Internal Report #57

VARIAN SOFTWARE FOR PACE SYSTEM

by

Frank Marshall

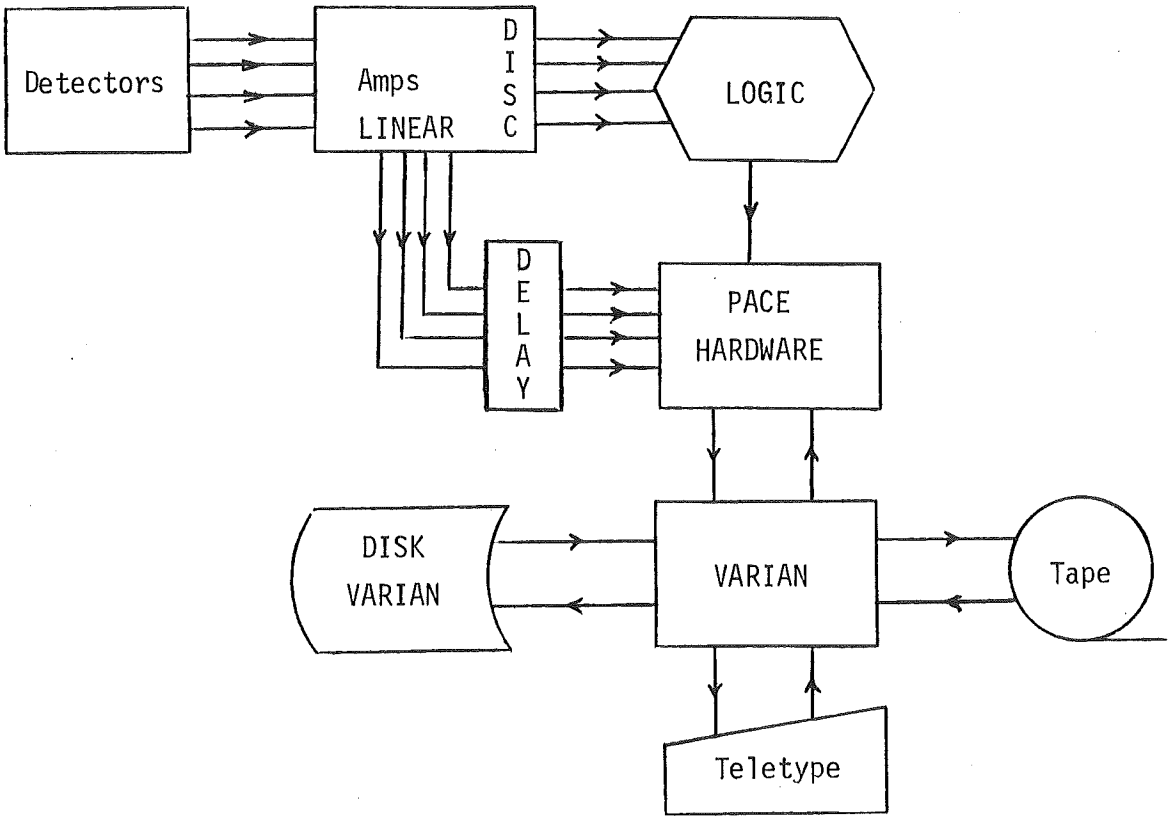
May 1974

TABLE OF CONTENTS

INTRODUCTION

The PACE* system is a computer-controlled data acquisition system. It has the capability of pulse-height analyzing as many as 8 detector signals that fire simultaneously. The PACE hardware can analyze a single pulse in about 5usec. It has 8192 channels, although only 2048 are currently used. The signature of events that are to be analyzed must be defined using external logic. A detailed description of the PACE hardware can be found in the Tennelec PACE Manual.

A block diagram for the entire computerized PACE system is shown below:



* An acronym for Pulsed Analog-to-digital Converter and Encoding system.

The flow of data for an analyzed event proceeds as follows. After examining the amplifiers' discriminator outputs, the logic sends an event pulse to the PACE hardware. PACE then accepts the delayed linear output of the amplifiers and stores their peak pulse heights. PACE then serially converts these analog signals to digital pulse heights and sends the data to the Varian. This digital data is eventually stored on magnetic tape. An operator controls the system using the teletype.

The remainder of this report describes the various computer programs available to handle and analyze PACE data. These programs are stored on the first physical file of tapes labeled 'PAC---' where '---' represents a 3 digit number. The scheme for loading these programs into the Varian is explained in L. C. Widdoes' Master Routine #2 write-up. Two of these programs may also be stored in a second Varian used as a disk.

THRESHOLD PROGRAM

PURPOSE: This is a calibration program for the PACE system that compares test pulse heights for a selected detector to a pulse height selected by the operator. The results are shown using the two Varian overflow lights. At the end of a run the total number of events high and low along with the mean and sigma of the test pulse height distribution is printed on the teletype.

TO START: All sense switches on the Varian should be off (up). The run switch of the PACE controller should be on and all detectors should be in the coincidence mode. The starting address is $08B3. The program does not use magnetic tape.

INPUT: All numbers input to this program are decimal integers. The integer may be signed or unsigned. It must have less than 10 digits and be terminated with a space. Errors while inputting integers cause the computer to print '?'. The computer then awaits another attempt.

