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TITLE	DIPDUB, A DUAL-INDEPENDENT PARAMETER, DOUBLE-PRECISION PULSE-HEIGHT ANALYSIS CODE
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DIPDUB, A DUAL-INDEPENDENT PARAMETER, DOUBLE-PRECISION PULSE-HEIGHT ANALYSIS CODE

DECUS Program Library Write-up | DECUS NO. 8-468

ABSTRACT

DIPDUB is a powerful, general-purpose pulse-height analysis (PHA) computer program written in assembly language. It is designed for those radiation physics applications where 255-channel resolution of energy spectra is adequate. A PDP-8/I* computer with extended memory is required for execution of the code. In order to fully utilize the features of this PHA code, the hardware must include two nuclear analog-to-digital converters, a fast paper tape read/punch unit, a DECtape* unit, and a DECwriter.*

The most significant features of DIPDUB are: (a) independent operation of 2 nuclear ADCs; (b) storage of 7 data regions in core; (c) DECtape storage capacity of 369 data blocks; (d) a very flexible data display section with linear, log, overlap, channel marking, and data-region identification; and (e) powerful spectrum stripping capability.

While the code may be useful to many installations in an unmodified form, some users may wish to make modifications to meet their specific requirements. This write-up includes a section describing core utilization and defining the most important of approximately 400 tags identifying various subroutines, pointers, variables, constants, and tables. To facilitate changes, a PDP-10 compilation and cross reference listing of the DIPDUB is available.

INTRODUCTION

In the field of radiation physics, pulse-height analysis (PHA) has been traditionally performed with the use of multichannel analyzers. Beginning with expensive, bulky, and highly unreliable instruments utilizing vacuum tubes, multichannel analyzers, over a period of two decades, have been developed into complex and reliable instruments (yet still expensive). The modern multichannel analyzer performs one (or several) function (s) well, but it is limited by its hard-wired construction.

With the advent of small computers, such as the Digital Equipment Corporation's PDP-8 series, the radiation physicist has a relatively inexpensive alternative to hard-wired devices. A computer-based data acquisition and analysis system, controlled by the proper software, can supply all the capability of a multichannel analyzer. More significant is the fact that a computer is infinitely more flexible, allowing an operator to modify pulse-height analysis software to suit his whim or to perform functions that are completely unrelated to physics (he might challenge the computer to a game of tic-tac-toe).

DIPDUB is a computer code for the specialized radiation physics problems associated with a whole-body counter. It is designed for use with radiation detectors such as NaI(Tl) crystal-photomultiplier tube assemblies where 255 channels provide sufficient peak resolution. This PHA code provides many useful functions including:

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*Digital Equipment Corporation

(a) Independent setup and control of two analog-to-digital convertors (ADCs).

(b) Seven 256-channel data regions in core.

(c) Storage capacity of 369 data blocks on a single DECtape with overwrite protection to prevent inadvertent destruction of valuable date previously stored on DECtape.

(d) Logarithmic display of any data region .

(e) Linear display of any data region in steps of 2 from full-scale of 8 counts/channel to 16,777,215 counts/channel.

(f) Background subtraction of any two data regions.

(g) Floating-point stripping of any fraction or multiple of one data region from another.

(h) Marker manipulation for channel identification.

(i) Integration between markers.

(j) Overlap display comparison of any two data regions.

HARDWARE CONFIGURATION

The DIPDUB computer program is designed for use with the following minimum hardware:

(a) PDP-8/I with 8K minimum core capacity (preferably with EAE and DECwriter).

(b) Fast paper tape read-punch unit.

(c) One DECtape transport (two preferably).

(d) PHA interface NK04-A.

(e) Two ADCs (Northern Scientific NS-629 and dual parameter control with live time clocks, NS-641 are recommended).

(f) Oscilloscope (Tektronix RM-503 will work with DEC type 34D control).

(g) Radiation detectors and associated electronics.

COMMAND STRUCTURE

Summary of Commands

Table 1 is a list of the 21 commands with a brief description of their functions.

