)$ and $P_2(C_2, E_2)$, then

$$E_1 = \frac{E_2 - E_1}{C_2 - C_1}$$

and

$$E_0 = E_2 - E_1 \cdot C_2;$$

the energy associated with a given channel N is

$$E_N = E_1 \cdot N + E_0.$$

Equation (1) is the energy calibration equation. The constants E_0 and E_1 may be re-evaluated as often as desired during processing. Any output obtained after a recalibration will contain the updated energy calibration.

PEAK LOCATION

Peaks are defined by three points: upper and lower channel extremities and a crest. The crest is located first and is defined as a channel whose count is greater than the counts of the adjacent channels. The lower extremity is defined as the highest channel below the crest where the slope of the data changes from negative to positive. The upper extremity is the lowest channel above the crest where the slope changes from negative to positive. These location criteria would define every ripple and bump in the data (Poisson noise, counting statistics, etc.) as a peak, if no other criteria were applied.

PEAK DETERMINATION

The peak determination criteria are set by the operator as he processes the data. This is usually done on the basis of deviation from background. The basic criterion applied is that a peak exists if and only if the operator says it exists. Given a channel number between the upper and lower bound, the program applies the described peak location criteria to define the peak.

In the automatic mode the program locates and classifies peaks according to their deviation from background. That is, the net peak area must be

Both T and B are good approximations of the areas. Sigma calculation is valid.

T is a good approximation of net peak area, but sigma cannot be calculated ($\sqrt{B} = 0$).

Peaks are piled up. T_1 and T_2 will underestimate the net peak areas. Sigmas will be small. B_1 and B_2 overestimate background areas.

FIG. 5. Peak location and determination.

greater than a specified number of standard deviations above the background area "B," where a standard deviation is defined to be $\sqrt{B}$.

A possible source of error occurs if the net background area is zero. Peaks falling into this category must be processed manually [Fig. 5(b)].

Errors may also result because of peak pileup or peaks standing on the crest of a Compton edge [Fig. 5(c)]. These errors are illustrated in the figures following this section.

AREA CALCULATIONS

Peak and background areas are calculated using the classical method (trapezoidal rule). Given

the upper and lower channel limits C_2 and C_1 for a peak, then

$$\text{Total Area} = \sum_{i=C_1}^{C_2} D_i$$

where D_i is the contents of channel C_i .

Then

$$\text{background area} = \frac{D(C_1) + D(C_2)}{2} \times (C_2 - C_1 + 1)$$

and

net peak area = $T - B$ [Fig. 5(b)].

SYSTEM SETUP AND OPERATION

CALIBRATION OF PSA

If at all possible, the PSA should be used in the full memory mode (1024 channels). The resolution for smaller memory increments (256 channels) is not generally adequate for spectrum analysis. Furthermore, the energy calibration for a 256-channel spectrum may be incorrect when displayed on the 4051.

Digital offsets should not be used. The offsetting procedure for the PSA is somewhat complicated, increasing the operator's opportunity for error. For greatest indicated accuracy, the spectrum should range from 0 to 4 MeV. (The PSA energy register range is 0 to 4096; therefore, a 0 to 5 MeV spectrum would be indicated as 0-05.00, giving only two-place (10-KeV) accuracy when 3-place is generally desired.)

The procedure for calibration is outlined as follows:

- (1) Select full memory.
- (2) Move A marker to lowest channel (channel 1).
- (3) Move B marker to highest channel (channel 1024).
- (4) Using "ECAL OFFSET," adjust "A MARK ENERGY" to zero.
- (5) Using "ECAL KeV," adjust "B MARK ENERGY" as close as possible to desired full scale energy.
- (6) Move the A marker to the calibration

source's low energy.

(7) Move the B marker to the calibration source's high energy.

(8) While acquiring the calibration source, adjust the ZERO and GAIN NORM controls to place the appropriate peaks in the marked channels.

The calibration spectrum should be recorded on the cassette recorder before the sample spectrum is taken. If this cannot be done, then at the very least, the calibration parameters (channels and energies) should be recorded.

DATA STORAGE ON CASSETTE

This would seem a simple enough task to perform, however it does have its pitfalls. First and foremost, each spectrum must be fully identified, before it is recorded, as to time, place, configuration, source description, and all of the PSA front panel display numbers. This type of identification allows for error checking when the tape is read into the 4051.

As an aid to the operator, who may have to read the data later, all of the leading carrier and about 15 sec of trailing carrier should be recorded. Thus, the tape deck must be started before pressing DATA OUT, and the recorder stopped about 15 sec after completing transmission before releasing the DATA OUT key. (The DATA OUT key is a latching type.)

The recording should begin eight revolutions from the physical beginning of the tape. To locate this point, press rewind until the tape stops; set the counter to zero; run the tape forward to 8 on the counter; and reset the counter to zero again. This ensures that the clear leader is past the tape head before recording is attempted.

Set Up the Hardware

(1) Make up all the cable connections illustrated in Fig. 6 for the 4051, CCI, modem, and 4631 (if you have one).

(2) Turn on the 4631, 4051, and modem. Leave the CCI off for now.

Set Up the Software

(1) Insert the "FIELD ANALYSIS" program tape in the 4051 tape slot.

(2) Press "AUTO LOAD."

(3) After the first page (or however many you wish to read), type "RUN" followed by ("RETURN"). The I/O program will be loaded.

OPERATIONS GUIDE

This section provides an outline of instructions for receiving the data. It is intended only to get you started and not as a substitute for experience.

Cable descriptions

A - RG58 or equivalent, BNC to spade clips (BNC end is made adaptable to cassette recorder by a BNC to appropriate plug-type pigtail).

B - 25 Pin, RS232C, standard cable, both ends male.

C - HP1B standard cable, stackable male/female both ends.

D - TEK 012-0547-00 or TEK 012-0630-01.

FIG. 6. Data transfer system interconnections.

Data Output Level Adjust

This adjustment may not always be necessary. It should be done if the modem carrier light will not stay on resulting in numerous interruptions in transmission, or the data looks like 1/4 stick of dynamite may have been used on it (this happens when the data out level is too high and saturates the modem input).

Either of these indications could also be the result of a noisy phone line; if so, the data output level adjust may or may not improve the situation.

Over-the-phone adjustment is best accomplished using two phone lines, one for the equipment and one for the operators. With only one phone line available the user may have to resort to trial and error by listening for distortions himself:

- (1) Set up the desired data link from the PSA to the modem.
- (2) Depress "DATA OUT" on the PSA.
- (3) Decrease "DATA OUT LEVEL" (CCW) on the PSA until the modem light goes out.
- (4) Increase "DATA OUT LEVEL" until the modem light remains on steady. (This indication may be affected by line noise.)
- (5) Wait for the completion of the data out cycle (3 min) and release "DATA OUT."

Data Receiving

- (1) Set up the desired data link from the PSA to the modem.
- (2) Turn on CCI.
- (3) Press "CLEAR CCI" (user key No. 7 on 4051).
- (4) Press "RECEIVE" (user key No. 6 on 4051).
- (5) When the modem light goes on, press the return key on the 4051.

The I/O light on the 4051 should come on solid then begin to blink as the data are received. If an error (SRQ) occurs, see the section entitled *Error Recovery*.

- (6) When data transmission is completed (about 3 min), the 4051 will signal (beep). Turn off the CCI, respond to the requests on the display screen of the 4051. A plot will automatically be generated for you.

Error Recovery

An internal error recovery routine will handle most small, nonfatal errors. However, an extended series of errors may result in total failure of the

receive algorithm.

As long as the 4051 keeps running, leave it alone. If, however, it is necessary to stop the transmission, the following procedure should be used:

- (1) Press "CLEAR ON ERROR", turn off CCI (User Key No. 8).*
- (2) Wait until present transmission completes.
- (3) Start over from step *Data: Receiving* step 2.

Data Analysis

The primer defines each function of each overlay, and each overlay lists the user-defined key assignments specific to it when called. This arrangement results in a guided tour through the program during execution. The best way to learn the program is by running it. If the user sticks with the defined functions and follows the lead of the program, neither the tape nor the data can be destroyed. A complete processing should take less than 15 min; however, longer times may be required, depending on the nature of the data.

The user gains access to the analysis overlay by pressing the user key marked "Load Analyze" while in the I/O overlay. Before calling the analysis overlay, the user should have completed all input/output operations. The program assumes that the last data set read into the 4051 is the one on which the user wishes to operate.

No attempt is made here to instruct the user in spectrum data analysis techniques. It is suggested that the user become familiar with the techniques *employed in general and with the functions supplied* in the analysis program. He is then free to employ his own analysis method.

To permanently record changes the user may make in the data set (calibrations, elapsed time, data modification, etc.), the user must return to the I/O overlay and use the library overwrite function.

*You may have to press "BREAK" several times and/or turn off the CCI

REFERENCES

1. A. McGibbon, Lawrence Livermore Laboratory, Internal Document M-079. Readers outside the Laboratory who desire further information on LLL internal documents should address their inquiries to the Technical Information Department, Lawrence Livermore Laboratory, Livermore, California 94550.
2. K. Crase, Lawrence Livermore Laboratory, private communication (1978).
3. Tele-Dynamics Instruction Manual for the 7202D/E-2P, Tele-Dynamics Division of AMBAC, Fort Washington, Pennsylvania.
4. Operating and Service Manual, Model 59403A Common Carrier Interface, Hewlett-Packard Co., Loveland, Colorado.
5. Tektronix 4051 Graphic System Reference Manual, Tektronix, Beaverton, Oregon (Jan., 1976).

APPENDIX A

DETAILED DESCRIPTION OF INTERCONNECTING HARDWARE

Teledynamics 7202D Data Set (Modem)

This particular modem was selected on the basis of its ability to accept the nonstandard audio frequency output of the PSA. The PSA frequencies are 2184.5 Hz and 1191.5 Hz. Other modems were tried and failed.

The modifications described below produce a one-way (i.e., incoming only) communication as neither the PSA nor the tape recorder can function in a two-way mode.

The straps are set as follows (up = removed):

A—DOWN	K—UP
B—UP	L—UP
C—UP	M—DOWN
D—DOWN	N—DOWN
E—DOWN	P—UP
F—UP	R—DOWN
G—UP	S—UP
H—UP	-8—DOWN
J—DOWN	All others straps—UP

Internal switch positions:

AUTO/MAN—MAN
NORM/LOC—NORM
NORM/REM—NORM

Traces cut on the RS232 connector board:

TRACES FROM RS232 CONNECTOR
PINS 4 AND 11

Jumpers on rear terminal strip:

FROM	TO
5	6
6	7
9	12

Audio input connections (rear terminal strip):

Signal 2
shield—1

RS232, 25 Pin connector from terminal jack to common carrier interface 'MODEM' jack.

Common Carrier Interface, HP 59403A

The common carrier interface (CCI) is needed to compensate for the lack of control characters in the PSA transmission. As shown in Fig. 2, no LFCR's are transmitted. Standard RS232C devices cannot generally receive the data without termination characters, therefore the data must be connected for reception over the GPIB (HPIB).