TO RUN: The program runs by executing subroutines selected by the operator. The operator identifies which subroutine by typing an identifying letter after the computer types '.' If an invalid letter is typed, the computer asks for a valid letter by typing another '.' The valid letters and the corresponding subroutines are listed below:

C COMMENTS. The computer will echo anything input from the teletype until the character '!' is encountered. This character causes a return to the command loop.

M The computer branches to the MASTER Routine.

S SET UP. The computer asks which detector to calibrate. The detector is identified by a decimal integer from 0 to 7. The computer then asks what spread of test pulse heights are acceptable. If zero is input, any test pulse height will be accepted. Otherwise, if the absolute value of the difference between the pulse height selected by the operator (using the 'T' command) and the test pulse height is greater than or equal to the spread, the event will be rejected. Rejected events do not contribute to the number high or low or the mean or sigma of the pulse height distribution.
In addition, rejected events do not light either overflow light. The purpose of the spread feature is to reject events that are not produced by test pulses.
An example of the set up command is shown below. Detector 0 is to be calibrated. A spread of 25 is chosen.

```
.S
DET = 0
SPREAD=+- 25
.
```

T THRESHOLD. This command is used to actually take the data points. The computer asks for the comparator pulse height. The pulse heights range from 0 to 2047 with overflows figured as channel 2048. The number of events to take is then input. Rejected events are not included for this number. The prograam does not check for bad IDs.
Typing any character of the teletype while data is being taken stops data acquisition. A summary of the data that was taken is then printed.
An example of the 'T' command is shown below. Channel 2000 was used as the comparator. One hundred events were taken. The results were then printed.

```
.THRESH.=2000
 NO. = 100
8 OF 100 LOW.  0 REJECTED.
MEAN = +01999.680  +- +0.3838952  CHANNELS
SIGMA = +03.838956
.
```

Z This command allows the operator to reject events in which the ZERO data flag is true. This indicates the detector did not fire or that the PACE system did not analyze the detector for that event. The computer asks if it is to reject zero pulse heights. A response of 'Y' is taken as affirmative. Any other response is taken as negative. Regardless of the response, if the detector has fired and been analyzed, but the ADC produces channel 0, the event will be included. Program begins by executing this command without operator requesting it.

PRIORITIES:

Any subroutine can be called at any time. Changes (e.g. which detector to calibrate) remain in effect until the subroutine is called again (unless an error occurs, see ERRORS). The program initializes itself to read detector 0 and has a spread of zero.

Events that are rejected because of a zero data flag do not light overflow lights or show up in any total.
Events that are rejected because they fall outside the acceptable spread do not light overflow lights, are not included in the number of events high or low or in the mean or sigma of the pulse height distribution, but are totalled at the end of the run.

OPTIONS: If sense switch 1 is on, the overflow lights will light but the events will not be included in any total. The overflow

lights will light even if the event is outside the acceptable spread.

ERRORS: Errors that cause the bell on the teletype to ring and print an error message restart the program. Thus detector 0 is selected and the spread is 0.
Setting the comparator channel to a value very different from the mean of the test pulse height distribtuion may cause errors in computing the sigma of the test pulse height distribution.

OUTPUT: The computer sets one of its two overflow lights depending on the comparison of the event pulse height to the comparator channel. The light remains on until the processing of another event begins. If the event pulse height is smaller than the comparator, O_1 is turned on. Otherwise O_2 is turned on.
At the end of a run, the total number of events low, the total number accepted, and the total number rejected due to spread are printed. The mean and sigma of the accepted pulse height distribution is also printed.
The mean should be interpreted as follows. If a test pulse corresponding to 10 MeV produces a mean of 950.0, then the average energy of all events with a pulse height of 950 is 10 MeV.

RATES: The maximum rate at which events can be analyzed is about 300/second. Events that occur before the computer is ready to read them are purged.

PACE PROGRAM

PURPOSE: This program puts data produced by the PACE system on magnetic tape for later analysis. It also enables the operator to write header and trailer records, select data file lengths, list event in real-time, print data from the magnetic tape on the teletype after it has been written, and produce a limited amount of real-time analysis.

TO START: The start address is $0700. The command loop begins at $0703. All sense switches should be off (up). The PACE system run switch should be on. All PACE detectors should be in the coincidence mode.

GENERAL RULES:

Numbers should be input from the teletype according to these rules:

1. All numbers are hexadecimal.
2. All numbers are unsigned.
3. There must be less than 9 digits.
4. Numbers must be terminated with a space.
5. The number must not have more significant digits than the computer expects.
6. If any of the above rules are violated, the computer types '?' and awaits a new attempt. This feature can be used to change an input by typing an invalid character.

The files on the magnetic tape are numbered starting with $0. The first physical file (FN $0) is a program file and should not be written on. Records within a file are numbered sequentially starting with $0. The first record of a data file (RN $0) is the header record. The last record of each data file is the trailer record. Care must be taken that the data is written on the desired file. The PACE tape format is given in more detail in Appendix 1.