TABLE 1

DIPDUB COMMANDS

COMMAND*	DESCRIPTION
Z	Zero the displayed data region.
XA	Disable ADC A.
XB	Disable ADC B.
Wn	Write the displayed data region using DECtape Transport 1 onto data block (n) ($0 \leq n \leq 368$).
T	Type the data between the markers of the displayed data region.
Sab or Sa,b	Strip data region (a) from data region (b).
Rn	Read DECtape data block (n) and display it ($0 \leq n \leq 368$).
Qa	Swap the data in the displayed region with that in data reg on (a).
P	Punch a binary tape of the displayed date region with the high speed paper tape punch.
Oab or Oa,b	Overlap and display data regions (a) and (b).
Mp,q**	Place vertical channel markers in channels (p) and (q).
MpK	Place lower marker in channel number p ($p<q$). (K) is any character except return, comma, or space.
L	Change the display from linear to logarithmic.
Ip,q**	Integrate between the markers (p) and (q).
EAa ↓	Enable ADC A and put the counts into data region (a).
EBa ↓	Enable ADC B and put the counts into data region (a).
CAx ↓	Set the clock for ADC A for (x) pulses ($1 \leq x \leq 16,777,215$).
CBx ↓	Set the clock for ADC B for (x) pulses ($1 \leq x \leq 16,777,215$).

* A carriage return must terminate each command string. Spaces within command strings are optional (e.g., Sab = S a b = S, a, b).

** A non-numeric character (other than a space) must separate p and q.

TABLE 1 (Cont'd)

COMMAND	DESCRIPTION
Bab or Ba,b ↲	Subtract data region (a) from data region (b).
ACL7DT ↲	Zero all the regions on the DECtape.
Display Commands	**Detailed Description of Commands**
Da ↲	Display the data stored in data region (a) where $1 \leq a \leq 7$. The number of counts full-scale is set with switches 7--11 of the switch register giving 26 ranges from full-scale of 8 counts/channel to 16,777,215 counts/channel in steps differing by a factor of 2. Region (a) is identified by number on the display. Dots mark each tenth channel position along the top and near the bottom of the display.
Oab ↲	Overlap the displays of data regions (a) and (b) ($1\leq a \leq 7$; $1\leq b \leq 7$). Region (b) is identified by number on the display.
L ↲	Compute the natural logarithm of the data in the region displayed. Store the logarithms in data region 7 and switch the display to 7.
Mp,q ↲	Place vertical channel markers in channels (p) and (q) ($1\leq p\leq q\leq 255$). A non-numeric character (other than a space or carriage return) must separate (p) and (q).
M	Place the lower marker at 1 and the upper marker at 255.
MpK	Place the lower marker at (p) (p< q and K is any non-numeric character except a carriage return, comma, or space).
Data Manipulation	
Z	Zero the data region being displayed (the ID number appears at the upper right-hand corner of the display).
Ip,q	Integrate the data between channels (p) and (q) in the data region displayed and type the result. After execution, the markers appear in channels (p) and (q). A non-numeric character (other than a space or carriage return) must separate (p) and (q).
I	Place the markers in channels 1 and 255, integrate the entire data region displayed, and type the result.
Bab	Subtract the data in region (a) and region (b), store the difference in data region 7, and switch the display to 7. In channels where the difference is negative, a zero is substituted so that a dot is displayed at the bottom of the scope.

Sab — Strip a fraction or multiple of the data in region (a) from the data in region (b), store the difference in 7 and switch the display to 7. In response to "FACTOR = " the operator must type the number (F) by which the data in region (a) is to be multiplied before subtracting the product from the data in region (b). This number must be in standard floating point format, e.g.,

± 5.38
±53.8 E-1
±.538 E+1

A negative input factor (-F) indicates (b + F*a), and a positive input factor indicates the normal stripping computation of (b - F*a).

Qa — Load the data from the displayed region into region (a) and place the data in region (a) into the displayed data region.

Clock Commands

CAx ↲ — Set the clock for ADC A for (x) pulses ($1 \leq x \leq 16{,}777{,}215$).

CBx ↲ — Set B clock.

The Northern Scientific NS-629 ADC's have the option for elapsed time mode, but in quantitative radiation-counting applications, the live time mode has more practical significance. At a clock oscillator frequency of 1000/sec, the live time range is:

10^{-3} minutes	minimum
279.62 hours	maximum

This range and precision is more than adequate for most counting applications.

Data Acquisition Commands

EAa ↲ — Enable ADC A for sorting of counts into date region (a) ($1 \leq a \leq 7$).

EBa ↲ — Enable ADC B.

The respective clock need not be reset by command prior to an enable command. The clock is automatically reset to the value fixed by the last clock command.

XA ↲ — Disable ADC A.

