

Internal Report No. 47

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Guide to IMP-H Integration

and

Quick Look Printouts

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I. Introduction

This guide assumes that the reader is familiar with the IMP-H Electron Isotope Spectrometer, described in SRL Internal Report 50. It is intended to serve as a reference source for the conventions and parameters that were assumed in the programs which produced the printouts as well as to acquaint him with some potentially misleading features of the integration and quick look printouts.

There are three main ways in which the experiment data are displayed in the printouts. First a "Selected Event" display lists individual events. Second a "Summary Page" shows rate data and a summary count of events by range, etc. Finally a set of four scatter plots displays events as a function of their pulse heights. Figures 1 and 3 show sample "Summary Page" and "Selected Event" pages which are discussed in Sections III-VII. The plots are described in Section VIII. Unless otherwise noted, the discussion below refers to both integration and quick look printouts. The PARET display option of the integration program will not be considered.

The Integration Printout Log (not included) lists all the available Integration Printouts by data, time, test conditions, etc., along with limited comments on experiment performance. The integration printouts themselves are in 5 blue binders labelled:

- INTEGRATION '71,
- TV 2,
- IMP-H INTEGRATION, Jan-July '72,
- IMP-H INTEGRATION, July-Aug '72,

and IMP-H RFI TEST, 7-28-72.

A corresponding log is maintained for the Quick Look Data. The logs also indicate some of the transient bugs in the printouts.

II. Headings

A. Quick Look Printout

Referring to Figure 1, field 1 contains descriptive information concerning the conditions under which the data was acquired. Usually this includes the bit rate and ground station identity. Field 2 indicates the orbit number (ascending node crossing number). Fields 3 and 4 give the UT at which the data was analyzed and acquired respectively. Field 5 gives an indication of data quality. All zeroes do not necessarily imply that all the data required to complete the display was successfully acquired. Field 6 indicates the version date of the MSOCC (Multi-Satellite Operational Control Center) computer program which produced this printout along with those of other experiments. In field 7 "ON LINE" and "OFF LINE" Data indicates whether the printout was produced in real time. Field 8 refers to the EIS power. Field 9 indicates whether the sectored rates were acquired in the OA SLAVE or TM SLAVE mode. Fields 8 and 9 are unreliable in the first two pages of the printout.

B. Integration Printout

Figure 2 shows the corresponding integration printout heading. Although rearranged, the fields have the same significance as described above. In this case the bit rate is shown separately in Field 10. Fields 8, 9 & 10 are meaningful only on the second and subsequent pages of the printout. On the first page, the following "default" values are always printed:

POWER OFF

OA TM (means TM SLAVE)

HI BIT RATE.

1 IMP-H HIGH BIT RATE DATA FROM ORBRAL 2 BRBIT: 0025 3 73/07/20 4 GMT 201 13 48 19 574 QUAL FLAGS: 000 (1-BAD) 5 SYSTEM MAR 20 73 6
 STONE CAL TECH CAL PAGE 0 SNAPSHOT 2 OFF LINE DATA SATELLITE CLOCK 038106:28.92 (115776) PCM 4 COMPUTER 2

EVENT SUMMARY

PAR	0	5	6	H-8	0	6789	0	0-6	0
HAZ	3	56	2	2-H8	0	5-T	0	0-H6	0
C9M	35	5-7	0	H-9	0	5H-T	0	0-7	0
PR3	62	5-8	0	2-H9	0	0	23	0-H7	0
UNC	0	5-9	0	7	2	01	1	0-8	0
2	0	H6	0	67	0	0-3	0	0-H8	0
25	0	2-H6	0	78	1	0-4	0	0-9	0
25H	0	H67	0	678	0	0-5	0	0-H9	0
54	0	2-H7	0	789	0	0-5H	0	U1	28

NORMALIZED RATES

EL8	0.05	PL8	0.00	D0	7.20	D3	10.25	D6	9.35	D10	14.07
E41	0.02	PHI	0.00	D1	8.15	D4	12.10	D7	9.20	D11	358.80
NEUT	0.08	DO*	0.65	D2	1.80	D5	9.75	D8	8.00	ADC	30.70
PEN	0.00	DO1*	0.05	D2H	0.10	D5H	0.50	D9	8.75	HAZ	0.00

RATE BLOCK

SCS	N/PG	A	B	C	E	F1	F2	F3	F4	F5
4	1	0	1	2	0	0	36	290	2	2
3	1	2	0	195	7176	160	175	10	2	209
2	1	0	0	13	1	187	184	273	2	14
1	1	0	0	144	614	163	205	242	1	160

C9MSTAT FIRST PR8P 3
 SECONO TEMPERATURE 3.7 DEG C

Figure 1

Figure 2. Integration Printout Heading

1
IMP INTEGRATION

CAI/ELECTRON ISOTOPE SPECTROMETER/STONE

2 POWER OFF 9 OA TM 10 HI BIT RATE

3 OCT 13 1753 04

4 SEP 18 1316 03

III. Selected Events

Figure 3 shows a sample page of selected events, each of which is displayed on one line of the printout.