COMMANDS: The PACE system is controlled by the operator issueing one of the following commands. When the computer is ready to accept a command, it types a ':' on the teletype and awaits a two letter command followed by a '.' The possible commands are:

IN. INITIALIZE the program. The program begins by executing this command without the operator requesting it. This command initializes various program constants, sets up buffer areas, and puts the computer is the interruptible environment. The computer requests a file number to which it positions the magnetic tape. This is to prevent accidentally writing on the program file.

OP. OPEN a data file. The computer prints the current file number. This is the current tape position. The program then requests the number of events per data record. The maximum number acceptable is $BC. However the maximum size that can be used by the PACE PLOT porgram is only $80. Thus if $A0 events per record are written only 80% can be analyzed by PACE PLOT. The computer then asks which detector to real-time pulse height analyze. Finally there are three comment fields, each terminated with a '!'. The fields are labelled 'DATE & TIME', 'DET. CODE', and 'COMMENTS'. The total number of characters in the comment fields is about 240 (decimal); the characters may be divided among the three fields in any fashion desired. There are two special characters for the comment fields: '←' restarts the fields, while '↑C' returns to the command loop without opening the file. The header record is verified by typing 'Y' when requested. This writes the header record on magnetic tape and competes the file opening. If the header is not verified (by typing any character but 'Y') an error is generated and control returns to the command loop. In this case, the file remains closed, and the header is not written on tape.
An example of the OP. command is shown below.

```
*
FN=1
:OP.
FN=$0001
#EVNTS/REC=$80
PHA DETECTOR $1
DATE & TIME:4-24-74!
DET.CODE :←
DATE & TIME:4-25-74!
DET.CODE :!
COMMENTS:!
VERIFY:Y
:
```

GO. Take data. The computer first requests the number of data records to write. If $0 is input, the program will run until halted manually. Otherwise control returns to the command loop after the requested number of data records have been written. The GO command can be halted by two means. Typing any character on the teletype will cause an immediate return to the command loop; data in the current data record will not be written on tape. The other method is turning Switch 3 on. If Switch 3 is on, the program returns to the command loop after the next

data record is written. With either method only complete data records are ever written. After asking for the number of data records, the computer checks Switch 1. If it is on the computer restarts the real-time analysis and asks which detector to analyze. If Switch 1 is off, the real-time analysis is merely continued.

While taking data the computer will list a sampling of events on the teletype. This listing will be suppressed if Sense Switch 2 is on. This activity has a lower priority than taking data or writing data on tape. Hence at high event rate very few events will be listed. One line on the teletype corresponds to one event. The line is first formatted by the computer and then printed as time is available. Thus an event may be printing that was written on tape several records ago. After an event has been printed, the computer awaits a new event before formatting a new line. The teletype can list about one event every 4 seconds.

Each teletype line gives the data for one event. There are eight groups of symbols per line corresponding to Detector 0 through Detector 7 reading from left to right. Each group gives the data for its detector in the following format where 'x' represents a hexadecimal digit.

--x	ID bits for this detector are incorrect. 'x' is the detector ID produced by PACE.
xxx	The detector's pulse height
***	The pulse height produced an overflow.
...	Detector did not fire.

An example of the GO command follows. In the first event listed only Detector 0 and Detector 7 fired. They had pulse heights of $6D0 and $6B9 respectively. The correct ID was produced for every detector.

```
GO.
#,REC=$2
6D0 ... ... ... ... ... ... 6B9
6CF ... ... ... ... ... ... 6B8
6CD ... ... ... ... ... ... 6B7
6D0 ... ... ... ... ... ... 6B9
6CE ... ... ... ... ... ... 6B8
6D1 ... ... ... ... ... ... 6BB
6D0 ... ... ... ... ... ... 6BA
6D2 ... ... ... ... ... ... 6BC
6CF ... ... ... ... ... ... 6B9
6CF ... ... ... ... ... ... 6B9
:
```

CL. CLOSE the current data file. The computer prints the current file and record numbers on the teletype, asks for comments for the trailer record as it did for the header record, and writes the trailer record and End-of-File if verified. Otherwise, the error exit is taken. The record number printed is the number of the trailer record; it is one more than the number of data records in the file. An example of the CL command follows.

```
 CL.
FN=$0001   RN =$0001
DATE & TIME:4-25-74; 13:00!
DET.CODE :[↑C]
:CL.
FN=$0001   RN =$0001
DATE & TIME:13:00 4-25-74!
DET.CODE :!
COMMENTS:TEST!
VERIFY:Y
:
```

SK. SKIP to the beginning of the requested file. Do NOT request File $0.

SL. SELECT the Tape Unit. This command is used to turn on the tape unit after an error has occurred. The computer cannot read or write tape unless the tape unit is selected (indicated by a light on the tape unit). If the error that deselected the tape unit occurred while the tape was moving, the tape should be rewound to the load point in order to insure that the computer has not lost track of the file number.