XB ↲ — Disable ADC B.

Date Input/Output Commands

ACL7DT ↲ — Initialize a DECtape for use by the DIPDUB code.

This command should be used to clear a data tape to prevent spurious overwrite flag at every write command. The "ACL7DT" command string is meant to be relatively accident proof since this particular combination of characters could hardly be entered inadvertently. Prior to giving this command, the data regions 1--6 must be zeroed with successive (Z) commands, i.e., D1; Z; D2; Z; D3; Z; ---.

This command does not operate the DECtape transport efficiently, but streamlining was thought unnecessary since the command would be executed infrequently, and execution requires less than 30 seconds.

Wn ↲ — Write the displayed data region onto DECtape data block (n) ($0 \leq n \leq 368$).

Transport 1 must be identified and write-enabled. If the DECtape has been initialized with the "ACL7DT" command, the first Wn command will proceed with no interruption. If the DECtape has not been cleared properly or if data has been written into block (n) by a previous (W) command, the message "OVERWRITE FLAG" will be typed and the computer will halt. If the command is correct, the operator must set the switch register to 00008 and press the CONTINUE switch. The original data will be replaced by data in the region being displayed on the oscilloscope. If upon checking the command is seen to be in error, the execution can be aborted by pressing CONTINUE with at least one switch of the switch register turned on (in normal operation the SR will seldom be 0000 incidentally).

Rn ↲ — Read the data stored on DECtape data block (n) into core in the displayed data region. Transport 1 must be identified and $0 \leq n \leq 368$.

The data originally in core in the data region being displayed <u>will be destroyed</u>.

P ↲ — Punch the data in the displayed data region onto paper tape in binary format using the fast paper tape unit.

Any data region 1--7 may be punched. When the data are read back into core using the BIN loader, the data will always be entered into data region 7 regardless of the original data region. Field 1 must be specified on the switch register when the BIN loader is called (SR = 1B7777, Load address; SR = 3777, start where B is the field where the BIN loader is being executed).

T ↲ Type the counts in the channels between the markers (inclusive) onto the DECwriter.

The first channel to be typed on each line is identified by a channel number. Leading zeros are suppressed for appearance. In cases of zero counts in a channel, a single 0 is printed in the least significant digit position for that channel.

Ip,q ↲ Integrate all the counts in the channels between the markers (p--q inclusive) and type on the DECwriter.

As for the mark command a non-numeric character (other than a space or carriage return) must separate (p) and (q). After execution, the markers are positioned in (p) and (q) to provide a visual check on the accuracy of the command string.

I ↲ The markers are positioned at 1 and 255 and the integral is typed on the DECwriter.

Limitation of Commands During ADC Operation

Due to the design of the interrupt service routine, the input/output commands may not work as expected. If an ADC is enabled, the DECtape commands (W) and (R), the type command (T), and the punch command (P) will not be honored and an error message will be typed. The ADC disable commands (XA) and/or (XB) can be given to halt data acquisition or the operator can elect to wait for normal time out to occur prior to giving (W), (R), (T), or (P) commands.

All the other routine commands will execute normally. However, in the case of the (L) and (S) commands, which require a number of seconds for execution, the ADC's will be temporarily ignored. These commands should be avoided whenever the dead time during data acquisition should be minimized for some operational reason.

Limitation of Commands During I/O Operations

After giving a DECtape command (W) or (R), a type command (T), or a punch command (P), the operator should not attempt to give additional commands until the I/O execution is complete. Execution will be terminated by this operator action. The operator may deliberately terminate an I/O operation, e.g., an extensive and unnecessary data printout can be stopped rather conveniently in this manner.

PROCEDURES FOR PROGRAM LOADING AND EXECUTION

Hardware Setup

1. Set up radiation detection system with proper detectors, HV and signal cables, preamplifiers, amplifiers, HV supply (leave HV off until connections are complete), and special purpose electronics.

2. Turn power on:

a. Computer console power switch key

b. DECwriter (or teletype) to LINE

c. All ORTEC NIM bins

d. Oscilloscope PWR. to ON (make sure that the intensity knob is turned fully counterclockwise to the OFF position).

e. HV supply (after checking to see that the HV setting does not exceed the normal operating level of the detector system).