The CCI performs the conversion from bit serial to bit parallel. No parity checking can take place, however, because the PSA does not transmit parity bits. The parity bit from the modem is random, requiring a modification in the CCI to prevent unwanted error interruptions.

In general, HPIB devices (CCI) and GPIB devices (4051) are compatible. However, this is not always the case with the CCI's. There is enough variation between the handshake timing specifications to allow both devices to be in specification yet be unable to communicate. Although the degree of compatibility can be determined with a logic analyzer, we resolved the problem by associating matched pairs of devices, i.e., a compatible CCI and 4051.

The common carrier interface is set up as follows:

Address (DIP switch inside):

1—OFF
2—ON
3—ON
4—ON
5—OFF
6—OFF
7—ON

The lead from the HPIB connector pin 16 (data bit 8) is disconnected. This can be done by removing the socket insert from internal plug P3 pin 6.

Front panel push buttons:

BAND RATE—300
INTERFACE—ASYN
PARITY—NONE

Cable connections:

FROM
CCI, MODEM (RS232C)
CCI, HP-IB

TO
MODEM, TERMINAL
4051, GPIB

When turned on, only the ON-LINE indicator should light.

APPENDIX B

PROGRAMMING CONSIDERATIONS

OVERALL PROGRAM CONTROL

The program tape **FIELD ANALYSIS** consists of four files. The first file is the initialization and primer program. It is in fact the only real program on the tape. The remaining three files contain overlays, designated I/O, **ANALYSIS**, and **PEAK SEARCH AUTO**.

All program variables are essentially global. This means that a variable, once defined, is accessible in all other overlays unless it is specifically deleted. This tends to cause a problem because the memory tables may become filled with unused or forgotten variables that will result in hardware errors and program termination. I have tried to follow the basic rule that any variable not intended to be shared with the other overlays is deleted before releasing the overlay present.

THE WHY AND HOW OF OVERLAY

The full memory capability of the 4051 is 32,000 bytes, 30,000 of which are available for program and data storage and 2,000 of which are claimed by the system for the operating tables. The present size of the entire program is 84,744 bytes for program alone!

Now for the How. The Initialize program supplies the first three lines of code, which remain constant throughout all overlays. These lines are:

```
1 GO TO 100
2 DELETE 5, 10000
3 APPEND 4
```

All overlays begin with line 4, which always reads

```
4 GO TO 100
```

Lines 8-80 are available for user definable key definitions. The actual programming for the overlay begins on line 100.

The overlay procedure is implemented in the main body of the overlay present. A jump (Go To) line N begins the process....

```
N PRINT "INSERT PROGRAM TAPE";
N + 10 INPUT XS
N + 20 DELETE (UNNECESSARY VARIABLES)
N + 30 FIND (FILE NO. OF OVERLAY)
N + 40 GO TO 2
```

GLOBAL VARIABLES

The global variables are specified; they either control program flow, or relate to the present data set. These variables have been defined as follows:

```
A0 A mark counts
A1 A mark energy
B0 B mark counts
```

B1 B mark energy
 C2 An analyzer constant
 D Data vector (1024 elements)
 E0 Energy calibration constant (Intercept)
 E1 Energy calibration constant (slope)
 F9 Julian day number
 J9 Hours (clock time)
 K9 Minutes (clock time)
 L9 Elapsed time
 O9 Sample i.d. number
 P0 P mark energy
 P1 Overlay i.d. number
 P2 Data present sentinel
 Q0 Quadrant number
 S9 Summation between markers
 T5 Data set title

GENERAL AND SHARED VARIABLES

Some variables, by either tradition or by assignment, have special uses.

I, J, K General index variables
 X\$, I\$ General string input variables
 N3, N4 General limit variable (beginning and ending)
 X General temporary store

APPENDIX C

FLOW CHARTS FOR PROGRAMS

FIELD ANALYSIS PROGRAMS

D. A. FUESS

SEPTEMBER 1, 1978

**PROGRAM LISTINGS IN TEK BASIC
LANGUAGE FOR THE TEK 4051.**

PROGRAM: INITIALIZE AND PRIMER
TAPE: FIELD ANALYSIS

```

1 GO TO 100
2 DELETE 5,10000
3 APPEND 4
4 GO TO 320
100 DIM D(1024)
110 D=0
120 P0=0
130 F9=0
140 Q0=0
150 O9=0
160 S9=0
170 J9=0
180 K9=0
190 B0=0
200 B1=0
210 L9=0
220 H0=0
230 H1=0
240 E1=0
250 E0=0
260 C2=0
270 F2=0
280 T$=""
290 P1=1
291 PAGE
292 GO TO 1000
300 FIND 2
310 GO TO 2
320 REM GLOBAL VARIABLES LIST
330 REM P0 = P MARK ENERGY
340 REM F9 = JULIAN DATE
350 REM Q0 = QUAD NUMBER
360 REM O9 = SAMPLE ID NUMBER
370 REM S9 = SUMATION BETWEEN MARKERS

```

```

1 GO TO 100
2 DELETE 5,10000
3 APPEND 4
4 GO TO 320
100 DIM D(1024)
110 D=0
120 P0=0
130 F9=0
140 Q0=0
150 O9=0
160 S9=0
170 J9=0
180 K9=0
190 B0=0
200 B1=0
210 L9=0
220 H0=0
230 H1=0
240 E1=0
250 E0=0
260 C2=0
270 F2=0
280 T$=""
290 P1=1