DM. DUMP the requested file and records on the teletype. The computer asks the number of events per data record. If there are fewer records in the file than a record number requested, the computer will read into the next file. If this happens, the computer may lose track of the file number. After executing this command, the tape must be repositioned using the SK command. Events are dumped using the same format used to list events real time. An example of the DM command follows.

```
DM.

FN=1
RNS $1  - $1
#EVNTS/REC=$10

FN,RN=$00010001
6D0 ... ... ... ... ... ... 6B9
6D1 ... ... ... ... ... ... 6BB
6CE ... ... ... ... ... ... 6B8
6CF ... ... ... ... ... ... 6B8
6D0 ... ... ... ... ... ... 6BA
6CE ... ... ... ... ... ... 6B8
6CD ... ... ... ... ... ... 6B7
6CC ... ... ... ... ... ... 6B6
6CF ... ... ... ... ... ... 6B9
6D0 ... ... ... ... ... ... 6B9
6CF ... ... ... ... ... ... 6B9
6CD ... ... ... ... ... ... 6B8
6CE ... ... ... ... ... ... 6B8
6CD ... ... ... ... ... ... 6B6
6D2 ... ... ... ... ... ... 6BB
6CF ... ... ... ... ... ... 6B9
:
```

AN. Print the results of the real-time ANALYSIS. The computer first prints which detector has been pulse height analyzed. The possible pulse heights are divided into $10 equal bins, and the number of times the pulse height of the selected detector falls into each bin is counted. The first bin includes pulse heights from $0 to $7F, the next from $80 to $FF and so on. The last one ranges from $780 to $7FF. If the selected detector has a bad ID for an event, that event is not pulse height analyzed. If the detector has the zero data flag true, the event is counted in the lowest bin. If the overflow flag is true, the event is not counted. The counts in each of the sixteen bins are printed as the first two lines of the analysis report. If the number for a bin is larger than $FFFF (about 65,000 decimal), the number will be printed as $FFFF. All numbers are hexadecimal.

The third line of the analysis report is the number of times each detector fired. Detector 0 is listed first and Detector 7 last. A detector has fired if its ID bits are correct and the zero data flag bit is not true.

The fourth line of the report is the number of bad ID's encountered for each detector. The detectors run from

0 to 7 as in line three. Any number larger than $FFFF will be printed as $FFFF in either line three or four.

The fraction of events that get analyzed depends on the event rate since analysis is the lowest priority activity. The last event of each data record is never analyzed.

An example of an analysis report follows.

```
AN.

PHA OF DET.$0000

0002 0001 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0079 0000 0000
007A 0000 0000 0001 0000 0000 0000 007B
0000 0001 0001 0001 0001 0001 0001 0001
:
```

MS. Branch to the MASTER Routine.

CT. CATALOGUE the requested range of data files. The computer requests the first and last files to be catalogued. It then spaces to the first file requested, and it reads the header and trailer records. From the data in these records it prints: the file number, the number of events per data record, the record number of the trailer record, and the comments in the header and trailer records. The file number printed may not be the physical file number corresponding to the current tape position.

If Switch 3 is on while the comments are being printed, control is returned to the command loop. If an invalid character is encountered in the comment fields, the computer types '?' and suppresses the printing of the remaining fields.

An example of the CT command follows.

```
 CT.

FNS=$1  - $2

HDR.OF FN $0001
#EVNT/REC=$0080
4-25-74!
!
!
TRLR.RN=$0001
13:00 4-25-74!
!
TEST!

HDR.OF FN $0002
#EVNT/REC=$0020
!
!
!
TRLR.RN=$0005
13:05!
DO D7 ONLY!
TEST!
:
```

INVALID COMMANDS:

Certain commands will not be accepted by the computer unless the current data file is appropriately open or closed.

The following commands can only be executed if the file is closed:
IN, OP, DM, SK, MS, CT.

These commands will only be executed if the file is open:
GO, CL.

These can always be executed:
AN, SL.

ERRORS: Errors detected by the computer because of invalid input parameters usually cause the computer to ignore the input and request another attempt. More serious errors, usually involving the tape deck, cause control to be passed to a special error routine. This routine rings the bell on the teletype, deselects the tape unit, and prints the message 'ERR ----.' The '----' is the address at which the error was detected. The most frequent error is detected at $1F86 and is caused by a tape reading error. After printing the message control is returned to the command loop. In order to read or write tape, the tape unit must now be selected using the SL command.

If the tape was moving when the tape unit was deselected, the tape must be rewound to the load point before proceeding.

SYSTEM HANG-UP:

The PACE system may stop processing events even though it is receving event pulses. Use the following recovery procedure.

1. Remove the event pulse line from the PACE hardware.
2. Step the computer and write down the address indicated by its panel lights. This is to assist in determining the cause of the hang-up at a later time.
3. Check the Data Transfer Line. If it is high (the small red light on) the problem is the computer. Go to step 6.
4. Turn the PACE hardware off by first turning the run switch off and then turning off the power.
5. After one minute turn the PACE hardware on by turning the power on and then turning on the run switch.
6. Reset the computer.
7. Enter $0A2A into the P-register.
8. Press run.
9. The PACE halt light (white) should come on, and the computer should print ':' on the teletype awaiting a new command. If both do not occur, either try again from step 1 or reload the PACE program either from magnetic tape or disk.
10. Reinsert the event pulses.
11. The system should now be ready.

SYSTEM RATES:

1. Events are read in about 140 usec.
2. Events can be read every 200 usec. Events that occur before the computer is ready to read them are purged. Thus there is 200 usec dead time after each event.
3. Real-time analysis takes about 1.6 msec per event. This is an event rate of about 600 per second. Higher event rates mean a smaller fraction of events get analyzed.
4. About 1 event every 4 seconds can be listed in real time on the teletype.
5. With $80 events per record, about 425 (decimal) events per second can be recorded. If the data records were infinitely long, about 500 events per second could be recorded.