3. Check ADC's and Two Parameter Adapter. Typical control settings are:

a. ADC zero level -- 0.50 x 10%

b. Conversion gain -- 256

c. Anticoincidence mode

d. ADC input select -- bipolar (input from amplified)

e. Analyze mode

f. Group size -- 256; digital gate switches off

g. SCA LLD -- approximately 1 x 10% if this pot is set too low, all ADC output is blocked

h. Mode switch -- X + Y

i. Clock -- INT (internal)

j. Time -- LIVE

k. Cts/Min -- 1000

l. ADC-memory configuration -- all (Y) bits jumpered to corresponding (M) bits, i.e., Y0-M0, Y1-M1, Y2-M2, --- , Y12-M12

Loading from Binary Paper Tape

To load DIPDUB into core from binary paper tape:

1. Insert tape in fast paper tape reader

2. Set console switches to 027777 for referencing the BIN loaded resident in FIELD 2 (Data Field = 0, Instruction Field = 2, and SR = 7777)

3. Depress LOAD ADD

4. Change bit 0 of the switch register to 0 (the switch register should now contain 3777)

5. Depress START

6. The tape has two sections. The PTR will stop at the end of the first section. Press START again and in a few seconds CONT to feed past the leader section and complete the loading of the final section of the paper tape

Execution

1. Set switches to the starting address of 200

Data Field	=	0
Instruction Field	=	0
Switch Register	=	0200

2. Depress LOAD and START switches in that order

3. The DECwriter will respond with a carriage return-line feed

4. Type D and increase the oscilloscope intensity for comfortable viewing

5. Type Z to clear the data region

SUGGESTIONS FOR EFFICIENT UTILIZATION

Command Sequences

The computer operator will quickly develop proficiency in the manipulation of DIPDUB commands. The short versions of the command strings can be used in many situations. Several particularly useful sequences are given in the following examples.

1. Energy calibration:

a. Load tape; start at 0200.

b. (D1) Display Data Region 1.

c. (Z) Clear.

d. M51, 128 Set markers in channels 51 and 128 for a calibration of 10 keV/channel with ^{22}Na total-energy peaks appearing in channels 51.6 and 128.

e. EA1 Enable ADC A to analyze and deposit data in Region 1. The Region 1 specification need not be repeated with subsequent EA commands.

f. Adjust HV or amplifier gain and/or zero.

(Z).

Continue this sequence of adjustments followed by the command (Z) until the calibration is set properly. Notice that EA need not be repeated until the live count is started.

2. Take a 30-minute count and store on DECtape block 17:

a. (XA) Terminate calibration.

b. (Z) Clear Data Region 1.

c. (CA30000) Set ADC clock A to 30 minutes.

d. Prepare for count (remove calibration scource, place sample, etc.).

e. (EA) Start count.

f. (M) Expand markers.

g. Adjust SR to obtain convenient display.

h. (W17) After count times out, store data on DECtape block 17 on transport 1.

DECtape Storage

The large storage capacity of a DECtape makes accurate and convenient identification of the 369 data blocks mandatory. A separate identification folder can be maintained for each DECtape. It is recommended that the first 10 data blocks of each DECtape be kept free for use as temporary storage prior to either discarding or assignment to a permanent storage block.

Consideration should be given to the maintenance of a backup DECtape that could be updated at regular intervals. The majority of the data blocks would always be duplicated at the time of a human error or a hardware malfunction.

The availability of two DECtape transports provides a convenient means for having ready accessibility to calibration and analysis data stored on one tape and general data stored on a second tape. The transport being referenced must be set to identification number 1 and the standby transport set to OFF LINE (or any number but 1).

Conversion from 256-Channel Configuration to 512-Channel Configuration

While the DIPDUB program is intended primarily for use in PHA applications where 255 channels provide sufficient energy resolution, by changing the number in a single location, 512 channels of data can be recorded. However, data display and manipulations must still be executed in 256-channel sections. The changes are as follows:

1. Computer location 1366 in Field 0 should contain:

256-channel configuration--0377
512-channel configuration--0777

2. ADC Group Size and Conversion Gain switches should both be set to 512 for the 512-channel configuration.

Channel 256 cannot be displayed and is unavailable for data storage in either 256 or 512 mode because the live time is recorded there. In 512-channel configuration, a 1-channel void will occur at channel 256.

SOFTWARE MAINTENANCE SUMMARY

The information given in this section may be used in conjunction with a listing and a source file to tailor the DIPDUB PHA code to the specific requirements at other installations.

General Information

The general outline of the core allocations is given in Table 2.