```

```

291 PAGE
292 GO TO 1000
300 FIND 2
310 GO TO 2
320 REM GLOBAL VARIABLES LIST
330 REM P0 = P MARK ENERGY
340 REM F9 = JULIAN DATE
350 REM Q0 = QUAD NUMBER
360 REM O9 = SAMPLE ID NUMBER
370 REM S9 = SUMATION BETWEEN MARKERS
380 REM J9 = HOURS (CLOCK TIME)
390 REM K9 = MINUTES (CLOCK TIME)
400 REM B0 = B COUNTS
410 REM B1 = B ENERGY
420 REM L9 = ELAPSED TIME
430 REM A0 = A COUNTS
440 REM A1 = A ENERGY
450 REM E1 = ENERGY CONSTANT (SLOPE)
460 REM E0 = ENERGY CONSTANT (INTERCEPT)
470 REM C2 = ANALYSER CONSTANT
480 REM D = DATA ARRAY (1024 CHANNELS)
490 REM P1 = PROGRAM CONTROL CONSTANT
500 REM ( THE NUMBER OF THE OVERLAY RUNNING)
510 REM P2 = DATA PRESENT SENTINAL
520 REM T$ = TITLE OF FILE AND DATA SET FOR PLOTTING
530 REM AND LIBRARY MAINTENANCE
1000 PRINT "THIS TAPE CONTAINS PROGRAMS FOR F.I.L.D SPECTRUM DATA"
1002 PRINT "ANALYSIS. THEY ARE SPECIFICLY DESIGNED AROUND THE"
1004 PRINT "PORTABLE SPECTRUM ANALYSER LEA74-000 IN USE IN THE "
1006 PRINT "NEST COMMUNITY."
1008 PRINT
1010 PRINT "*****"
1012 PRINT "* THESE PROGRAMS ARE PRIMARILY INTENDED FOR HIGH *"
1014 PRINT "* PURITY OR LITHIUM DRIFTED GERMANIUM PULSE *"
1016 PRINT "* HEIGHT DATA FILES. *"
1018 PRINT "*****"
1020 PRINT
1022 PRINT "FOR YOUR CONVENIENCE A COMPLETE OPERATORS MANUAL HAS"
1024 PRINT "BEEN INCLUDED IN THIS PORTION OF THE PROGRAM."
1026 PRINT "IF YOU WANT TO GO STRAIGHT TO THE PROCESSING PROGRAMS"
1028 PRINT "TYPE 'RUN' AFTER ANY PAGE, PRESS (RETURN) TO VIEW THE"
1030 PRINT "NEXT PAGE OF THE MANUAL."
1032 PRINT
1034 PRINT "THE STATEMENT '(RETURN)' ALWAYS REFERS TO THE RETURN KEY"
1036 PRINT
1038 PRINT "*****"
1040 PRINT "YOU SHOULD ALWAYS LEAVE THE LAST TAPE REQUESTED BY*"
1042 PRINT "THE PROGRAM IN THE TAPE SLOT TO ENSURE PROPER *"
1044 PRINT "FUNCTIONING OF THE PROGRAM. IF AN ERROR OCCURS *"
1046 PRINT "DURING OVERLAY BECAUSE THE WRONG TAPE WAS IN THE *"
1048 PRINT "TAPE DRIVE YOUR DATA MAY BE LOST AND THERE IS NO *"
1050 PRINT "SIMPLE RECOVERY PROCEDURE."
1052 PRINT "*****"
1054 PRINT
1056 INPUT X$
1058 IF X$="RUN" THEN 300
1060 PAGE
1062 PRINT " PROGRAMS FOR FIELD SPECTRUM ANALYSIS"
1064 PRINT
1066 PRINT "Two kinds of tapes are used to do an analysis-"
1068 PRINT "this program tape and data library tapes"
1070 PRINT
1072 PRINT "The programs on this tape are separated into"
1074 PRINT "functional units. Each unit is as complete as"
1076 PRINT "possible within its functional description to"
1078 PRINT "minimize the amount of overlaying and reduce"
1080 PRINT "the overall running time of the program."
1082 PRINT

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1084 PRINT "In this document the term "data set" refers to"
1086 PRINT "the data presently in the analyser. The term"
1088 PRINT "\"data file\" refers to data on a data library tape."
1090 PRINT
1092 PRINT "THIS TAPE SHOULD ALWAYS BE INITIALIZED USING"
1094 PRINT "THE AUTO-LOAD FUNCTION OF THE 4051 TERMINAL."
1096 PRINT
1098 PRINT "The programs contained on this tape are:"
1100 PRINT
1102 PRINT "  1. INITIALIZATION AND PRIMER"
1104 PRINT "  2. I/O OVERLAY"
1106 PRINT "  3. ANALYSIS OVERLAY"
1108 PRINT "  4. PEAK SEARCH AUTO OVERLAY"
1110 PRINT "  5. (MASTER ISOTOPE SEARCH OVERLAY, LATER)"
1112 PRINT "  6. (ISOTOPE ENERGY AND INTENSITY LIBRARY, LATER)"
1114 PRINT
1116 PRINT "Each of these will be covered in detail in the"
1118 PRINT "following pages of the primer."
1120 INPUT X$
1122 IF X$="RUN" THEN 300
1124 PAGE
1126 PRINT "      DESCRIPTION OF THE PROGRAMS"
1128 PRINT
1130 PRINT "1. INITIALIZATION AND PRIMER"
1132 PRINT
1134 PRINT "  This program is always loaded first. It establishes"
1136 PRINT "  the overlay procedure to be used throughout the"
1138 PRINT "  remainder of the processing. The primer you are"
1140 PRINT "  reading now is a part of this program."
1142 PRINT
1144 PRINT "      FUNCTIONAL DESCRIPTION"
1146 PRINT
1148 PRINT "The primer is arranged in pages and can be viewed one"
1150 PRINT "page at a time by pressing the RETURN key to advance"
1152 PRINT "the page. After any page you may type the word "RUN"...
1154 PRINT "to skip the remainder of the primer and go straight to"
1156 PRINT "the I/O overlay."
1158 INPUT X$
1160 IF X$="RUN" THEN 300
1162 PAGE
1164 PRINT "2. I/O OVERLAY"
1166 PRINT "The I/O overlay is called from either the PRIMER"
1168 PRINT "or the ANALYSIS overlay. It provides all of the"
1170 PRINT "input and output functions for the pulse height"
1172 PRINT "data. These functions include:"
1174 PRINT "  -INPUT OF DATA FROM THE ANALYSER OR TAPE"
1176 PRINT "  -CREATION OF LIBRARY STORAGE FOR DATA"
1178 PRINT
1180 PRINT "  4. PEAK SEARCH AUTO OVERLAY"
1182 PRINT "  5. (MASTER ISOTOPE SEARCH OVERLAY, LATER)"
1184 PRINT "  6. (ISOTOPE ENERGY AND INTENSITY LIBRARY, LATER)"
1186 PRINT
1188 PRINT "Each of these will be covered in detail in the"
1190 PRINT "following pages of the primer."
1192 INPUT X$
1194 IF X$="RUN" THEN 300
1196 PAGE
1198 PRINT "      DESCRIPTION OF THE PROGRAMS"
1200 PRINT
1202 PRINT "1. INITIALIZATION AND PRIMER"
1204 PRINT
1206 PRINT "  This program is always loaded first. It establishes"
1208 PRINT "  the overlay procedure to be used throughout the"
1210 PRINT "  remainder of the processing. The primer you are"
1212 PRINT "  reading now is a part of this program."
1214 PRINT
1216 PRINT "      FUNCTIONAL DESCRIPTION"
1218 PRINT

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1148 PRINT "The primer is arranged in pages and can be viewed one"
1150 PRINT "page at a time by pressing the RETURN key to advance"
1152 PRINT "the page. After any page you may type the word "RUN""
1154 PRINT "to skip the remainder of the primer and go straight to"
1156 PRINT "the I/O overlay."
1158 INPUT X$
1160 IF X$="RUN" THEN 300
1162 PAGE
1164 PRINT "2. I/O OVERLAY"
1168 PRINT "The I/O overlay is called from either the PRIMER"
1170 PRINT "or the ANALYSIS overlay. It provides all of the"
1172 PRINT "input and output functions for the pulse height"
1174 PRINT "data. These functions include:"
1176 PRINT "  -INPUT OF DATA FROM THE ANALYSER OR TAPE"
1178 PRINT "  -CREATION OF LIBRARY STORAGE FOR DATA"
1180 PRINT "  -DECODING OF DATA FROM THE ANALYSER"
1182 PRINT "  -READING AND WRITING OF DATA LIBRARIES"
1184 PRINT "  -PLOTING THE DATA IN THE PSA FRONT PANEL FORMAT"
1186 PRINT
1188 PRINT "FUNCTIONAL DESCRIPTION"
1190 PRINT
1192 PRINT "A. RECEIVE DATA FROM NODEM"
1194 PRINT "  Data is received via the modem and common carrier"
1196 PRINT "  interface and loaded into a receiving array. After"
1198 PRINT "  all data is received it is automatically decoded"
1200 PRINT "  to produce the binary form used in further processing."
1202 PRINT "  The energy constants transmitted by the PSA are"
1204 PRINT "  used to arrive at the preliminary energy calibration."
1206 PRINT
1208 PRINT "B. PLOT DATA"
1210 PRINT "  The data is plotted in a format which resembles the"
1212 PRINT "  front panel display of the PSA in log mode. The energy"
1214 PRINT "  calibration of the PSA is shown below a dotted line"
1216 PRINT "  across the lower portion of the screen."
1218 PRINT
1220 PRINT "C. CREATE NEW DATA LIBRARY"
1222 PRINT "  This function establishes the proper file structure"
1224 PRINT "  on a BLANK tape for future data storage."
1226 PRINT
1228 PRINT "  IF THIS FUNCTION IS USED ON"
1230 PRINT "  A PREVIOUSLY WRITTEN TAPE ALL PREVIOUSLY WRITTEN FILES"
1232 PRINT "  WILL BE FOREVER LOST!";
1234 INPUT X$
1236 IF X$="RUN" THEN 300
1238 PAGE
1240 PRINT "D. LIST A DATA LIBRARY INDEX"
1242 PRINT "  This function lists all of the data file"
1244 PRINT "  index numbers and the data file name for all"
1246 PRINT "  files on the library tape. The file names are"
1248 PRINT "  assigned at the time the data is received."
1249 PRINT
1250 PRINT "  A protective feature provides that no two data"
1252 PRINT "  file names in any one library can be duplicated."
1254 PRINT
1256 PRINT "E. WRITE DATA INTO A DATA LIBRARY"
1258 PRINT "  This function stores the present data set in"
1260 PRINT "  the library inserted into the tape slot. Data"
1262 PRINT "  files are stored and retrieved in sequential"
1264 PRINT "  order. If the data set you are attempting to write"
1266 PRINT "  already exists (by file name) you can either"
1268 PRINT "  type "WRITE" to overwrite the data file or"
1270 PRINT "  assign a new (different) name under which the"
1272 PRINT "  data can be stored. The overwrite feature allows"
1274 PRINT "  for storage of recalibrated data, updated data"
1276 PRINT "  or data in which overflows etc. have been corrected."
1278 PRINT
1280 PRINT "F. READ DATA FROM A DATA LIBRARY"
1282 PRINT "  Files are requested by file index number (see 2.D above)"
1284 PRINT "  The data and all descriptive constants (except for"

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1286 PRINT " the results of previous analysis) are retrieved from"
1288 PRINT " the data library tape and stored in the system buffers"
1290 PRINT " for use. Any function can be performed on data from"
1292 PRINT " a library just as if the data had been input via the"
1294 PRINT " PSA)"
1296 INPUT X$
1298 IF X$="RUN" THEN 300
1300 PAGE
1302 PRINT "G. One additional function has been provided on"
1304 PRINT " a limited time basis to care for data files"
1306 PRINT " from a previous era. These files can be recognized"
1308 PRINT " by a rather far off energy calibration. The correct"
1310 PRINT " energy calibration will be calculated and displayed"
1312 PRINT " by pressing the SHIFT key with the PLOT function."
1314 PRINT " After using this function the data file should be"
1316 PRINT " overwritten to store the correct energy calibration"
1318 PRINT " in the data library. This function will be unnecessary"
1320 PRINT " when all old format files have been converted to new"
1322 PRINT " and hence will be discarded."
1324 INPUT X$
1326 IF X$="RUN" THEN 300
1328 PAGE
1330 PRINT "3. ANALYSIS OVERLAY"
1332 PRINT "
1334 PRINT " The analysis overlay is the heart of the processing"
1336 PRINT " capability. It provides all of the data manipulation"
1338 PRINT " functions normally employed in a data analysis. The"
1340 PRINT " program has been written so that the user may select"
1342 PRINT " any combination of process modes extending from the"
1344 PRINT " fully manual to the fully automatic. No attempt has been"
1346 PRINT " made to establish a set procedure for data analysis"
1348 PRINT " beyond the algorithms used to determine the parameters"
1350 PRINT " called for. This allows each user to follow his own"
1352 PRINT " "tried and true" methods using the supplied functions"
1354 PRINT " as tools."
1356 PRINT "
1358 PRINT "FUNCTIONAL DESCRIPTION"
1360 PRINT "
1362 PRINT "A. INITIALIZE"
1364 PRINT " This function establishes the special variables used"
1366 PRINT " in the analysis of the data. It is not intended to be"
1368 PRINT " called directly by the user though no errors will"
1370 PRINT " result if it is called."
1372 PRINT "
1374 PRINT "G. PLOT ALL DATA"
1376 PRINT " All data (from channel 1 to channel 1024) is plotted"
1378 PRINT " in a linear plot. The 'X' axis is labeled in both"
1380 PRINT " energy and channel, the 'Y' axis is counts. All plots"
1382 PRINT " are suppressed zero on both axes."
1384 INPUT X$
1386 IF X$="RUN" THEN 300
1388 PAGE
1390 PRINT "C. PLOT DATA BETWEEN SPECIFIED LIMITS"
1392 PRINT " This function is basically the same as function"
1394 PRINT " B. with the exception that the user supplies"
1396 PRINT " the beginning (XMIN) and ending (XMAX) channel"
1398 PRINT " limits for the plot."
1400 PRINT "
1402 PRINT "D. SCAN THE DATA IN THE AUTOMATIC MODE"
1404 PRINT " This is a special plotting mode in which the data"
1406 PRINT " is presented in 100 channel increments starting"
1408 PRINT " with channel 1 and ending with channel 1024. The"
1410 PRINT " plotting window is defined by a starting channel"
1412 PRINT " and a width in channels. During the scan process the"
1414 PRINT " user may 1.) change the window width by typing an"
1416 PRINT " integer 2.) mark, as a peak, the highest point in the"
1418 PRINT " presently displayed frame or 3.) go on to the next"
1420 PRINT " frame by typing (RETURN)."
1422 PRINT "

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1424 PRINT " In the case where a peak is marked the scan recommences"
1426 PRINT " from the terminus of the marked peak. In the case"
1428 PRINT " where a new width is specified the scan repeats from"
1430 PRINT " the last starting channel using the new width, the"
1432 PRINT " new width remains in effect until changed by the user."
1434 PRINT " If the frame was passed by typing (RETURN) the next"
1436 PRINT " frame is displayed beginning with the last channel of"
1438 PRINT " the last frame minus one. This may at first seem a bit"
1440 PRINT " confusing but a little experience with the function"
1442 PRINT " followed by rereading this paragraph should make"
1444 PRINT " it clear,"
1446 INPUT X$
1448 IF X$="RUN" THEN 300
1450 PAGE
1452 PRINT "E. SCAN DATA BETWEEN SPECIFIED LIMITS"
1454 PRINT " This mode is essentially the same as the automatic"
1456 PRINT " scan mode except that the user specifies the starting"
1458 PRINT " channel, ending channel and the scan increment."
1460 PRINT " See 3.0 for further explanation of the scan function."
1462 PRINT
1464 PRINT "F. CLEAR ON ERROR"
1466 PRINT " This function can be used at any time to stop whatever"
1468 PRINT " happens to be going on at the time. It always returns"
1470 PRINT " the computer to a stable stop mode from wherever it"
1472 PRINT " happens to be."
1474 PRINT
1476 PRINT "G. MARK A SPECIFIED PEAK"
1478 PRINT " This is the manual peak marking function. When called"
1480 PRINT " it prompts the user for a channel number near the desired"
1482 PRINT " peak. In this case "near" means that no other peak"
1484 PRINT " lies between the specified channel and the desired"
1486 PRINT " peak. It is better, however, to specify a channel"
1488 PRINT " number below the peak than above as the search"
1490 PRINT " method looks toward higher channels first."
1492 PRINT
1494 PRINT "H. RESTART THE SCAN WHERE I LEFT OFF"
1496 PRINT " This function restarts a scan from the last frame"
1498 PRINT " presented. It is used when an interruption has"
1500 PRINT " occurred in the scan for any reason, and the user"
1502 PRINT " wishes to begin where he left off before the"
1504 PRINT " interruption."
1506 INPUT X$
1508 IF X$="RUN" THEN 300
1510 PAGE
1512 PRINT "I. INTEGRATE BETWEEN LIMITS"
1514 PRINT " Used to integrate between channel limits"
1516 PRINT " specified by the user. The results of integration"
1518 PRINT " are both the net area above background and the"
1520 PRINT " net area of the background. The background is"
1522 PRINT " determined by the classical trapezoidal method."
1524 PRINT
1526 PRINT "J. PEAK SEARCH AUTO"
1528 PRINT " This function calls an overlay which first locates"
1530 PRINT " all possible peaks in the data, then classifies the"
1532 PRINT " peaks by their deviation from background. It assumes"
1534 PRINT " that the background is Poisson distributed with"
1536 PRINT " the standard deviation equal to the squareroot of"
1538 PRINT " the background area. The sorted peaks are binned into"
1540 PRINT " groups and placed in the "Q". A list of the contents"
1542 PRINT " of the Q is provided to the user. At the end of the"
1544 PRINT " search the ANALYSIS overlay is automatically reloaded."
1546 PRINT
1548 PRINT " The user selects peaks from the Q using the ADD PEAKS"
1550 PRINT " FROM THE Q function (which will be explained further"
1552 PRINT " under its own heading)."
1554 PRINT
1556 PRINT "K. DELETE A MARKED PEAK"
1558 PRINT " This function deletes a peak, which the user selects"
1560 PRINT " by peak number, from the list of marked peaks."

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1562 INPUT X$
1564 IF X$="RUN" THEN 300
1566 PAGE
1568 PRINT "L. PRESENT A SHORT LIST OF PEAKS"
1570 PRINT " This function produces a list of the marked"
1572 PRINT " peaks including peak number, channel number,"
1574 PRINT " and peak energy. This function is used for a"
1576 PRINT " quick look as the long list takes considerably"
1578 PRINT " longer to produce."
1580 PRINT
1582 PRINT "M. ENERGY CALIBRATE"
1584 PRINT " This function allows the user to change the energy"
1586 PRINT " calibration for the data set present in the computer."
1588 PRINT " The calibration is specified by two channel energy"
1590 PRINT " pairs, one low and one high. The function generates"
1592 PRINT " the constants for the calibration equation"
1594 PRINT "  $E=MX+B$  where M is the slope, X is the channel and"
1596 PRINT " B is the intercept. This calibration assumes a linear"
1598 PRINT " system."
1600 INPUT X$
1602 IF X$="RUN" THEN 300
1604 PAGE
1606 PRINT "O. SORT PEAKS"
1608 PRINT " This function sorts the list of marked peaks"
1610 PRINT " by channel number (and hence energy) and removes"
1612 PRINT " duplicate peaks from the listing."
1614 PRINT
1616 PRINT "P. INTEGRATE PLOT"
1618 PRINT " This function integrates the present plotting window"
1620 PRINT " and displays the results of integration below"
1622 PRINT " the X axis table."
1624 PRINT
1626 PRINT "Q. LIST DATA BETWEEN LIMITS"
1628 PRINT " This function lists the channel number, number of "
1630 PRINT " counts in the channel and the channel energy"
1632 PRINT " for all channels between the limits specified by"
1634 PRINT " the user."
1636 PRINT
1638 PRINT "R. LONG LIST OF MARKED PEAKS"
1640 PRINT " This function lists for each peak in the list of"
1642 PRINT " marked peaks: the peak number, the channel number,"
1644 PRINT " the energy, the width of the peak (full width at"
1646 PRINT " background level) in channels, the net peak area"
1648 PRINT " in counts and the number of standard deviations"
1650 PRINT " above background. This list is recomputed each time"
1652 PRINT " to allow dynamic energy calibration and reduce the"
1654 PRINT " storage space required (which is at a premium)."
1656 PRINT " The listing takes about one half second per line"
1658 PRINT " depending on the nature of each peak."
1660 INPUT X$
1662 IF X$="RUN" THEN 300
1664 PAGE
1666 PRINT "S. GO TO THE I/O OVERLAY"
1668 PRINT " This functions reloads the I/O overlay, keeping"
1670 PRINT " all data as it is, to allow the user to overwrite"
1672 PRINT " the data into the data library if any changes"
1674 PRINT " were made or read in a new data set."
1676 INPUT X$
1678 IF X$="RUN" THEN 300
1700 PAGE
1702 PRINT " THE END"
1704 END