PACE PLOT

PURPOSE: This program is designed to allow the operator to produce 2-D plots on the teletype using the Varian. The data are taken from a selected PACE data file. The sum of the pulse heights of any group of detectors can be plotted along the x- or y-axis. Events to be plotted can be chosen by requiring any number of detectors to have fired or not to have fired. In addition the off-set and compression along each axis is operator controlled.

TO START: The starting address is $02BE. All switches should be off (up). The program cannot fit in core with any other PACE programs except DISK CONTROL. To select the Tape Unit, restart the program at $02BB.

TO RUN: The program reads one file of PACE data and produces the plot from that data according to parameters input by the operator from the teletype. All numbers input are hexadecimal and are input as in the PACE program. The parameters are:

1. The number of events per data record. This number must not be greater than $80. If the data records are longer, input $80 and only the first $80 events of each record will be used. If more than $70 events per record are requested, the DISK CONTROL program will be written over.
2. The number of data records to be read. This number does not include the header or trailer record. If the program tries to read more records than are physically on the data file, it will start reading from the next file and may lose track of the file number.
3. The detector code which identifies which detector is to be included along each axis. The code is a string of 8 characters, the first for detector 0 and the last for detector 7. If the character is 'Y' the corresponding detector is included. Otherwise the detector is excluded.
4. Compression of the axes. This is the number of channels each point of the plot corresponds to.
5. Off-set of the axes. 4.) and 5.) together determine where a given pulse height sum will appear on the plot:

   position = (pulse height sum - offset)/compression

   The arithmetic is integer. The answer must be from 0 to 31 (decimal) inclusive to be plotted. (See OPTIONS for the exception to this rule). There are $800 channels/detector. Thus if a single detector's pulse height determines the position, an offset of $0 and a compression of $40 will cover the entire range of possible pulse heights.
6. Coincidence and anti-coincidence requirements are input as were the detector codes.
7. The number of the file to be used. This is the physical file number, not necessarily the number written on tape.
8. Comments for the plot ending with '!'

OUTPUT: The program spaces to the correct file and reads the data and produces the plot. The plot size is 32 x 32. The number of points that fall into each bin is indicated by an ASCII character. The compression scheme is roughly logarithmic and is given on the following page.

After the plot has been printed, the number of points plotted, the number of points meeting the coincidence and anti-coincidence requirements but not plotted, and the number of bad ID's encountered all all printed in hexadecimal.

ERRORS: The most common error is a tape reading error. When this occurs an error message is printed identifying the record number. The operator is then asked if he wants to continue the tape reading program. A 'Y' response tells the computer to ignore the bad record and continue reading data. Any other response ignores the bad record and prints the 2-D plot that has already been accumulated from the previous data records.

If a bad ID is encountered for any of the detectors, the record number, event number, and the raw data for that event is listed on the teletype if Switch 2 is on. The first event of a record is event $0.

TO STOP: When finished printing, the program types 'MST?'. If 'Y' is typed, the program branches to the Master Routine. Otherwise, PACE PLOT is rerun.

OPTIONS:
Switch 1 on: Accept bad ID events as good events.
Switch 2 on: Print bad ID events.
Switch 3 on: Off scale events will be plotted at the edge of the plot. These events will be counted as points plotted for the totals.

RATE: With $80 events per data record, the program processes about 180 events per second. It takes about 2 minutes to print the plot.

TO ABORT: If the program is stopped during the tape reading segment, the operator should restart the computer at address $0400 and wait until the computer prints on the teletype. This procedure restores the Master Routine to its original form. This procedure can also be used print the plot before all requested records have been read.

EXAMPLE: A sample execution of PACE PLOT is shown after the following page.