Specific Information

A page-by-page description of the major blocks of coding is given in this section. Symbolic name tags are identified when this information could be particularly useful in tracing. All numbers are octal.

Interrupt Service Routine *0

0--5; 20--37; 63--65

Whenever an interrupt request occurs, the AC and Link are saved and peripheral devices are tested in the following order: DECtape, ADC A clock, ADC B clock, ADC A data, ADC B data, printer, fast PTP, and keyboard. After servicing the device requesting the interrupt, a JMP CONTIN command restores AC, Link, and Memory Field, turns the interrupt back on and returns to the background program (normally the display routine) through a JMP I O command.

Auto Index Registers *10

10--17

Extensive use is made of these eight autoindex registers for programming efficiency.

Page 0 Constants and Pointers *105

105--177

Frequently used constants, subroutine pointers, and table pointers are stored in these locations.

Program Starting Address *200

BEGIN,

Upon LOAD ADDRESS and START the printer and keyboard flags are cleared, the memory registers are set to data field 0, instruction field 0, a carriage return and line feed are performed and the code is ready for the first command, which should be a display command.

STTCOM,	Sets up the command buffer pushup list, BUFAD, for storage of a new command string.
DECODE,	Controls keyboard reading and loading of command string into the pushup list.
CMMAND,	Identifies the command letter and jumps to the proper routine.
SAVACL,	Saves the AC and Link upon an interrupt request.
RESACL,	Restores the AC and Link upon exit from an interrupt service.
RDCHK,	Loads the register CHAR with command characters one at a time. Only significant characters are returned in CHAR. Spaces and commas are ignored.

<u>Data Region Identification *400</u>

ORIGIN,	Identifies the data region requested in a command string, and returns the starting address of the data region in the register SETING.

<u>Zero Data Region Being Displayed</u>

ZERO	Resets all channels in the data region being displayed.

<u>Background Subtract Routine</u>

BKG,	Performs an unweighted subtraction of the first data region from the second data region specified in the command string.

<u>Display Routine *600</u>

DSPLAY,	This is the primary background program. It controls the display of data in any one or two data regions with the vertical scale being determined from the SR bits 7, 8, 9, 10 and 11.
DISDR7,	Sets up the display switch to data region 7 at the end of execution of the (B), (S) and (L) commands.

<u>Type Routine *1000</u>

TYPE,	Identifies the data region being displayed, determines the starting and stopping channels from the marker positions, loads channel data and calls output routine.
PNTDEC,	Routine for printing decimal integers on the DECwriter. It references the entries in TABLE 3 to convert the double precision binary data in registers HIGH and LOW to the decimal equivalent.

ADC Service Routines *1200

ADATA,	Section to read a channel address from ADC A, convert it to the proper location in Field 1, and increment that location.
BDATA,	Similar service for ADC B.
DSABLE,	Upon an XA or XB command the ADC being referenced is identified and disabled.
CLKFLA,	Disables ADC A when the clock has timed out, then jumps to FULL for the correct message.
CLKFLB,	Similar treatment for B clock full.
CRCHK,	Checks a command string for a carriage return and indicates an error if some other character was entered by the operator.

Marker Routine *1400

MARK,	Calls marker routine MARKI.
MARKI,	Calls decimal number input routine to determine binary equivalent for the lower and upper markers if specified, checks the validity of the marker input.

Integration Routine

INTEG,	Calls MARKI for limits of integration, sums the contents of the channels between the markers, and calls the decimal number output routine PNTDEC.

Overlap Routine

OVRLAP,	Identifies the data regions to be displayed and loads the respective starting addresses (-1) in register OVRLP and DISZRO.

Clock Service Routines *1600

CLKLD,	After a CA or CB command, the proper ADC clock is set by calling either CLKA or CLKB to load the permanent clock registers CLKA1, CLKA2, or CLKB1, CLKB2.

Increment Clocks

ICLKA,	Upon a clock pulse, A clock is incremented and tested for an overflow.
ICLKB,	Similar function for B clock.

Enable ADC's

ENABLE,	After an EA or EB command, the proper ADC is enabled after first resetting the temporary clock registers CKA1, CKA2, or CKB1, CKB2 from the permanent clock registers.

Read Decimal Input from Keyboard *2000

RDIN,	Decodes the keyboard input and converts it to its binary equivalent. It exits with the binary number in OVFL and ADDR.