```

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MEM
12026
SPA
28296

```

PROGRAM: INPUT / OUTPUT

TAPE: FIELD ANALYSIS

FILE: 2

```
4 GO TO 100
12 REM ... LIST DATA LIB INDEX
13 GO TO 1690
16 REM ... READ FROM DATA LIB
17 GO TO 2300
20 REM ... WRITE INTO DATA LIB
21 GO TO 1800
24 REM ... INPUT VIA MODEM
25 GO TO 400
28 REM ... CLEAR CCI
29 GOSUB 360
30 OFF SRQ
31 END
32 REM ... CLEAR ON ERROR
33 END
36 REM ... PLOT DATA
37 GO TO 1060
40 REM ... GOTO ANALYSE
41 GO TO 2540
52 REM ... CREATE DATA LIB
53 GO TO 1540
56 REM ... READ OLD LIB FORMAT
57 GO TO 2610
76 REM ... CALIBRATE & PLOT
77 GO TO 1020
100 IF P1<>1 THEN 130
110 DIM D(1024)
120 P1=2
130 PAGE
140 PRINT "          DATA I/O PROGRAM"
150 PRINT
160 PRINT "          USED TO ENTER DATA FROM MODEM"
170 PRINT "          OR DATA LIBRARY OR TO WRITE DATA"
180 PRINT "          TO A DATA LIBRARY."
190 PRINT
200 PRINT " USER KEYS ARE:"
210 PRINT "1. INITIALIZE (NOT NORMALLY USED)"
220 PRINT "3. LIST DATA LIBRARY INDEX"
230 PRINT "4. READ DATA FROM DATA LIBRARY"
240 PRINT "5. WRITE DATA TO DATA LIBRARY"
250 PRINT "6. INPUT VIA MODEM"
260 PRINT "7. CLEAR CCI"
270 PRINT "8. CLEAR ON ERROR"
280 PRINT "9. PLOT DATA"
290 PRINT "10. GO TO ANALYSE"
300 PRINT "13. CREATE DATA LIBRARY"
310 PRINT "14. READ OLD LIBRARY FORMAT"
320 PRINT "19. CALIBRATE AND PLOT"
330 SET KEY
340 END
350 WBYTE @24:
360 POLL A,B;17
370 WBYTE @25:
380 PRINT " SRQ (";B;" )"
390 RETURN
400 DIM A$(1),B$(64),C$(5)
410 A$=""
420 B$=""
430 C$=""
440 D=0
```

```

450 L=1
460 PRINT "(RETURN) WHEN MODEN LIGHT IS ON";
470 INPUT X$
480 ON SRQ THEN 350
490 FOR K=1 TO 64
500 FOR I=1 TO 5
510 RBYTE X
520 NEXT I
530 A$=CHR(X)
540 B$=B$&A$
550 FOR I=L TO L+15
560 C$=""
570 FOR J=1 TO 5
580 RBYTE X
590 A$=CHR(X)
600 C$=C$&A$
610 NEXT J
620 D(I)=VAL(C$)
630 NEXT I
640 L=L+1
650 NEXT K
660 WBYTE 063,95:
670 OFF SRQ
680 PRINT "GGGGGDATA RECEIVED, TURN OFF DCI"
690 X$=SEG(B$,1,4)
700 P0=VAL(X$)
710 X$=SEG(B$,5,3)
720 F9=VAL(X$)
730 X$=SEG(B$,8,1)
740 Q0=VAL(X$)
750 X$=SEG(B$,9,2)
760 O9=VAL(X$)
770 X$=SEG(B$,11,8)
780 S9=VAL(X$)
790 X$=SEG(B$,19,2)
800 J9=VAL(X$)
810 X$=SEG(B$,22,2)
820 K9=VAL(X$)
830 X$=SEG(B$,24,5)
840 B0=VAL(X$)
850 X$=SEG(B$,29,4)
860 B1=VAL(X$)
870 X$=SEG(B$,33,5)
880 L9=VAL(X$)
890 X$=SEG(B$,38,5)
900 A0=VAL(X$)
910 X$=SEG(B$,43,4)
920 A1=VAL(X$)
930 X$=SEG(B$,49,3)
940 E1=VAL(X$)
950 X$=SEG(B$,52,4)
960 E0=VAL(X$)
970 X$=SEG(B$,56,2)
980 C2=VAL(X$)
990 IF Q0=8 THEN 992
991 Q0=Q0-4
992 DELETE A$,B$,C$
1000 PRINT "TITLE FOR THIS DATA SET (AND FILE):"
1010 INPUT T$
1020 IF E0<1000 THEN 1040
1030 E0=E0-10000
1040 E1=E1*4.092/1024
1050 P2=1
1060 PAGE
1070 PRINT 032,21:0,45
1080 PRINT " P MARK ENERGY"
1090 PRINT USING "0X,4D":P0
1100 PRINT