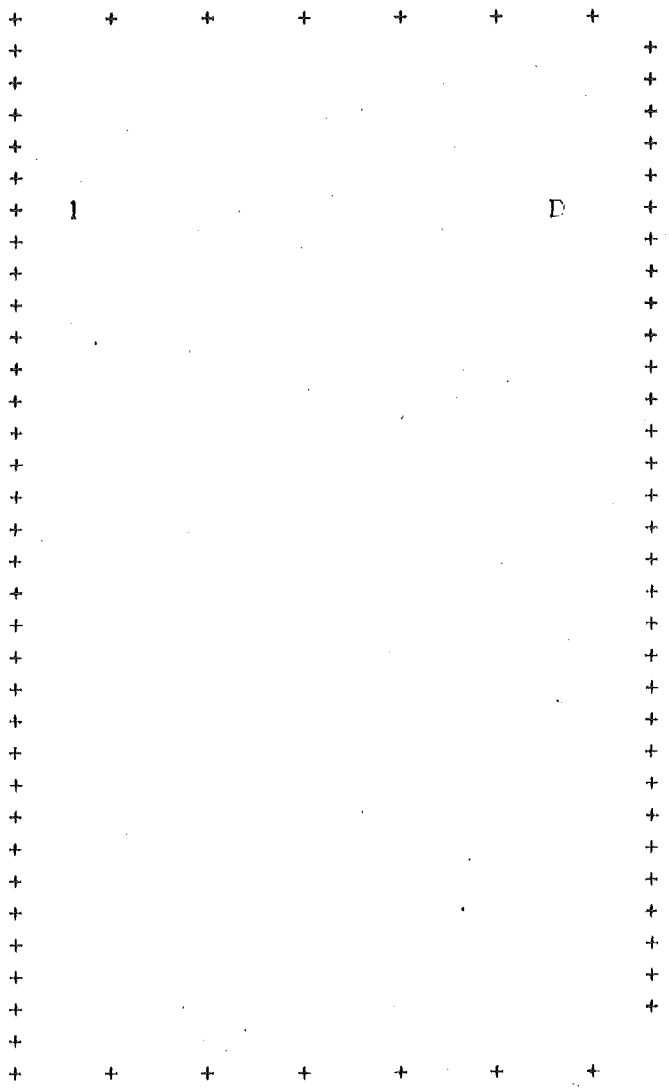
12/12/73

COMPRESSION SCHEME FOR FANCY PACE PLOTS

SYMBOL	LOWER BOUND OF BIN	
	HEX	DECIMAL
blank	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	6	6
6	8	8
7	C	12
8	10	16
9	18	24
A	20	32
B	30	48
C	40	64
D	60	96
E	80	128
F	C0	192
G	100	256
H	180	384
I	200	512
J	300	768
K	400	1024
L	600	1536
M	800	2048
N	C00	3072
P	1000	4096
Q	1800	6144
R	2000	8192
S	3000	12288
T	4000	16384
U	6000	24576
V	8000	32768
W	C000	49152

Any number larger than $C000 or 49152 will be printed as 'W'.

```
FV/RC=$20
#DAT.REC.=$4
DET.CODES: X=Y-------- Y=--------Y
X-COMPR.=$40   Y=$40
X-OFF =$0   Y-OFF =$0
COINC=Y-------- ANTI=---------
FN=2
COM: TEST!
```




```
00000007F PPLT.
00000000 NPLT.
00000001 BAD IDS
MST?Y
*
```

DISK CONTROL

The upper of the two Varians in the rack is the Disk Varian; the lower is referred to as the Varian. Data can be transferred from the Varian to the Disk Varian and vice versa. The data transfer rate is about one 8-bit word every 40usec--about 3 times as fast as the Kennedy Tape Unit.

LOADING data (or a program) is defined as moving data from the Disk Varian to the Varian. STORING data (or a program) is defined as moving data from the Varian to the Disk Varian.

Two Pace programs can now be stored in the Disk Varian--PACE and PACE PLOT.

TO USE:

On the Disk Varian, put $0024 into the P-register and press run. On the Varian start at the location shown below corresponding to the desired operation.

OPERATION	START ADDRESS	EXIT
Load PACE	$17BC	execute Pace program
Load PACE PLOT	$17C9	execute PACE PLOT program
Store PACE	$1798	branch to MASTER routine
Store PACE PLOT	$17A4	branch to MASTER ROUTINE

In order to load a program it must have previously been stored in the Disk Varian. Turning the Disk Varian off does not erase the program. In order to store a program it must be in the Varian's core.

ERRORS:

Symptoms:
1. Disk Varian halts.
2. Not finished within 5 sec.
3. Does not exit correctly

Remedy: For 1. or 2. make sure the Disk control programs are in the Varian and Disk Varian. Make sure no cards have fallen out the back of the Varian. For 3. make sure the program was actually in the source machine. Or try again.

PROGRAM LOCATION:

The Disk Control program is located at $1798 to $18B9 in the Varian. A different program is located between $0020 and $00FD in the Disk Varian. This program exists as paper tape and is loaded into the Disk Varian using the Absolute Loader with the teletype connected to the Disk Varian.

The Disk control program in the Varian will be erased by loading THRESHOLD, PACE MASS PLOT, or asking for more than $70 events in PACE PLOT.

PACE MASS PLOT

PURPOSE: This program is designed to convert the 2-D plots produced by the PACE PLOT program into a mass histogram. It must be used immediately following the execution of the plot program since it uses the same storage area in order to pass data from the plot program to the mass program. However, it cannot be in core at the same time as the plot program.

METHOD: The program assumes the 2-D plot is a graph of the energy lost in the first detector along the x-axis versus the total remaining energy along the y-axis. The energy is determined using a linear fit to the position along the x or y axis. The mass is determined from the two energy losses using a relationship derived from the assumption that a particle's range is a power law function of its energy:

$$R = k\ E^{A}$$

Using

$$R(M,Z,E) = (M/Z^2)\ R(1,1,E/M)$$

the mass is given by

$$M = (k/LZZ)^{s}\ (E^{A} - E'^{A})^{s} \quad \text{where } s = 1/(A-1)$$

L = thickness of first detector
E'= remaining energy after first detector

TO RUN: The program starts at $053E. All inputs are decimals. The decimals must be less than 10 digits long, contain a decimal point, and be terminated with a space.
The program first asks for the constants to be used.
L = thickness of the first detector (mm)
Z = charge of the incident particle
k = constant in range equation
A = constant in range equation
For 1-10MEV protons, k is about .012 and A about 1.77
Next are the limits on the total energy for acceptable events.
Then the starting mass and bin size for the mass histogram are input.
There are always 20 bins in the histogram.
Finally the conversion constants for changing the 2-D plot position into energy are input. The constants are used as follows:

$$E_x = AX + BX \cdot POS_x \quad \text{(Energy in Mev)}$$

$$E_y = AY + BY \cdot POS_y$$

The postions on the 2-D plot range from 0 to 31 (decimal).
This is NOT the pulse height produced by the PACE system.
If E_y is less than 100 kev, the point is ignored.

