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IMP H & J EIS
ELECTRONIC CALIBRATION

by

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IMP-H and J-EIS Electronic Calibration

I. Introduction

The energy loss of charged particles in the solid state detectors aboard the IMP EIS instruments is converted into digitized information (channel #'s). The purpose of this report is to describe the calibration procedure used to determine the energy loss if the channel is known, to supply some calibration data, and to point out some of the problems in interpreting the data. The report is generally arranged in the chronological order of the calibration procedure.

II. Electronic Calibration Procedure

A. Initial Calibration

The first step in the calibration procedure is to obtain a calibrated standard. This was done with a standard breadboard test pulser, a standard breadboard test capacitor of 1/2 pf., a 100μ thick solid state detector with an Am^{241} alpha source mounted close to its active area, a precision voltage source, and an amplifier and pulse height analyzer system. Figure 1 illustrates the schematic setup. If the standard test pulser/test capacitor combination is linear and has no offset, then it is only necessary to determine the voltage from the precision voltage source that causes the same response in the pulse height analyzer as do the alpha particles in the solid state detector (see internal report #31).

The next step is to calibrate the internal test pulser-detector-ADC system in the instrument. This is done after the detector stack has been installed and connected to the ADC's. The setup is shown schematically in Figure 2. The voltage corresponding to each ADC threshold and to the thresholds of channels 20, 100, and 1000 are determined using the breadboard test pulser and the

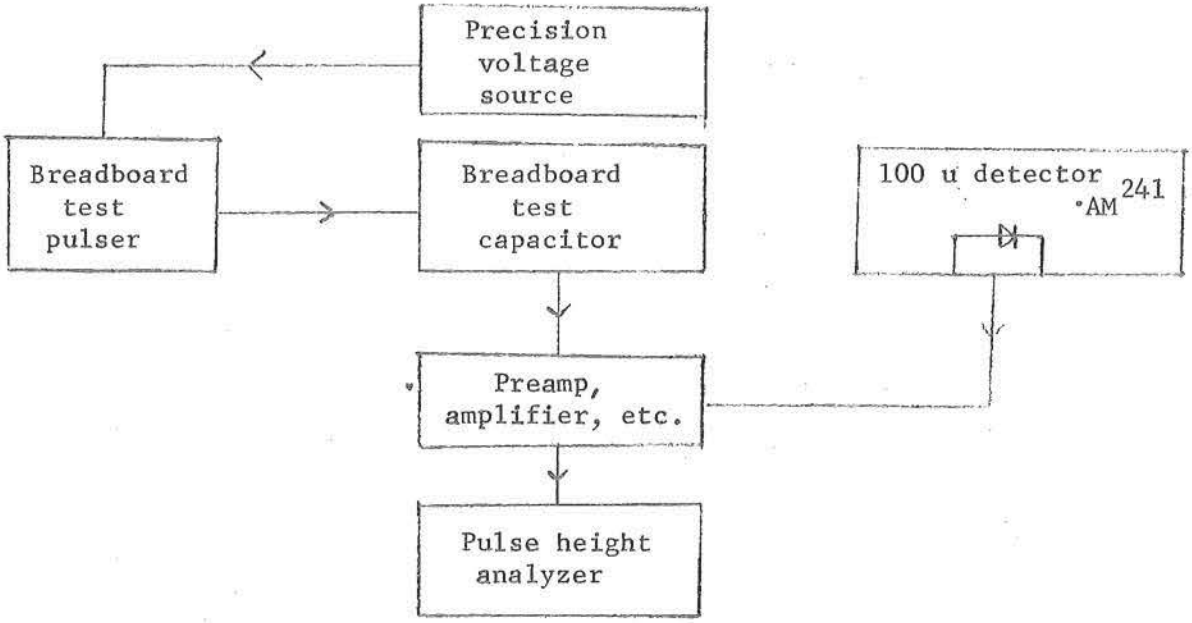

Precision voltage source
Breadboard test pulser
Breadboard test capacitor
100 u detector
241 AM
Preamp, amplifier, etc.
Pulse height analyzer