Fix the Maximum Display Scale *2200

S0,S1,--S25	Coding sections called after interrogation of the SR to display the proper bits from the 24 bits of double-precision data in the data region being displayed.
PTIME,	Convert the live time pulses to a decimal integer, insert a decimal between the 3rd and 4th significant digit, and print the time in minutes. (Will operate correctly only when clock rate is 1000 pulses/minute.)

Binary Punch Routine *2600

PUNCH,	Identify data region and punch the data in binary format using the fast paper tape punch.
BINPCH,	Routine called by PUNCH for punching the bits in the AC in two 6-bit rows.
CHECK,	Routine for computing the checksum to be punched at the end of the tape.
DECTM,	Called by PTIME, this subroutine modifies the subroutine PNTPEC in order to load a decimal print matrix PNTTM for printing the time.

Dectape I/O Routines *3000

READDT,	Referenced after R command to control DECtape reading.
WRITE,	Referenced after W command to control DECtape writing.
WRT1,	Execute a write.
SETUP,	Secure the contents of the Program Counter, AC, and Link to be reset by RESTOR prior to return through CONTIN after command execution.
EXEQ,	Call the DECtape handler after setup of the read or write function.

OVRWRT,	Causes a computer halt if an overwrite has been requested through a W command.

DECtape Handler DEC-08-SUCO-PA *3200

DIS = CONLNK	Defines the indirect linkage to CONTIN
DTERR = ERRLNK	Defines the indirect linkage to ER2

Initialize a DECtape for Data Storage *3400

ACLEAR,	Controls the storage of zeros on the DECtape after an ACL7DT command.

Log Display *3600

LOGDIS,	Controls the use of the Floating Point Package #3 (with EAE) for conversion of linear data in the displayed data region to logarithmic data to be put in Data Region 7.
FIXFAC,	Converts the value in the floating AC to a 10-digit integer for display.
FLOAT,	Converts a double-precision integer from the displayed data region into a real number in the floating AC.

Spectrum Stripping Routine *4000

STRIP,	Controls the use of the floating point packages for input of a real number for use as a factor to multiply one data region and subsequent subtraction from the second data region.
INLOOP,	Check for valid input of a real number.
FLTCAL,	Converts data in first region from a double-precision integer to a real number in the floating AC.
FLTGRS,	Similar conversion for the second data region specified in the S command.
MESAGE,	Print the text fixed in a table.

Data Region Identification for Display *4200

ID,	Identify data region being displayed, determine the proper number matrix address in TABL11, fill the display matrix and call MATDIS.
MATDIS,	Display the matrix bit by bit in each of the 3 words.

FIXLIN,	Convert the number currently in the floating accumulator to a double precision integer and load it into the proper data channels.

<u>Storage of all Tables *4400</u>

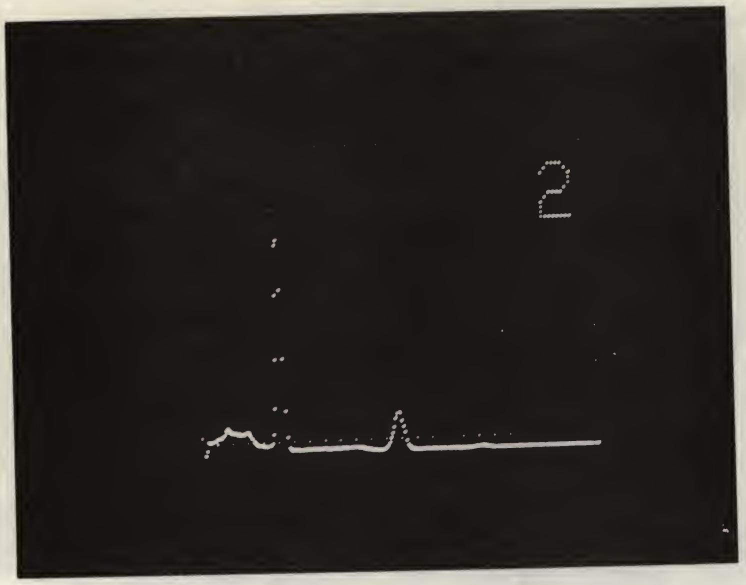
TABLE1,	Pointer to all the command routines.
TABLE2,	Command decoder based on the ASCII code for the initial command letters.
TABLE3,	Double precision storage of successively lower powers of ten in their octal equivalent.
TABLE4,	Text for CHANNEL OVERFLOW message.
TABLE5,	Pointers to the display scaling loaders.
TABLE6,	Text for CLOCK FULL message.
TABLE7,	Command string check for ACL7DT.
TABLE8,	Text for OVERWRITE FLAG message.
TABLE9,	Text for FACTOR request in the stripping routine.
TABL10,	Text for ERROR message.
TABL11,	Number matrix pointers.
MATRIX,	Display matrix.
ID1, ---	Number matrices for 7 numbers.
BUFAD,	Command string input buffer.
TMP,	Temporary link to error routine from command pointer table. This could be used to identify an additional command routine.