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1110 PRINT USING 1120:"DAY QUAD","SAMPLE","INTEGRAL A TO B"
1120 IMAGE 6X,8A,14X,6A,13X,15A
1130 PRINT USING 1140:F9,00,09,S9
1140 IMAGE 6X,3D,2X,1D,18X,2D,18X,8D
1150 PRINT
1160 PRINT USING 1170:"TIME","B MARK COUNTS","B MARK ENERGY"
1170 IMAGE 7X,4A,15X,13A,10X,13A
1180 PRINT USING 1190:J9,K9,B0,B1
1190 IMAGE 7X,2D,".",2D,18X,5D,18X,5D
1200 PRINT
1210 PRINT USING 1220:"LIVE TIME","A MARK COUNTS","A MARK ENERGY"
1220 IMAGE 4X,9A,13X,13A,10X,13A
1230 PRINT USING 1240:L9,A0,A1
1240 IMAGE 6X,6D,17X,6D,17X,6D
1250 FOR I=1 TO 34
1260 PRINT "- ";
1270 NEXT I
1280 PRINT
1290 PRINT "ENERGY CALIBRATION: KEV/CHAN = ";E1
1300 PRINT "          " KEV OFFSET = ";E0
1310 PRINT "          " KEV FULL SCALE = ";E1*1024+E0
1320 VIEWPORT 10,120,50,90
1330 WINDOW 1,1024,0,5
1340 AXIS 50,1
1350 AXIS 0,0,1024,5
1360 MOVE 0,0
1370 FOR I=1 TO 1024
1380 X=D(I)
1390 IF X=0 THEN 1410
1400 X=LGT(X)
1410 DRAW I,X
1420 NEXT I
1430 MOVE 256,0
1440 DRAW 256,5
1450 MOVE 512,0
1460 DRAW 512,5
1470 MOVE 768,0
1480 DRAW 768,5
1490 HOME
1500 PRINT T$
1510 END
1520 REM LIBRARY MAINTENANCE FOR NEST DATA
1530 REM ... CREATE NEW LIBRARY TAPE
1540 REM PAGE
1550 PRINT "DATA LIBRARY TAPE NUMBER: ";
1560 INPUT L
1570 PRINT "DATA LIBRARY IDENTIFICATION ";
1580 INPUT L$
1590 PRINT "INSERT NEW (BLANK!) TAPE (RETURN)";
1600 INPUT X$
1610 FIND 0
1620 MARK 1,1000
1630 FIND 1
1640 WRITE @33:"DATA",L,L$
1650 F=1
1660 F$="LAST"
1670 WRITE @33:F,F$
1680 END
1690 REM ... READ LIBRARY INDEX
1700 REM PAGE
1710 PRINT "INSERT DATA LIBRARY TAPE (RETURN)";
1720 INPUT X$
1730 FIND 1
1740 I=I+1
1750 IF I<>4 THEN 1780
1760 READ @33:X$
1770 IF X$="DATA" THEN 1800
1780 PRINT "DATA TAPE IS NOT IN THE CORRECT FORMAT."
1790 GO TO 1710

```

```

1800 READ @33:L,L$
1810 PAGE
1820 PRINT L$;" LIBRARY (TYPE ";L$;")"
1830 READ @33:F,F$
1840 IF F$="LAST" THEN 1870
1850 PRINT F$;" "IF$
1860 GO TO 1830
1870 RETURN
1880 REM ... WRITE DATA INTO LIB
1890 REM PAGE
1900 PRINT "INSERT DATA LIBRARY TAPE (RETURN)";
1910 INPUT X$
1920 FIND 1
1930 I=TYP(0)
1940 IF I<>4 THEN 1970
1950 READ @33:X$
1960 IF X$="DATA" THEN 1990
1970 PRINT "DATA LIBRARY NOT IN PROPER FORMAT"
1980 GO TO 1900
1990 READ @33:L,L$
2000 READ @33:F,F$
2010 IF F$=T$ THEN 2200
2020 IF F$<>"LAST" THEN 2000
2030 FIND 1
2040 READ @33:X$,L,L$
2050 F1=F-1
2060 IF F1=0 THEN 2110
2070 READ @33:F,F$
2080 IF F<>F1 THEN 2070
2110 WRITE @33:F1+1,T$
2120 WRITE @33:F1+2,"LAST"
2130 FIND F1+2
2140 MARK 1,10496
2150 FIND F1+2
2160 WRITE @33:P0,F9,Q0,O9,S9,J9,K9,B0,B1,L9,A0,A1,E1,E0,C2,D
2161 CLOSE
2170 PRINT "DATA FILE: ";T$
2180 PRINT "WRITTEN IN LIBRARY: ";L$
2190 RETURN
2200 PRINT "DATA FILE ";T$
2210 PRINT "IS AN EXISTING DATA FILE"
2220 PRINT "TYPE 'WRITE' TO OVERWRITE IT, (RETURN) OTHERWISE."
2230 INPUT X$
2240 IF X$="WRITE" THEN 2280
2250 PRINT "TYPE NEW ID FOR PRESENT DATA"
2260 INPUT T$
2270 GO TO 1920
2280 F1=F-1
2290 GO TO 2150
2300 REM ... READ DATA FROM LIBRARY
2310 REM PAGE
2320 PRINT "INSERT DATA LIBRARY TAPE (RETURN)";
2330 INPUT X$
2340 PRINT "FILE NUMBER: ";
2350 INPUT F
2360 F=F+1
2370 FIND 1
2380 I=TYP(0)
2390 IF I<>4 THEN 2420
2400 READ @33:X$
2410 IF X$="DATA" THEN 2440
2420 PRINT "DATA LIBRARY NOT IN PROPER FORMAT"
2430 GO TO 2320
2440 READ @33:L,L$
2450 FOR I=1 TO F-1
2460 READ @33:F1,T$
2470 NEXT I
2480 FIND F
2490 READ @33:P0,F9,Q0,O9,S9,J9,K9,B0,B1,L9,A0,A1,E1,E0,C2,D

```



```

2500 P2=1
2510 PRINT "DATA FILE: ";T$;" READ."
2520 RETURN
2530 REM ... GOTO ANALYSIS PROGRAM
2540 DELETE A$,B$,C$,D$,E$,X,I,J,A,B
2550 DELETE L$,F,F$
2560 REM PAGE
2570 PRINT "INSERT PROGRAM TAPE (RETURN)"
2580 INPUT X$
2590 FIND 3
2600 GO TO 2
2610 PRINT "INSERT OLD LIBRARY TAPE (RETURN)"
2620 INPUT X$
2630 PRINT "TITLE FOR THE DATA"
2640 INPUT T$
2650 PRINT "FILE NUMBER: ";
2660 INPUT F
2670 GOSUB 2480
2680 PRINT "FILE NUMBER ";F
2690 END

```

```

MEM
22809
SPA
20592

```

PROGRAM: ANALYSE

TAPE: FIELD AHAH.SCS

FILE: 3

```
4 GO TO 100
8 REM ... PLOT ALL (2)
9 N1=1
10 N2=1024
11 GO TO 530
12 REM ... PLOT LIMITS (3)
13 GO TO 470
16 REM ... SCAN AUTO (4)
17 GO TO 3080
20 REM ... SCAN LIMITS (5)
21 GO TO 2980
24 REM ... CLEAR ON ERROR (6)
25 END
29 REM ... MARK LIMITS (7)
29 GO TO 1940
32 REM ... SCAN RESET (8)
33 GO TO 3140
36 REM ... INTEGRATE LIMITS (9)
37 GO TO 1400
40 REM ... LOCATE PEAKS AUTO (10)
41 GO TO 3460
44 REM ... DELETE MARKED PEAK (11)
45 GO TO 2120
48 REM ... LIST PEAKS SHORT (12)
49 GO TO 2430
52 REM ... ENERGY CALIBRATE (13)
53 GO TO 3290
60 REM ... SORT PEAKS (15)
61 GO TO 2230
64 REM ... INTEGRATE AUTO (16)
65 GO TO 1490
68 REM ... LIST LIMITS (17)
69 GO TO 1650
72 REM ... LIST PEAKS LONG (18)
73 GO TO 2640
76 REM ... GO TO I/O PROGRAM (19)
77 GO TO 3400
80 REM ... GO TO STANDARD PEAKS LIBRARY (20)
100 IF P2=3 THEN 170
110 P2=3
120 DIM D(1024)
130 DIM R(3)
140 DIM P(100)
150 N9=0
160 L=0
170 SET KEY
180 IF P2=4 THEN 3530
190 REM
200 PAGE
210 P9=0
220 PRINT "          PLOTTING AND DATA MANIPULATION"
230 PRINT
240 PRINT "          D. A. FUESS"
250 PRINT
260 PRINT "USER DEFINED KEYS:"
270 PRINT "1. INITIALIZE (NOT NORMALLY USED)"
280 PRINT "2. PLOT ALL DATA (1 TO 1024)"
290 PRINT "3. PLOT BETWEEN SPECIFIED LIMITS"
300 PRINT "4. SCAN AUTO (1 TO 1024 INC 100)"
310 PRINT "5. SCAN BETWEEN SPECIFIED LIMITS"
```

```

320 PRINT "6. CLEAR ON ERROR (STOPS WHATEVER'S GOING ON)"
330 PRINT "7. MARK SPECIFIED PEAK"
340 PRINT "8. RESTART SCAN WHERE I LEFT OFF"
350 PRINT "9. INTEGRATE OVER SPECIFIED LIMITS"
360 PRINT "10. LOCATE PEAKS AUTO"
370 PRINT "11. DELETE A MARKED PEAK"
380 PRINT "12. LIST MARKED PEAKS (SHORT FORMAT)"
390 PRINT "13. ENERGY CALIBRATE"
400 PRINT "15. SORT PEAKS, DELETE DUPLICATIONS"
410 PRINT "16. INTEGRATE THE PRESENT PICTURE FRAME"
420 PRINT "17. LIST DATA OVER SPECIFIED LIMITS"
430 PRINT "18. LIST MARKED PEAKS (LONG FORMAT)"
440 PRINT "19. GO TO I/O PROGRAM"
450 PRINT "20. GO TO STANDARD PEAKS LIBRARY, NOT YET)"
460 END
470 REM ... PLOT THE DATA
480 PRINT "X MIN: ";
490 INPUT N1
500 PRINT "X MAX: ";
510 INPUT N2
520 IF N2<N1 THEN 1370
530 PAGE
540 PRINT "LOCATING MAXIMUM AND MINIMUM VALUE"
550 Y1=1000000
560 Y2=0
570 FOR I=N1 TO N2
580 IF Y1<D(I) THEN 600
590 Y1=D(I)
600 IF Y2>D(I) THEN 630
610 N7=I
620 Y2=D(I)
630 NEXT I
640 PAGE
650 VIEWPORT 15,120,12,91
660 WINDOW N1,N2,Y1,Y2
670 T1=INT((N2-N1)/10)
680 IF T1<1 THEN 710
690 T3=(N2-N1)/T1
700 IF T1>1 THEN 730
710 T1=1
720 T3=N2-N1
730 T2=INT((Y2-Y1)/10)
740 T4=10
750 IF T2>1 THEN 780
760 T2=1
770 T4=Y2-Y1
780 AXIS T1,T2
790 AXIS 0,0,N2,Y2
800 FOR I=1 TO T3+1
810 MOVE T1*(I-1)+N1,Y1
820 PRINT "JHH";T1*(I-1)+N1
830 MOVE T1*(I-1)+N1,Y1
840 PRINT "JHH"
850 PRINT USING "SD":E1*(N1+T1*(I-1))+E0
860 NEXT I
870 MOVE (N1+N2)/2,Y1
880 PRINT "JJHHHHHHHCHANNEL(ENERGY)"
890 FOR I=1 TO T4+1
900 MOVE N1,T2*(I-1)+Y1
910 PRINT "HHHHH";T2*(I-1)+Y1
920 NEXT I
930 MOVE N1,(Y1+Y2)/2
940 PRINT "HHHHHHHHKKK";
950 PRINT "C";"JH";
960 PRINT "O";"JH";
970 PRINT "U";"JH";
980 PRINT "N";"JH";
990 PRINT "T";"JH";
1000 PRINT "S";"JH";

```