A. Format for each 'selected event'

'PAGE' = the telemetry page # (0,1,2,3) from which the data for this event was taken.

N/PG = (0,1, , 31) = event number within that page.

RO,..RZ have the usual significance with T, C & Z standing for D10, D11 & HAZARD, respectively.

The unlabelled column is the analysis type.

A and B are the A and B register pulse heights, after the transformations have been made.

S (=1,..8) is a number formed from the S bits in the digital scan data. Table 1 relates this bit pattern to the sector number used in identifying the sectored rates and to the direction of the telescope axis, with respect to the sun-satellite line.

B. Criteria for events to be displayed in the 'selected event field'

The printing option parameter (=PROP, displayed under the rate block in Figure 1) determines which events are displayed in the selected event field. Usually PROP = 3, in which case all new, correct parity events included in the event summary are listed

If PROP = 0, the listing is suppressed.

If PROP = 1, only 'uncommon' events are printed.

PAGE	N/PG	R0	R1	R2	R3	R4	R5	R5H	R6	R7	R8	R9	RA	RB	RZ	A	B	S
0	18	0														3	0	1
0	20						5		6	7	8					2	16	2
0	21						5									1	24	7
0	22						5		6	7	8	9	T			2	62	46
0	23						5									1	57	7
0	24						5		6	7	8	9	T			2	1	29
0	25						5	H								1	209	7
0	26						5		6	7	8					2	47	33
0	27						5		6	7	8	9	T			2	1	17
0	28						5		6	7	8	9	T			2	0	7
0	29						5		6	7					Z	2	14	6
0	30															3	6	0
0	31															3	1	0
1	0															3	19	7
1	1						5		6	7	8	9				1	19	7
1	2						5		6	7	8	9				2	00	79
1	3						5		6	7	8	9	T			2	73	48
1	4						5		6	7	8	9	T			2	1	130
1	5						5		6	7	8	9	T			2	22	7
1	6						5		6	7	8	9	T			2	7	1
1	7						5		6	7	8	9	T			1	1	7
1	8						5		6	7	8	9	T			2	2	8
1	9						5		6	7	8	9	T			2	2	46
1	10						5		6	7	8	9	T			1	1	16
1	11						5		6	7	8	9	T			2	1	7
1	12						5		6	7	8	9	T			2	6	6
1	13						5		6	7	8	9	T			2	1	6
1	14						5		6	7	8	9	T			2	70	4
1	15						5		6	7	8	9	T			3	0	8
1	16						5		6	7	8	9	T		Z	2	0	8
1	17						5		6	7	8	9	T			3	0	5
1	18						5		6	7	8	9	T			2	16	3
1	19						5		6	7	8	9	T			1	7	5
1	20						5		6	7	8	9	T			3	22	3
1	21						5		6	7	8	9	T			1	1	3
1	22						5		6	7	8	9	T			3	19	7
1	23						5		6	7	8	9	T			1	7	7
1	24						5		6	7	8	9	T			3	2	0
1	25						5		6	7	8	9	T			2	68	12
1	26						5		6	7	8	9	T			2	1	2
1	27						5		6	7	8	9	T			1	3	7
1	28						5		6	7	8	9	T			1	3	3
1	29						5		6	7	8	9	T			3	10	9
1	30						5		6	7	8	9	T			3	15	0
1	31						5		6	7	8	9	T			3	1	0
1	32						5		6	7	8	9	T			2	45	1
1	33						5		6	7	8	9	T			1	50	16
1	34						5		6	7	8	9	T			2	1	7
1	35						5		6	7	8	9	T			3	19	5
1	36						5		6	7	8	9	T			2	1	13
1	37						5		6	7	8	9	T			3	1	0
1	38						5		6	7	8	9	T			2	25	3
1	39						5		6	7	8	9	T			1	23	8

Figure 3

Table 1. Interpretation of Sector Numbers

Displayed Sector #	Sun referenced Sector #	⟨Direction⟩*
1	3	301°
2	2	346°
3	0	76°
4	1	31°
5	4	256°
6	5	211°
7	7	121°
8	6	166°

* See IR #43 for definition.