TABLE2

MEMORY REQUIREMENTS OF DIPDUB

Field	Location*	Description
0	0000--3177 3400--4756	Author's coding
0	3200--3377	Digital Equipment-supplied DECtape handler DEC-08-SUCO-PA
0	7; 40-61; 4757-7577	Digital Equipment-supplied Floating Point Package #3 DIGITAL-8-25-F-BIN
0	7600-7777	Loaders (RIM, BIN)
1	600-1577	Data Region 1
1	1600-2577	Data Region 2
1	2600-3577	Data Region 3
1	3600-4577	Data Region 4
1	4600-5577	Data Region 5
1	5600-6577	Data Region 6
1	6600-7577	Date Region 7
1	7600-7777	Loaders (RIM, BIN)

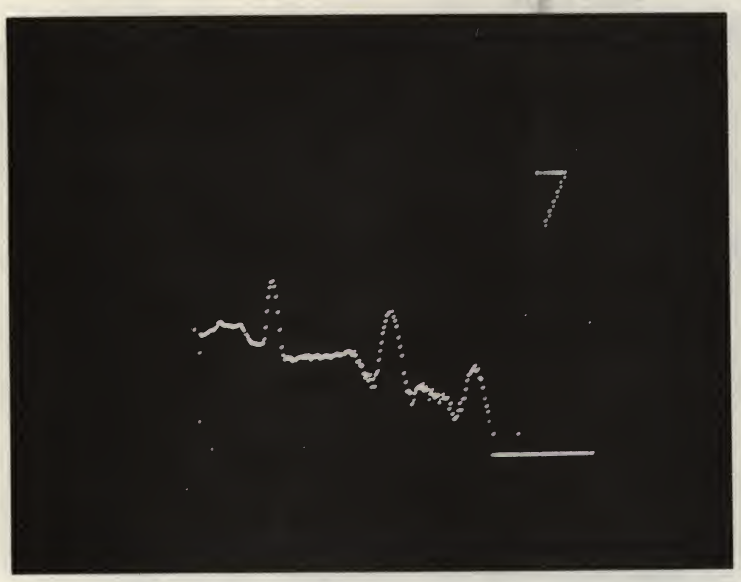
* Octal



Sodium-22 Energy Spectrum

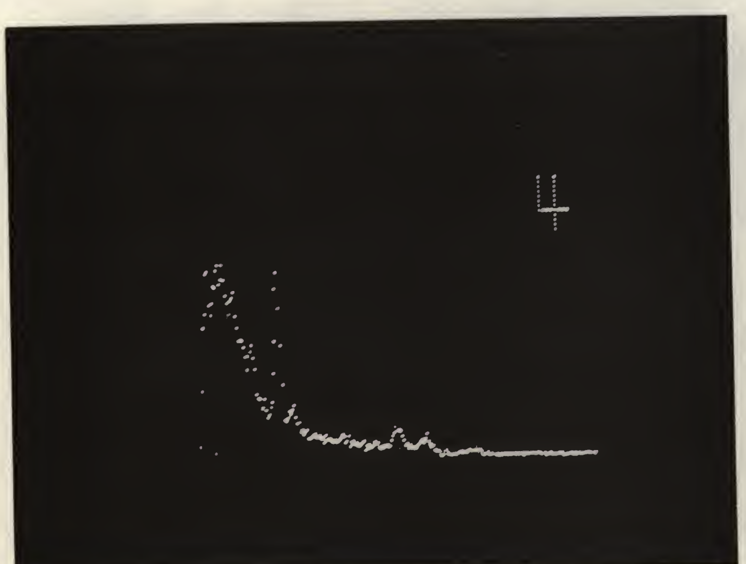
Linear Display

10 keV/Channel



Logarithmic Display of

Data Region 2



Typical Sample Count