```

1010 MOVE N1,Y2
1020 PRINT "K1978:";F9;"":J9;K9
1030 MOVE N1+(N2-N1)/3,Y2
1040 PRINT "KET = ";L9
1050 MOVE N1+(N2-N1)*2/3,Y2
1060 PRINT "KID = ";O9
1070 MOVE N1,Y1
1080 FOR I=N1 TO N2
1090 DRAW I,D(I)
1100 NEXT I
1110 VIEWPORT 114,119,85,90
1120 WINDOW 0,20,0,20
1130 AXIS
1140 AXIS 0,0,20,20
1150 MOVE 1,20
1160 DRAW 1,1
1170 DRAW 10,1
1180 DRAW 12.5,4
1190 DRAW 4,4
1200 DRAW 4,20
1210 MOVE 5,20
1220 DRAW 5,5
1230 DRAW 13.5,5
1240 DRAW 16,8
1250 DRAW 8,8
1260 DRAW 8,20
1270 MOVE 9,20
1280 DRAW 9,9
1290 DRAW 17.2,9
1300 DRAW 20,12
1310 DRAW 12,12
1320 DRAW 12,20
1330 HOME
1340 PRINT T$;
1350 P9=1
1360 RETURN
1370 PRINT "BAD LIMITS SPECIFIED."
1380 PRINT "NOTHING DONE ..."
1390 END
1400 REM INTEGRATE FROM N3 TO N4
1410 GOSUB 3570
1420 PRINT "INTEGRATE FROM: ";
1430 INPUT N3
1440 PRINT "          TO: ";
1450 INPUT N4
1460 GOSUB 1510
1470 PRINT "INTEGRAL (<;N3;->;N4;)"= "T;" BACKGROUND = "B
1480 END
1490 N3=N1
1500 N4=N2
1510 IF N3=>N4 THEN 1370
1520 B=(D(N3)+D(N4))/2*(N4-N3+1)
1530 T=0
1540 FOR I=N3 TO N4
1550 T=T+D(I)
1560 NEXT I
1570 T=T-B
1580 IF B<>0 THEN 1600
1590 B=1
1600 IF P9=0 THEN 1640
1610 PRINT @32,21:40,0
1620 PRINT "INTEGRAL= "T;" BACKGROUND= "B;
1630 PRINT @32,21:0,96
1640 RETURN
1650 REM LIST FROM N3 TO N4
1660 GOSUB 3570
1670 PRINT "LIST FROM: ";
1680 INPUT N3
1690 PRINT "          TO: ";

```

```

1700 INPUT N4
1710 GO TO 1740
1720 N3=N1
1730 N4=N2
1740 IF N3>N4 THEN 1370
1750 K=INT((N4-N3)/30)+1
1760 FOR J=1 TO K
1770 PAGE
1780 P9=0
1790 PRINT "VALUES FROM ";T$
1800 PRINT "CHANNEL","ENERGY","COUNTS"
1460 GOSUB 1510
1470 PRINT "INTEGRAL (";N3;"-";N4;" )= ";T;" BACKGROUND = ";B
1480 END
1490 N3=N1
1500 N4=N2
1510 IF N3>N4 THEN 1370
1520 B=(D(N3)+D(N4))/2*(N4-N3+1)
1530 T=0
1540 FOR I=N3 TO N4
1550 T=T+D(I)
1560 NEXT I
1570 T=T-B
1580 IF B<>0 THEN 1600
1590 B=1
1600 IF P9=0 THEN 1640
1610 PRINT @32,21;40,0
1620 PRINT "INTEGRAL= ";T;" BACKGROUND= ";B;
1630 PRINT @32,21;0,96
1640 RETURN
1650 REM LIST FROM N3 TO N4
1660 GOSUB 3570
1670 PRINT "LIST FROM: ";
1680 INPUT N3
1690 PRINT "          TO: ";
1700 INPUT N4
1710 GO TO 1740
1720 N3=N1
1730 N4=N2
1740 IF N3>N4 THEN 1370
1750 K=INT((N4-N3)/30)+1
1760 FOR J=1 TO K
1770 PAGE
1780 P9=0
1790 PRINT "VALUES FROM ";T$
1800 PRINT "CHANNEL","ENERGY","COUNTS"
1810 L=(J-1)*30+N3
1820 M=N7+30*J
1830 IF M<N4 THEN 1850
1840 M=N4
1850 FOR I=L TO M
1860 PRINT I,E1*I+E0,D(I)
1870 NEXT I
1880 IF M=N4 THEN 1930
1890 PRINT "MORE";
1900 INPUT I$
1910 IF I$="NO" THEN 1930
1920 NEXT J
1930 RETURN
1940 REM ... PEAK LISTING TABLE ADDITIONS
1950 PRINT "CHANNEL NUMBER NEXT PEAK: ";
1960 INPUT N7
1970 IF D(N7)<D(N7+1) THEN 2000
1980 IF D(N7)<D(N7-1) THEN 2020
1990 GO TO 2050
2000 N7=N7+1
2010 GO TO 1970
2020 N7=N7-1
2030 GO TO 1970

```

```

2040 REM N7 SET PRIOR TO CALLING
2050 N9=N9+1
2060 IF N9=101 THEN 2090
2070 P(N9)=N7
2080 RETURN
2090 PRINT "PEAKS TABLE IS FULL P(;"N7;") NOT LISTED."
2100 N9=100
2110 END
2120 GOSUB 3570
2130 PRINT "NUMBER OF PEAK TO BE DELETED: ";
2140 INPUT N3
2150 IF N9=0 THEN 2220
2160 IF N9=1 THEN 2210
2170 IF N3=N9 THEN 2210
2180 FOR I=N3 TO N9-1
2190 P(I)=P(I+1)
2200 NEXT I
2210 N9=N9-1
2220 RETURN
2230 REM ... SORT PEAKS / DELETE DUPLICATES
2240 IF N9=0 THEN 2350
2250 IF N9=1 THEN 2350
2260 REM ... SORT PEAKS
2270 FOR J=N9-1 TO 1 STEP -1
2280 FOR I=1 TO J
2290 IF P(I)<P(I+1) THEN 2330
2300 X=P(I)
2310 P(I)=P(I+1)
2320 P(I+1)=X
2330 NEXT I
2340 NEXT J
2350 REM ... DELETE DUPLICATES
2360 FOR J=N9-1 TO 1 STEP -1
2370 IF J=N9 THEN 2420
2380 IF P(J)<>P(J+1) THEN 2410
2390 N3=J+1
2400 GOSUB 2160
2410 NEXT J
2420 RETURN
2430 REM ... SHORT LISTING OF PEAKS
2440 PAGE
2450 P9=0
2460 PRINT "PEAKS IN ";T$
2470 IF N9=0 THEN 2620
2480 J=0
2490 PRINT "NUMBER","CHANNEL","ENERGY"
2500 FOR I=1 TO N9
2510 PRINT I,P(I),E1*P(I)+f.0
2520 J=J+1
2530 IF J<30 THEN 2600
2540 PRINT "MORE";
2550 INPUT X$
2560 PAGE
2570 PRINT "PEAKS IN ";T$
2580 PRINT "NUMBER","CHANNEL","ENERGY"
2590 J=0
2600 NEXT I
2610 END
2620 PRINT "NO PEAKS LISTED"
2630 RETURN
2640 REM ... PEAKS LIST LONG
2650 PAGE
2660 P9=0
2670 PRINT "PEAKS IN ";T$
2680 IF N9=0 THEN 2620
2690 PRI USI 2700:"NUMBER","CHANNEL","ENERGY","WIDTH","INTEGRAL","SIGMA"
2700 IMAGE 6A,2X,7A,2X,6A,2X,5A,2X,8A,2X,5A
2710 J=0
2720 FOR K=1 TO N9

```

```

2730 REM ... FIND LOWER BOUND
2740 X=P(K)
2750 X=X-1
2760 IF D(X)<D(X-1) THEN 2780
2770 GO TO 2750
2780 N3=X
2790 REM ... FIND UPPER BOUND
2800 X=P(K)
2810 X=X+1
2820 IF D(X)<D(X+1) THEN 2840
2830 GO TO 2810
2840 N4=X
2850 GOSUB 1520
2860 PRINT USING 2870:K,P(K),E1*P(K)+E0,N4-N3,T,T/SQR(B)
2870 IMAGE 1X,3D,5X,4D,3X,5D,2D,2X,3D,2X,6D,1D,1X,4D,2D
2880 J=J+1
2890 IF J<30 THEN 2960
2900 PRINT "MORE";
2910 INPUT X$
2920 PAGE
2930 PRINT "PEAKS IN "I$
2940 PRI USI 2700:"NUMBER","CHANNEL","ENERGY","WIDTH","INTEGRAL","SIGMA"
2950 J=0
2960 NEXT K
2970 END
2980 REM ... SCAN ROUTINE
2990 GOSUB 3570
3000 PRINT "SCAN PARAMETERS:"
3010 PRINT "FROM CHANNEL: ";
3020 INPUT N1
3030 PRINT "TO CHANNEL: ";
3040 INPUT N8
3050 PRINT "INCREMENT: ";
3060 INPUT S0
3070 GO TO 3110
3080 S0=100
3090 N1=1
3100 N8=1024
3110 N2=N1+S0
3120 IF N2>N8 THEN 3140
3130 N2=N8
3140 GOSUB 550
3150 PRINT "ENTER (INK);M;OR RETURN ";
3160 INPUT I$
3170 IF I$="END" THEN 3200
3180 IF I$="M" THEN 3210
3190 IF I$(">") THEN 3260
3200 GO TO 3230
3210 GOSUB 2040
3220 N2=N2+1
3230 IF N2>N8 THEN 3200
3240 N1=N2-1
3250 GO TO 3110
3260 S0=VAL(I$)
3270 GO TO 3110
3280 RETURN
3290 REM ... ENERGY CALIBRATE
3300 GOSUB 3570
3310 PRINT "LOW CHANNEL, ENERGY ";
3320 INPUT C5,E5
3330 PRINT "HIGH CHANNEL, ENERGY ";
3340 INPUT C6,E6
3350 E1=(E6-E5)/(C6-C5)
3360 E0=E6-E1*C6
3370 DELETE C5,C6,E5,E6
3380 PRINT "E0= ";E0;" E1= ";E1
3390 END
3400 REM ... GO BACK TO I/O PROGRAM

```

```

3410 GOSUB 3570
3420 PRINT "INSERT PROGRAM TAPE (RETURN)"
3430 INPUT X$
3440 FIND 2
3450 GO TO 2
3460 REM ... GO TO PEAK SEARCH AUTO
3470 GOSUB 3570
3480 PRINT "INSERT PROGRAM TAPE (RETURN)"
3490 INPUT X$
3500 P2=4
3510 FIND 4
3520 GO TO 2
3530 REM ... ADD PEAKS FROM THE Q
3540 P2=3
3550 GOSUB 2230
3560 GO TO 2640
3570 IF P9=0 THEN 3600
3580 PAGE
3590 P9=0
3600 RETURN

```