Note that to be considered new in these programs, either the A or B registers must be non-zero. Therefore D0 single events with zero pulse height will be neither counted as new nor displayed.

IV. Event Summary

Referring to Figure 1, the display consists of 45 different sums of events, arranged in 5 columns of 9 each. Six of these sums are described below while the remaining 39 sums are defined in Table 2. These 39 are range sums in which only good parity, new, non-hazard events are included. If PROP = 3 then the sums are over same set of events included in the preceding 'Selected Event' list.

- | | |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| PAR (Parity error) | - parity error in at least one channel (may also count half sequences for which there is no data - especially at beginning or end of an interval). |
| HAZ (Hazard) | - RZ set in a new, good parity event. |
| PR3 (Priority 3) | - new, good parity, non-hazard events in which R11 was set. |
| COM (Common) | - a new, good parity, non-hazard event whose range bits corresponded to 1 of the 39 combinations listed in Table 2. |
| UNC (Uncommon) | - a new, good parity, non hazard, event with whose range did not correspond to any of these combinations. |
| U1 (Not new event) | - a good parity, not new event (or a new D0 single event with zero pulse height). |

Table 2. Ranges included in Event Summary and Plots

Label	Range	Plot	X Axis	Y Axis
2	D2	1	D2	-
25	D25	1	"	D5
25H	D25H	1	"	"
5H	D5H	1	-	"
5	D5	2	D5	-
56	D56	2	"	Σ
5-7	D567	2	"	"
5-8	D5678	2	"	"
5-9	D56789	2	"	"
H6	D5H6	2	"	"
2-H6	D25H6	2	"	"
H67	D5H67	2	"	"
2-H7	D25H67	2	"	"
H-8	D5H678	2	"	"
2-H8	D25H678	2	"	"
H-9	D5H6789	2	"	"
2-H9	D25H6789	2	"	"
7	D7	2	-	"
67	D67	2	-	"
78	D78	2	-	"
678	D678	2	-	"
789	D789	2	-	"
6789	D6789	2	-	"
5-T	D56789T	3	D5	"
5H-T	D5H6789T	3	"	"
0	D0	4	D0	0
01	D01	4	"	Σ
0-3	D013	4	"	"
0-4	D0134	4	"	"
0-5	D01345	4	"	"
0-5H	D01345H	4	"	"
0-6	D013456	4	"	"
0-H6	D01345H6	4	"	"
0-7	D0134567	4	"	"
0-H7	D01345H67	4	"	"
0-8	D01345678	4	"	"
0-H8	D01345H678	4	"	"
0-9	D013456789	4	"	"
0-H9	D01345H6789	4	"	"

Let NSUM = total number of events summarized.

Then NSUM = PAR + HAZ + COM + PR3 + UNC + U1

and COM = '2' + '25' + '25H' + ... + '0-H9'.

The time interval covered by the event summary is not coincident with the time interval over which the rates were accumulated. With the exception noted below, all the rates are accumulated over an integral number of subcom states. In the first subcom state, only events 8-31 are included in the sum. In addition the first 8 events in the subcom state following the rate accumulation period are also included except for the last summary period before the plots are printed, in which case, the first 18 events in the following subcom state are included.

Therefore if NSCS is the total number of subcom states over which rates were accumulated,

$$\text{NSUM} = 32 \times \text{NSCS} \quad (+10)$$

where the (+10) should be included only if this is the last summary display before the plots.

V. Rate Block

The format of the rate block is largely self-explanatory. The N/PG gives the number of subcom states (or data pages) over which each rate was accumulated. Rates are summed over sectors and over snapshots within each subcom state before being displayed.

If the equation:

$$\text{NSUM} = 32 * \text{NSCS} [+10]$$

explained in Section IV is not satisfied or if all four N/PG values are not the same, then the rate block data should be regarded as suspect, since all the rates may not have been accumulated over the full number of subcom states shown.

Table 3 correlates the page # used in identifying events in time with the subcom states during which rates were accumulated and with the pages in which the rate data appears in the telemetry.

Because the program uses a 24 bit accumulator, negative numbers are displayed if the entry is greater than $2^{23} - 1(8,388,607)$. If (-N) is displayed, the entry should read $(16,777,216-N)$.