OUTPUT: After the parameters have been input, the program calculates the mass histogram. It takes about 100 seconds times the fraction of plot positions that contain at least one event. The mass histogram is then listed on the teletype. The listing consists of the lower bound of the mass bin and the number of points in the corresponding bin.

TO STOP: After printing the mass histogram, the computer types 'MS?' A response of 'Y' returns control to the Master Routine. Any other response causes the MASS PLOT program to be rerun.

OPTIONS: If Switch 3 is on, points along the edge of the plot are not included.

EXAMPLE: A sample execution of the program is shown below.

```
L,Z,K,A=.492 1.0 .012 1.77
EMIN,EMAX=5. 15.
MASS ST, STEP=.5 .1
AX,BX,AY,BY=0. .227 0. .278
MASS & NO.
+00.500000 +00.000000
+00.600000 +00.000000
+00.700000 +00.000000
+00.800000 +00.000000
+00.900000 +01.000000
+01.000000 +0511.0001
+01.100001 +00.000000
+01.200001 +00.000000
+01.300001 +00.000000
+01.400001 +00.000000
+01.500001 +00.000000
+01.600001 +00.000000
+01.700001 +00.000000
+01.800001 +00.000000
+01.900001 +00.000000
+02.000002 +00.000000
+02.100002 +00.000000
+02.200002 +00.000000
+02.300002 +00.000000
+02.400002 +00.000000

MS?Y
*
```

BAID

Baid is described in the Varian 520/i Computer Handbook. It is a collection of routines which are used as de-bugging aids. Baid #2 and Baid #3 differ only in their location in core.

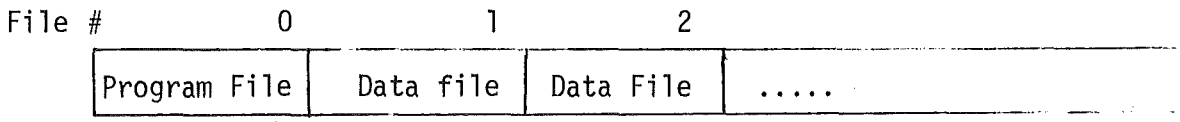
APPENDIX

The following pages show the PACE Data Tape Format, the effect of the Sense Switches for all PACE programs, the allocation of computer core for all programs found on PACE tapes, and an index of a PACE tape program file.

1-8-74

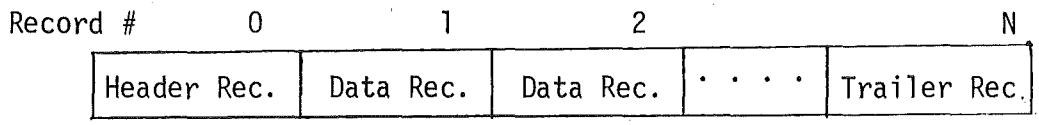
PACE DATA TAPE FORMAT

I. FILES



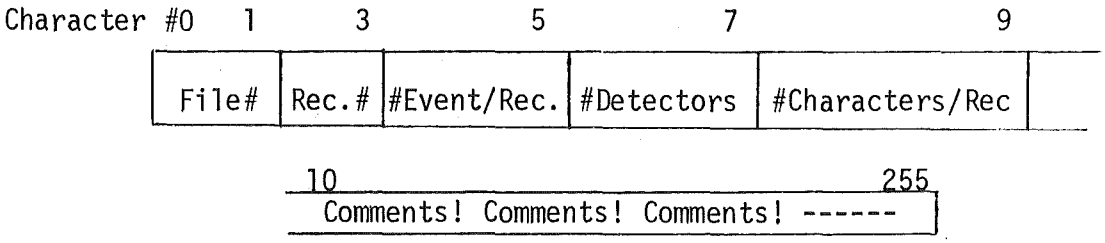
II. RECORDS

A. DATA FILE RECORDS

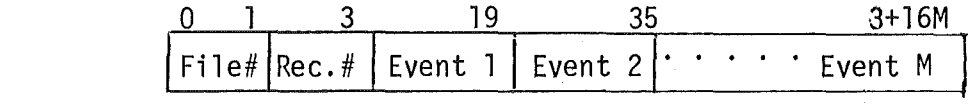


III. CHARACTERS (eight bits)

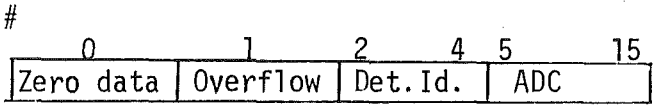
A. HEADER RECORD CHARACTERS



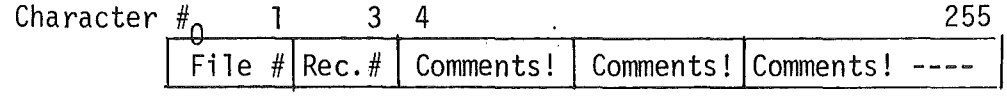
B. DATA RECORD CHARACTERS



Each event consists of data from each detector, from detector 0 to detector 7. The data from each detector looks like:



C. TRAILER RECORD CHARACTERS



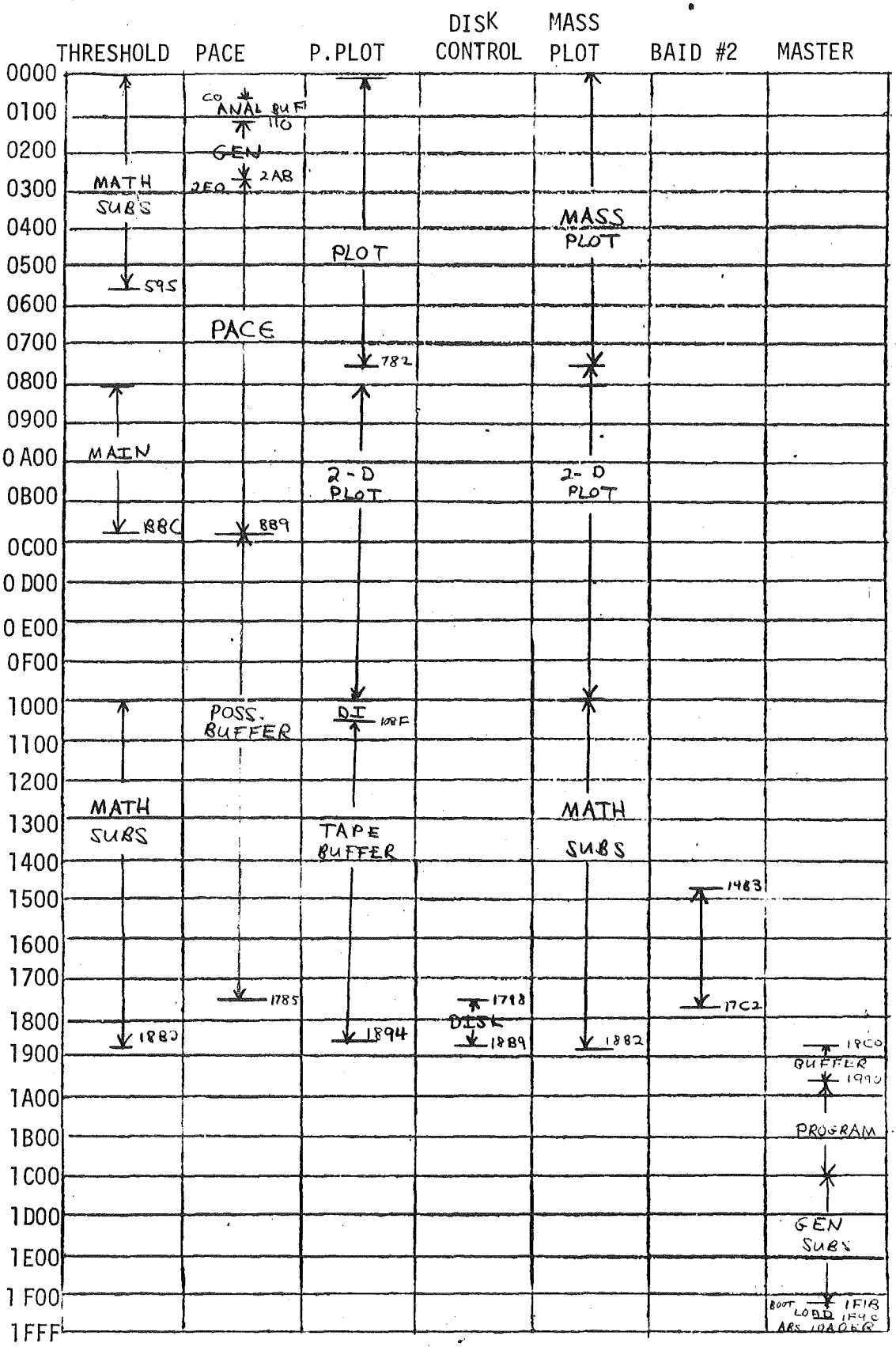
EFFECT OF SENSE SWITCHES

PROGRAM

	THRESHOLD	PACE	PACE PLOT	MASS PLOT
SWITCH 1	event only lights overflow lights	restart real-time analysis	accept bad ID's	
SWITCH 2		suppress real-time event listing	print bad ID's	
SWITCH 3		stop at end of data record. or stop catalog	plot off-scale points on plot edge	ignore edge points

4/22/74

VARIAN CORE ALLOCATION



```
*I.

01
THRESHOLD.3-28-74./0000-0595,0800-0BBC,1000-18B2;08B3!

02
PACF.4-10-74./0110-0BB9;0700!

03
PACE PLOT.6-1-74./0004-0782,1001-108F;02BE!

04
PACE DISK CONTROL.4-9-74./1798-18B9;1C00!

05
PACE MASS PLOT.1-16-74./0000-0788,1000-18B2;053F!

06
RAID #2./14B3-17C2;164C!

07
RAID #3./0CB3-0FC2;0E4C!

EOF

*
```