```

MEM
20290
SPA
28000

```


PROGRAM: PEAK SEARCH
TAPE: FIELD ANALYSIS
FILE 4

```

4 GO TO 100
100 REM THIS IS A TEST PROGRAM TO LOCATE PEAKS IN A HPGE
110 REM SPECTRAL DATA FILE AND CLASSIFY THE PEAKS LOCATED
120 REM BY SIGMA LEVEL. ONLY THE 100 HIGHEST SIGMA PEAKS
130 REM ARE REPORTED. (THE PEAK STORAGE SPACE IN THE ANALYSIS
140 REM PROGRAM ALLOWS FOR A MAXIMUM OF 100 PEAKS.)
150 REM
160 SET NOKEY
170 PAGE
180 PRINT "CHANNEL NUMBER FOR BEGIN SEARCH: ";
190 INPUT Z1
200 IF Z1>10 THEN 220
210 Z1=10
220 PRINT "CHANNEL NUMBER FOR END OF SEARCH: ";
230 INPUT Z2
240 PRINT "LOWEST ACCEPTABLE SIGMA LEVEL: ";
250 INPUT Z3
260 IF Z2<1014 THEN 280
270 Z2=1014
280 PRINT "PEAK SEARCH OF ";T$
290 Z0=Z1
300 Z0=Z0+1
310 IF Z0=>Z2 THEN 670
320 IF D(Z0)<D(Z0+1) THEN 300
330 IF D(Z0)<D(Z0-1) THEN 300
340 N3=Z0
350 N4=Z0
360 N3=N3-1
370 IF N3=1 THEN 400
380 IF D(N3)<D(N3-1) THEN 400
390 GO TO 360
400 N4=N4+1
410 IF N4=1024 THEN 440
420 IF D(N4)<D(N4+1) THEN 440
430 GO TO 400
440 B=(D(N3)+D(N4))/2*(N4-N3+1)
450 T=0
460 FOR I=N3 TO N4
470 T=T+D(I)
480 NEXT I
490 T=T-B
500 IF B>0 THEN 520
510 B=1
520 IF T/SQR(B)<Z3 THEN 560
530 N9=N9+1
540 IF N9=101 THEN 580
550 P(N9)=Z0
560 Z0=N4
570 GO TO 300
580 PRINT "NO MORE ROOM IN PEAKS ARRAY, (100 MAX)"
590 PRINT "PEAKS BEYOND CHANNEL ";Z0;" HAVE NOT BEEN LISTED."
600 PRINT "TYPE NEW SIGMA LEVEL OR 0 (0=END LIST)"
610 INPUT Z3
620 IF Z3=0 THEN 650
630 N9=0
640 GO TO 290
650 N9=100
660 SET KEY
670 PRINT N9;" PEAKS LISTED FOR THIS SPECTRUM"

```

680 PRINT "RETURNING TO ANALYSIS FOR SORTING"
690 DELETE Z1,Z2,Z3
700 FIND 3
710 GO TO 2

MEM
28226
SPA
4536

PROGRAM: SPECTRA MATH FUNCTIONS

TAPE: FIELD ANALYSIS

FILE: 5

NOTE: NOT CALLED DIRECTLY, MUST BE MANUALLY
OVERLAYED IN THE ANALYSE PROGRAM.
DESTROY AFTER USE AS IT MAY CAUSE
MACHINE ERRORS DUE TO MEMORY OVERFLOW.

```

3610 PAGE
3620 PRINT "INSERT LIBRARY TAPE (RETURN)";
3630 INPUT I$
3640 PRINT "LIBRARY FILE NUMBER: ";
3650 INPUT F
3660 FIND F+1
3670 FOR I=1 TO 15
3680 READ @33:X
3690 NEXT I
3700 PRINT "QUADRANT (0=ALL): ";
3710 INPUT Q
3720 PRINT "SUBTRAHEND FACTOR: ";
3730 INPUT F
3740 IF Q=0 THEN 3930
3750 Q=(Q-1)*256
3760 J=256
3770 PRINT "MINUEND QUADRANT: ";
3780 INPUT K
3790 K=(K-1)*256
3800 PRINT "DIFFERENCE QUADRANT: ";
3810 INPUT N3
3820 N3=(N3-1)*256
3830 IF Q=0 THEN 3870
3840 FOR I=1 TO Q
3850 READ @33:X
3860 NEXT I
3870 FOR I=1 TO J
3880 READ @33:X
3890 D(I+N3)=D(I+Q)+X*F
3910 NEXT I
3920 END
3930 J=1024
3940 K=0
3950 GO TO 3870

```

```

MEM
29270
SPA
2448

```

1	ASCII	PROGRAM	30208
2	ASCII	PROGRAM	30208
3	ASCII	PROGRAM	30208
4	ASCII	PROGRAM	30208
5	ASCII	PROGRAM	30208
6	LAST		768

TAPE LIST INDEX FROM FIELD ANALYSIS TAPE
SEP 1, 1978

APPENDIX C

FLOW CHARTS FOR PROGRAMS

FLOWCHART SYMBOLS

```

0      ( BEGIN )
      **** KEY #1 ****
4      >>1
      **** KEY #3 ****
12     ( REM ... LIST DATA LIB INDEX )
      >>2
13     **** KEY #4 ****
16     ( REM ... READ FROM DATA LIB )
      >>3
17     **** KEY #5 ****
20     ( REM ... WRITE INTO DATA LIB )
      >>4
21     **** KEY #6 ****
24     ( REM ... INPUT VIA NODEM )
      >>5
25     **** KEY #7 ****
28     ( REM ... CLEAR CCI )
29     ( GOSUB 360 ) >>6
A

```

A
30
31
32
33
36
37
40
41
52
53
56
57
B

8

**** KEY! #19 ****

76

REM ... CALIBRATE & PLOT

77

1>>

YES

100

PI < 1

YES

110

DIM D(1024)

120

P1=2

12>>

130

PAGE

140

PRINT " DATA I/O PROGRAM"

150

PRINT

160

PRINT " USED TO ENTER DATA FROM MODEM"

170

PRINT " OR DATA LIBRARY OR TO WRITE DATA"

180

PRINT " TO A DATA LIBRARY."

190

PRINT

200

PRINT " USER KEYS ARE:"

210

PRINT "1. INITIALIZE (NOT NORMALLY USED)"

220

PRINT "3. LIST DATA LIBRARY INDEX"

230

PRINT "4. READ DATA FROM DATA LIBRARY"

240

PRINT "5. WRITE DATA TO DATA LIBRARY"

250

PRINT "6. INPUT VIA MODEM"

C

C
260
270
280
290
300
310
320

330
340

350

360
370
380
390

400
410
D

D
 420
 430
 440
 450
 460
 470
 480
 490
 500
 510
 520
 530
 540
 550
 560
 570
 E

E
 580
 590
 600
 610
 620
 630
 640
 650
 660
 670
 680
 690
 700
 710
 720
 730

F

F

740
750
760
770
780
790
800
810
820
830
840
850
860
870
880
890
900
910
920
930
940
950
960
970
980

```

Q0=VAL(X$)
X$=SEG(B$,9,2)
Q9=VAL(X$)
X$=SEG(B$,11,8)
S9=VAL(X$)
X$=SEG(B$,19,2)
J9=VAL(X$)
X$=SEG(B$,22,2)
K9=VAL(X$)
X$=SEG(B$,24,5)
B0=VAL(X$)
X$=SEG(B$,29,4)
B1=VAL(X$)
X$=SEG(B$,33,5)
L9=VAL(X$)
X$=SEG(B$,38,5)
A0=VAL(X$)
X$=SEG(B$,43,4)
A1=VAL(X$)
X$=SEG(B$,49,3)
E1=VAL(X$)
X$=SEG(B$,52,4)
E0=VAL(X$)
X$=SEG(B$,56,2)
C2=VAL(X$)

```

990

Q0=8 YES → 14

991

Q0=Q0-4

G

H

```

N
1120      IMAGE 6X,8A,14X,6A,13X,15A
1130      /PRINT USING 1140:F9,00,09,S9/
1140      IMAGE 6X,3D,2X,1D,18X,2D,18X,8D
1150      PRINT
1160      /PRINT USING 1170:"TIME","B MARK COUNTS","B MARK ENERGY"/
1170      IMAGE 7X,4A,15X,13A,10X,13A
1180      /PRINT USING 1190:J9,K9,B0,B1/
1190      IMAGE 7X,2D,".",2D,18X,5D,18X,5D
1200      PRINT
1210      /PRINT USING 1220:"LIVE TIME","A MARK COUNTS","A MARK ENERGY"/
1220      IMAGE 4X,9A,13X,13A,10X,13A
1230      /PRINT USING 1240:L9,A0,A1/
1240      IMAGE 6X,6D,17X,6D,17X,6D
1250      /FOR I=1 TO 34/
I

```

I
1260

PRINT "- ";

1270

NEXT I

1280

PRINT

1290

PRINT "ENERGY CALIBRATION: KEV/CHAN = ";E1

1300

PRINT " KEV OFFSET = ";E0

1310

PRINT " KEV FULL SCALE = ";E1*1024+E0

1320

OPENPORT 10,120,50,90

1330

WINDOW 1,1024,0,5

1340

AXIS 50,1

1350

AXIS 0,0,1024,5

1360

MOVE 0,0

1370

FOR I=1 TO 1024

1380

X=D(I)

1390

X=0

YES

>>16

J

J
1400
16>>
1410
1420
1430
1440
1450
1460
1470
1480
1490
1500
1510
1520
K

N

P

R
2350
2360
2370
2380
2390
2400
2410
2420
2430
2440
2450

S

S
2460
2470
2480
2490
2500
2510
2520
2530
2540
2550
2560
2570
2580
T

BR#	FROM	TO		BR#	FROM	TO
1	4	100		19	1790	1710
2	13	1690		20	1840	1870
3	17	2300		21	1860	1830
4	21	1880		22	1940	1970
5	25	400		23	1960	1990
6	29	360	*SUBR. CALL	24	1980	1900
7	37	1050		25	2010	2200
8	41	2540		26	2020	2000
9	53	1540		27	2060	2110
10	57	2610		28	2080	2070
11	77	1020		29	2240	2280
12	100	130		30	2270	1920
13	480	350	*INTERRUPT	31	2290	2150
14	990	992		32	2390	2420
15	1020	1040		33	2410	2440
16	1390	1410		34	2430	2320
17	1750	1780		35	2600	2
18	1770	1800		36	2670	2480 *SUBR. CALL