The rate block values may also reflect a round-off error due to the 24 to 12 and 24 to 10 bit compression in the telemetry. Table 4 shows the significance of this.

Table 3. Page Numbers and Sub-Com States

	Page	A5	A6	SCS of rate being accumulated	SCS of rate in sectored rate output
T	0	0	0	4	1
I	1	1	0	3	4
M	2	0	1	2	3
E	3	1	1	1	2

Table 4. Rates - Calculation and Corrections

Rate	Formula Used	Renormalization Constant			Rate Compression Errors		
		HI BITRATE		LO BITRATE	Max	Max %	rms
		OA MODE	TM MODE	OA MODE	'Exact Value' of Rnorm ⁺	Error	Error*
ELO	(A1+A3)/(N1+N3)	1.115	.977	4.568	25	1.6%	.11%
EH1	(B2+B4)/(N2+N4)	1.115	.977	4.568	25	1.6%	.11%
PLO	(A2+A4)/(N2+N4)	1.115	.977	4.568	25	1.6%	.11%
PHI	(B1+B3)/(N1+N3)	1.115	.977	4.568	25	1.6%	.11%
PEN	E4/N4	1.115	.977	4.568	25	1.6%	.16%
NEUT	(F41+...F44)/(N1+...N4)	.977	.977	.977	51	.4%	.03%
DO*	C2/N2	1.115	.977	4.568	25	1.6%	.16%
DO1*	E2/N2	1.115	.977	4.568	25	1.6%	.16%
DO	C1/N1	1.115	.977	4.568	25	1.6%	.16%
D1	F11/N1	.977	.977	.977	25	.4%	.08%
D2	F24/N4	.977	.977	.977	25	.4%	.08%
D2H	C4/N4	1.115	.977	4.568	25	1.6%	.16%
D3	F21/N1	.977	.977	.977	25	.4%	.08%
D4	F31/N1	.977	.977	.977	51	.4%	.06%
D5	C3/N3	1.115	.977	4.568	25	1.6%	.16%
D5H	F33/N3	.977	.977	.977	51	.4%	.06%
D6	F12/N2	.977	.977	.977	25	.4%	.08%
D7	F22/N2	.977	.977	.977	25	.4%	.08%
D8	F13/N3	.977	.977	.977	25	.4%	.08%
D9	F23/N3	.977	.977	.977	25	.4%	.08%
D10	(F32+F34)/(N2+N4)	.977	.977	.977	51	.4%	.04%
D11	E3/N3	1.115	.977	4.568	25	1.6%	.16%
ADC	E1/N1	1.115	.977	4.568	25	1.6%	.16%
HAZ	F14/N4	.977	.977	.977	25	.4%	.08%

Nx = y.N/PG entry for SCS x, where y = 20 (hi bit rate)
 = 80 (lo bit rate)

⁺for HI BIT RATE, OA SLAVE mode.

* assuming a 1 album sum and random input.

VI. Normalized Rates

Table 4 also shows how the normalized rates are calculated. Note that the normalization routine assumes all rates are accumulated for 20 seconds/subcom state (80 seconds at the low bit rate). This introduces a systematic error in all the normalized rates which is listed in Table 5 as a "renormalization constant".

$$\text{True Rate} = (\text{Displayed Rate}) * (\text{Renormalization constant})$$

The effect is between -3% and + 12% for nominal spin periods at the high bit rate.

Also tabulated are estimates of the uncertainty due to rate compression. This uncertainty will be less than statistical errors for random data at rates below 20,000/sec.

There are several conditions under which the normalized rates may be grossly incorrect.

1. The normalized rate display 'saturates' at 8360./sec (2067./sec at the low bit rate; 837./sec for integration data analyzed before Feb 4, '72).
2. Negative entries in the rate block void the corresponding normalized rate.
3. If the sum of the accumulated counts for any normalized rate exceeds $2^{23} - 1$ (8,388,607), the display will be incorrect.
4. At low bit rates or abnormal spin periods, some of the normalized rates may be significantly in error.
5. If $N/PG = 0$ in the rate block, the corresponding normalized rates may be large and meaningless.

6. If the NSUM check described in Section IV is not satisfied, or if all N/PG entries are not the same, the normalized rates should be considered suspect.

In cases 1 to 4, the correct value can be recovered from the rate block data.

VII. Other Fields

A. COMSTAT

The field to the right of 'SECOND' represents the command status at the end of the summary period. The field to the right of 'FIRST' refers to an undetermined earlier time.

A blank field implies all detectors enabled; disabled detectors are represented by the characters 0, 1, ..., 9, T, C.

B. PROP

This specifies the selected event printing option described in Section III B.

C. TEMP

The chassis temperature in degrees C displayed here is meaningful only when experiment power is ON.

VIII. PLOTS

Each set of 4 scatter plots shows all the 'COMMON' events that were counted during the preceding Event Summary. Each event is assigned to the plot appropriate to its range, and assigned an X and Y coordinate according to its A and B pulse heights. Each plot shows the number of events as a function of their X and Y coordinates. If the number of events exceeds 10 or more, letters are plotted as shown in Table 6.

Table 2 shows the event ranges that are assigned to each plot, along with the corresponding interpretation of the X and Y axes. Table 5 shows the compression schemes used to relate the A and B values to the limited number of X and Y coordinates available. The compression scheme displays the low channels with full resolution, while higher channels are compressed to distinguish hydrogen and helium isotope tracks. Higher Z particles (and underflows) appear along the outer edges.

The plots themselves are not labeled, but are always printed in the same order. The numbers 0 thru 54 appearing along the left edge identify the number. A sample of Plot 1 is shown in Figure 4.

Note that neutral particles appear along the left edge of plot 2, while D5 singles appear along the upper edge of Plot 1.

In the quick look printouts, the plots are cumulative (appearing every 10 albums or so) starting from the beginning of the run. The integration program, however, effectively clears the 'plot accumulator' after each set of plots.

Figures 5 to 9 are copies of the overlays* which may be helpful in interpreting the plots. The first merely is used to interpolate the column numbers while the other 4 represent 'predicted instrument response'. Energies shown represent 'detected energy' as opposed to incident energy. Full size transparencies of the overlays are available.

*Prepared by Mark Bleck, whose notes should be consulted for further details.

Table 5. Axis Compression for Plots

Axis Position*	- Y Axis -		- X Axis -	
	D2	Σ	D5	D0
0	d2	0	-	-
1	0-2	1	d5	0,1
2	3,4	2	0,1	2
3	5,6	3	2,3	3
4	7,8	4	-	4
5	9	5	4	5
6	10	6	5	6
.
14	18	14	13	14
15	19,20	15,16	14	15
.
19	27,28	23,24	18	19
20	29,30	25-28	19	20
.
24	37,38	41-44	23	24
25	39-42	45-52	24	25
26	43-46	53-60	25,26	26
.
29	55-58	77-84	31,32	29
30	59-62	85-100	33,34	30
.
34	75-78	149-164	41,42	34
35	79-82	165-196	43,44	35
.
39	95-98	293-324	51,52	39
40	99-102	325-388	53,54	40
41	103-106	389-452	55,56	41,42
.
44	151-158	581-644	61,62	47 48
45	159-174	645-772	63,64	49,50
.
49	223-238	1157-1284	71,72	57,58
50	239-494	1285-3340	73,74	59,60
51	495-750	3341-5396	75-78	61,62
52	751-1006	5397-7452	79-82	63,64
53	> 1006	> 7452	83-86	65,66
54	-	-	87-90	67,68
.
70	-	-	151-154	99,100
71	-	-	155-158	101-104
.
75	-	-	171-174	117-120
76	-	-	175-182	121-124
.
100	-	-	367-374	217-220
101	-	-	375-407	221-224
.
125	-	-	1143-1174	317-320
126	-	-	1175-2099	321-576
127	-	-	2100-3022	577-832
128	-	-	> 3023	> 832

*The X axis values of 1-128 correspond to columns, counting left to right. The Y axis values of 0-53 correspond to rows, counting top to bottom.

Table 6. Plotted Symbols

Symbols	Nmin - Nmax
Blank	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8-9
A	10-11
B	12-13
C	14-15
D	16-19
E	20-23
F	24-27
G	28-31
H	32-39
J	40-47
K	48-55
L	56-63
M	64-79
N	80-95
P	96-111
R	112-127
S	128-159
T	160-191
U	192-223
V	224-255
W	256-319
X	320-383
Y	384-447
Z	448-511
*	≥ 512

```

0 3G 028A2+51211123 1 11
1
2
3
4
5
6
7
8
9
10
11
12 H 1
13 J
14 H 1
15 G
16 M 1 1
17 M 31
18 L 1 1 1
19 K 2 3 1
20 M 1 1
21 L 112211 11
22 M 111
23 M 2 1
24 Y 1 1 1
25 N 1 1 1 5111 1
26 Y 11 2 221 111
27 Y 221 1 1
28 L 21211
29 J 1
30 1
31 2
32
33 2
34
35 1
36
37 1
38 1
39
40
41
42
43
44 1
45 1
46
47 1
48
49
50
51
52
53
54
    
```