```

0      BEGIN
      **** KEY #1 ****
4
      **** KEY #2 ****
8      REM ... PLOT ALL (2)
      N1=1
      N2=1024
11
      **** KEY #3 ****
12     REM ... PLOT LIMITS (3)
13
      **** KEY #4 ****
16     REM ... SCAN AUTO (4)
17
      **** KEY #5 ****
20     REM ... SCAN LIMITS (5)
21
      **** KEY #6 ****
24     REM ... CLEAR ON ERROR (6)

```

A
25

END

**** KEY #7 ****

28

REM ... MARK LIMITS (7)

29

→>6

**** KEY #8 ****

32

REM ... SCAN RESET (8)

33

→>7

**** KEY #9 ****

36

REM ... INTEGRATE LIMITS (9)

37

→>8

**** KEY #10 ****

40

REM ... LOCATE PEAKS AUTO (10)

41

→>9

**** KEY #11 ****

44

REM ... DELETE MARKED PEAK (11)

45

→>10

**** KEY #12 ****

48

REM ... LIST PEAKS SHORT (12)

B

8			
49			→>11
	**** KEY #13 ****		
52	◀REM ... ENERGY CALIBRATE (13)▶		
			→>12
53	**** KEY #15 ****		
60	◀REM ... SORT PEAKS (15)▶		
			→>13
61	**** KEY #16 ****		
64	◀REM ... INTEGRATE AUTO (16)▶		
			→>14
65	**** KEY #17 ****		
68	◀REM ... LIST LIMITS (17)▶		
			→>15
69	**** KEY #18 ****		
72	◀REM ... LIST PEAKS LONG (18)▶		
			→>16
73	**** KEY #19 ****		
76	◀REM ... GO TO I/O PROGRAM (19)▶		
C

D
200

210

220

230

240

250

260

270

280

290

300

310

320

330

340

350

360

370

380

390

400

410

420

430

440

450

460

E

PAGE

P9=0

```
PRINT "      PLOTTING AND DATA MANIPULATION"
PRINT
PRINT "      D. A. FUESS"
PRINT
PRINT "USER DEFINED KEYS:"
PRINT "1. INITIALIZE (NOT NORMALLY USED)"
PRINT "2. PLOT ALL DATA (1 TO 1024)"
PRINT "3. PLOT BETWEEN SPECIFIED LIMITS"
PRINT "4. SCAN AUTO (1 TO 1024 INC 100)"
PRINT "5. SCAN BETWEEN SPECIFIED LIMITS"
PRINT "6. CLEAR ON ERROR (STOPS WHATEVER'S GOING ON)"
PRINT "7. MARK SPECIFIED PEAK"
PRINT "8. RESTART SCAN WHERE I LEFT OFF"
PRINT "9. INTEGRATE OVER SPECIFIED LIMITS"
PRINT "10. LOCATE PEAKS AUTO"
PRINT "11. DELETE A MARKED PEAK"
PRINT "12. LIST MARKED PEAKS (SHORT FORMAT)"
PRINT "13. ENERGY CALIBRATE"
PRINT "15. SORT PEAKS, DELETE DUPLICATIONS"
PRINT "16. INTEGRATE THE PRESENT PICTURE FRAME"
PRINT "17. LIST DATA OVER SPECIFIED LIMITS"
PRINT "18. LIST MARKED PEAKS (LONG FORMAT)"
PRINT "19. GO TO I/O PROGRAM"
PRINT "20. (GO TO STANDARD PEAKS LIBRARY, NOT YET)"
```

END

F

580

590

Y1=D(I)

22>>

600

610

N7=1

620

Y2=D(I)

23>>

630

NEXT I

640

PAGE

650

VIEWPORT 15,120,12,91

660

WINDOW N1,N2,Y1,Y2

670

T1=INT((N2-N1)/10)

680

G

G
690

$T3 = (N2 - N1) \times Y1$

700

YES
 $T1 > 1$

→ 25

24>>

710
720

$T1 = 1$
 $T3 = N2 - N1$

25>>

730
740

$T2 = \text{INT}((Y2 - Y1) / 10)$
 $T4 = 10$

750

YES
 $T2 > 1$

→ 26

760
770

$T2 = 1$
 $T4 = Y2 - Y1$

26>>

780
790

AXIS T1, T2
AXIS 0, 0, N2, Y2

800

FOR I=1 TO T3+1

810

MOVE T1*(I-1)+N1, Y1

H

```

820      PRINT "JHH";T1*(I-1)+N1
830      MOVE T1*(I-1)+N1,Y1
840      PRINT "JJHH";
850      PRINT USING "SD":E1*(N1+T1*(I-1))+E0
860      NEXT I
870      MOVE (N1+N2)/2,Y1
880      PRINT "JJHHHHHHCHANNEL(ENERGY)"
890      FOR I=1 TO T4+1
900      MOVE N1,T2*(I-1)+Y1
910      PRINT "HHHHH";T2*(I-1)+Y1
920      NEXT I
930      MOVE N1,(Y1+Y2)/2
940      PRINT "HHHHHHHKKK";
950      PRINT "C";"JH";

```

I

I
960
970
980
990
1000

```
PRINT "O"; "JB"  
PRINT "U"; "JB"  
PRINT "N"; "JB"  
PRINT "T"; "JB"  
PRINT "S"; "JB"
```

1010

MOVE N1,Y2

1020

PRINT "K1978:";F9;" ";J9;K9

1030

MOVE N1+(N2-N1)/3,Y2

1040

PRINT "KET = ";L9

1050

MOVE N1+(N2-N1)*2/3,Y2

1060

PRINT "KID = ";O9

1070

MOVE N1,Y1

1080

FOR I=N1 TO N2

1090

DRAW I,DCI

1100

NEXT I

1110

VIEWPORT 114,119,85,90

J

J
1120

WINDOW 0,20,0,20

1130
1140

AXIS
AXIS 0,0,20,20

1150

MOVE 1,20

1160
1170
1180
1190
1200

DRAW 1,1
DRAW 10,1
DRAW 12.5,4
DRAW 4,4
DRAW 4,20

1210

MOVE 5,20

1220
1230
1240
1250
1260

DRAW 5,5
DRAW 13.5,5
DRAW 16,8
DRAW 8,8
DRAW 8,20

1270

MOVE 9,20

1280
1290
1300
1310
1320

DRAW 9,9
DRAW 17.2,9
DRAW 20,12
DRAW 12,12
DRAW 12,20

K

P

U
2450
2460
2470
2480
2490
2500
2510
2520
2530
2540
2550
2560
U

U
2570
2580

PRINT "PEAKS IN ";I\$
PRINT "NUMBER","CHANNEL","ENERGY"

2590

J=0

55>

2600

NEXT I

2610

END

54>

56>

2620

PRINT "NO PEAKS LISTED"

2630

RETURN

16>

81>

2640

REN ... PEAKS LIST LONG

2650

PAGE

2660

P9=0

2670

PRINT "PEAKS IN ";I\$

W

M

2680

2690 ~~FOR~~ USI 2700:"NUMBER","CHANNEL","ENERGY","WIDTH","INTEGRAL","SIGMA"

2700 IMAGE 6A,2X,7A,2X,6A,2X,5A,2X,8A,2X,5A

2710

J=0

2720

FOR K=1 TO N9

2730

REM ... FIND LOWER BOUND

2740

X=P(K)

58>>

2750

N=X-1

2760

D(X)<D(X-1) YES >>57

2770

57>>

2780

N3=X

2790

REM ... FIND UPPER BOUND

X

Y

b

```

3270 67>>
3280 72>>
3290 12>>
3300 REM ... ENERGY CALIBRATE
3310 GOSUB 3570
3320 PRINT "LOW CHANNEL, ENERGY ";
3330 INPUT C5,E5
3340 PRINT "HIGH CHANNEL, ENERGY ";
3350 INPUT C6,E6
3360 E1=(E6-E5)/(C6-C5)
3370 E0=E6-E1*C6
3380 DELETE C5,C6,E5,E6
3390 PRINT "E0= ";E0;" , E1= ";E1
3400 END

```

C

BR#	FROM	TO	BR#	FROM	TO
1	4	100	34	1740	1379
2	11	530	35	1830	1850
3	13	470	36	1880	1930
4	17	3080	37	1910	1930
5	21	2980	38	1970	2000
6	29	1940	39	1980	2020
7	33	3140	40	1990	2050
8	37	1400	41	2010	1970
9	41	3460	42	2030	1970
10	45	2120	43	2060	2090
11	49	2430	44	2120	3570
12	53	3290	45	2150	2220
13	61	2230	46	2160	2210
14	65	1490	47	2170	2210
15	69	1650	48	2240	2350
16	73	2640	49	2250	2350
17	77	3400	50	2290	2330
18	81	2	51	2370	2420
19	100	170	52	2380	2410
20	100	3530	53	2400	2160
21	520	1370	54	2470	2620
22	580	600	55	2530	2600
23	600	630	56	2680	2620
24	680	710	57	2760	2780
25	700	730	58	2770	2750
26	750	780	59	2820	2840
27	1410	3570	60	2830	2810
28	1460	1510	61	2850	1520
29	1510	1370	62	2890	2960
30	1580	1600	63	2990	3570
31	1600	1640	64	3070	3110
32	1660	3570	65	3120	3140
33	1710	1740	66	3140	550

BR#	FROM	TO	BR#	FROM	TO
67	3170	3200	75	3300	3570
68	3180	3210	76	3410	3570
69	3190	3260	77	3450	2
70	3200	3230	78	3470	3570
71	3210	2040	79	3520	2
72	3230	3280	80	3550	2230
73	3250	3110	81	3560	2640
74	3270	3110	82	3570	3600

A
230

INPUT Z2

240

PRINT "LOWEST ACCEPTABLE SIGMA LEVEL: ";

250

INPUT Z3

260

22 < 1014 YES → 3

270

Z2 = 1014

3 >>

280

PRINT "PEAK SEARCH OF ";

18 >>

290

Z0 = Z1

5 >>

6 >>

16 >>

300

Z0 = Z0 + 1

310

Z0 >= Z2 YES → 4

B

C

410

420

430

440

450

460

470

480

490

500

510

D

BR#	FROM	TO	BR#	FROM	TO
1	4	100	11	420	440
2	200	220	12	430	400
3	260	280	13	500	520
4	310	670	14	520	560
5	320	300	15	540	580
6	330	300	16	570	300
7	370	400	17	620	650
8	380	400	18	640	290
9	390	350	19	710	2
10	410	440			

8

3610

PAGE

3620

PRINT "INSERT LIBRARY TAPE (RETURN)";

3630

INPUT I\$

3640

PRINT "LIBRARY FILE NUMBER: ";

3650

INPUT F

3660

FIND F+1

3670

FOR I=1 TO 15

3680

READ Q33IX

3690

NEXT I

3700

PRINT "QUADRANT (Q=ALL): ";

3710

INPUT Q

3720

PRINT "SUBTRAHEND FACTOR: ";

3730

INPUT F

A

BR#	FROM	TO	BR#	FROM	TO
1	3740	3930	3	3950	3870
2	3830	3870			