Figure 4

1

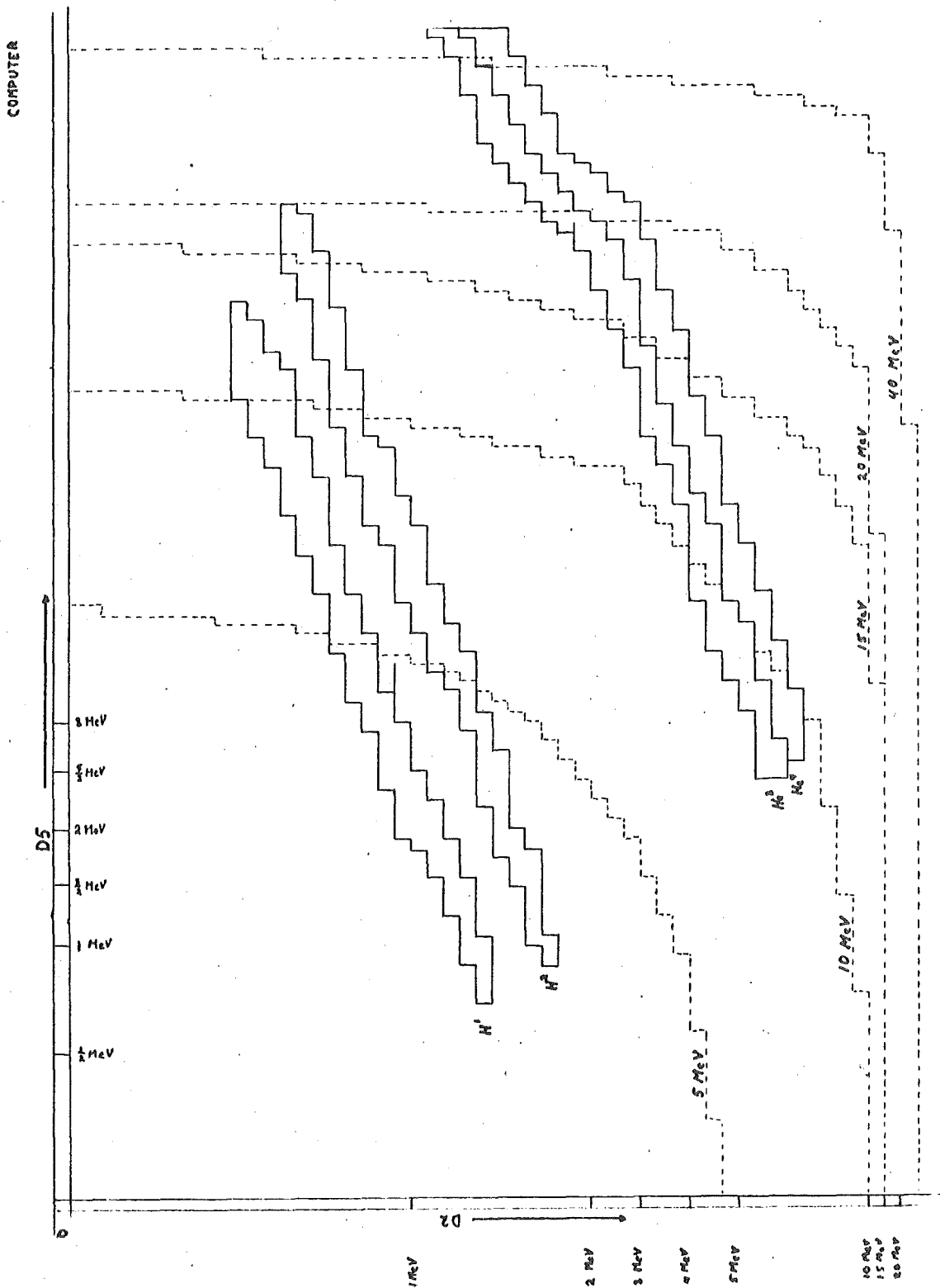


Figure 6

2

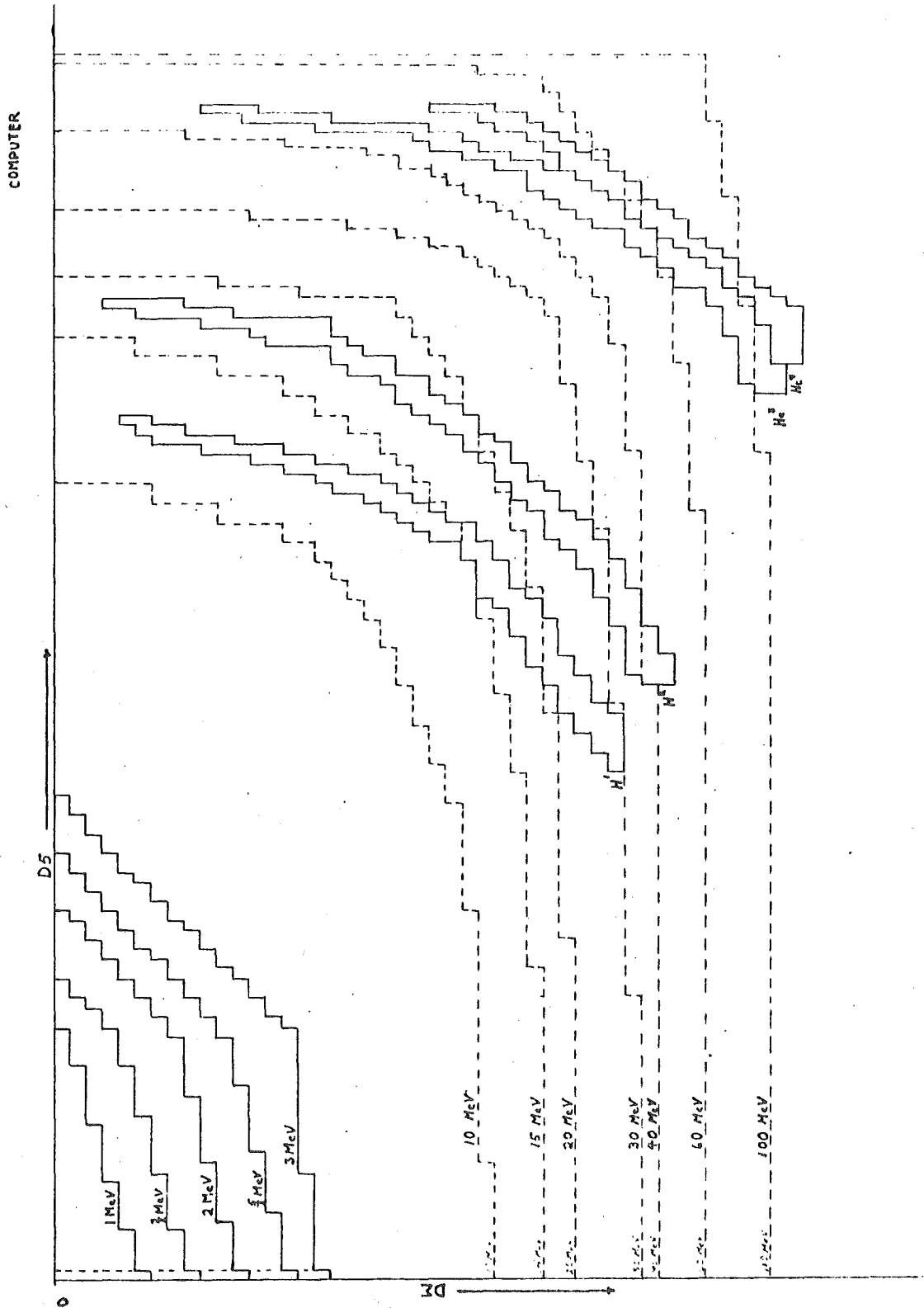


Figure 7

D5 - Z after ZINBAR PEAKS

3

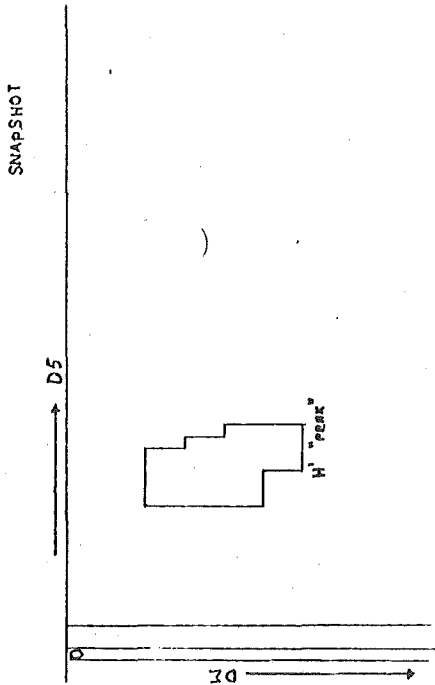


Figure 8

4

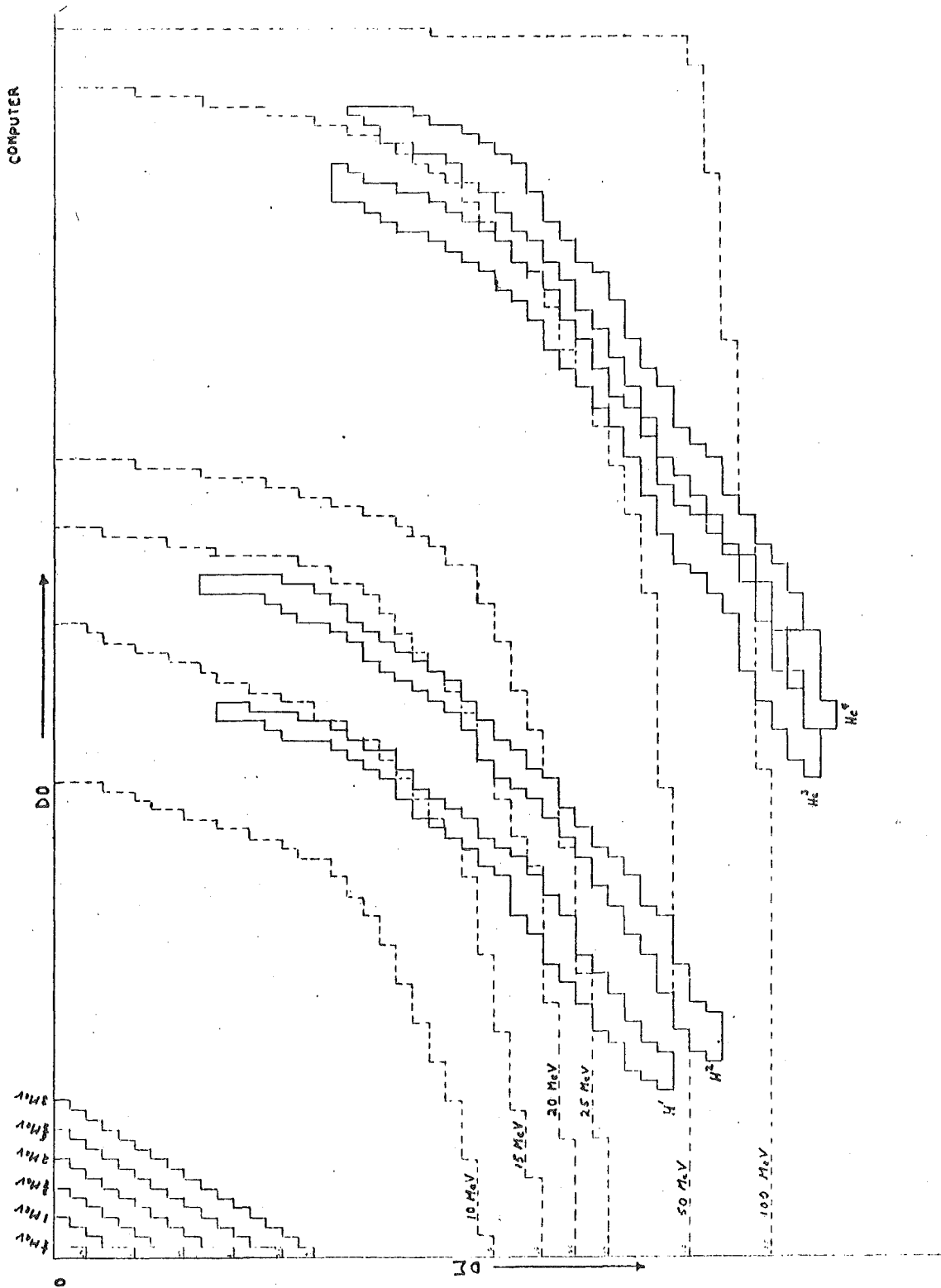


Figure 9