Figure 1

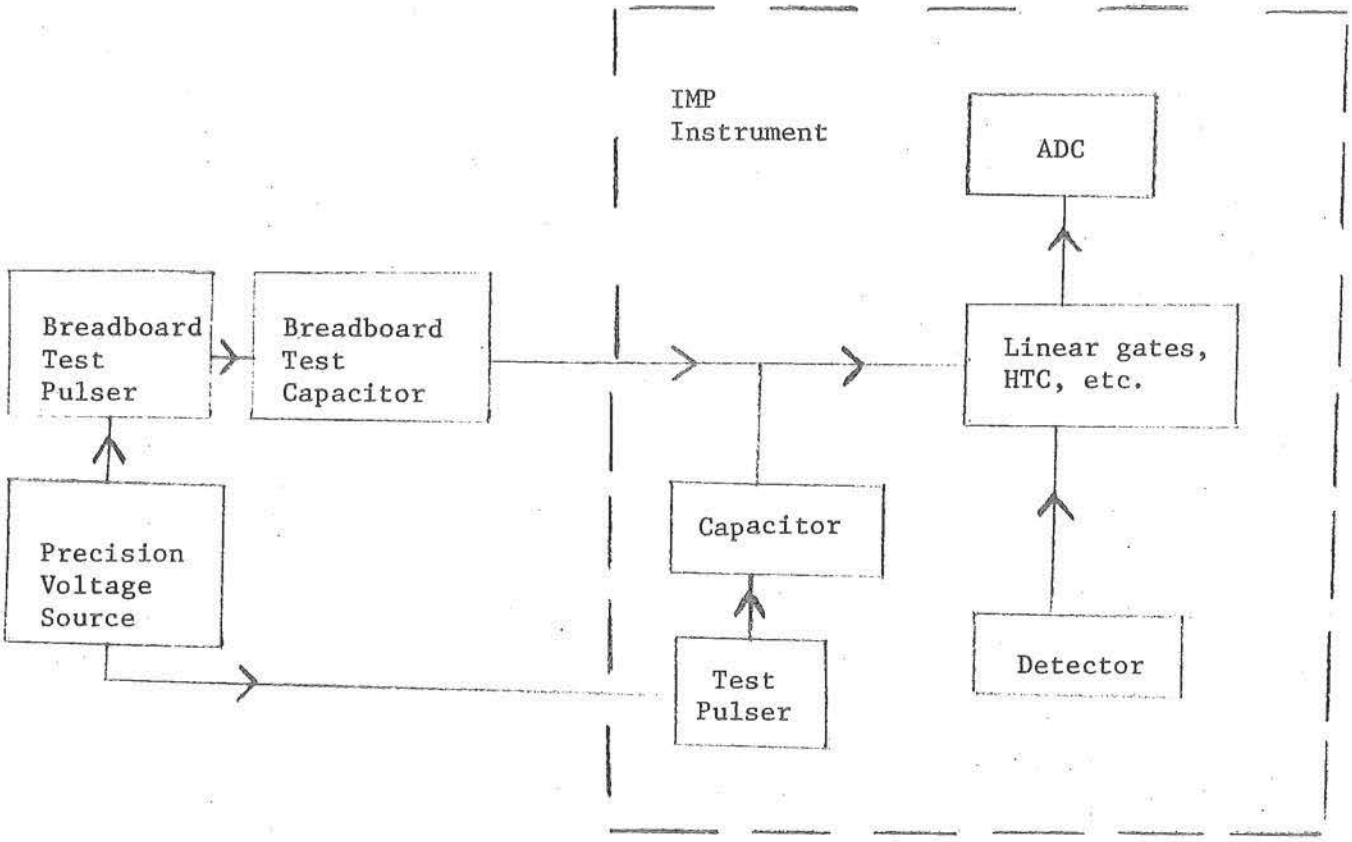

IMP
Instrument
ADC
Breadboard
Test
Pulser
Breadboard
Test
Capacitor
Linear gates,
HTC, etc.
Capacitor
Precision
Voltage
Source
Test
Pulser
Detector

Figure 2

instrument test pulser. (The threshold of channel n is obtained when 50% of the pulses are in channel n and 50% in channel n-1.) These points not only calibrate the internal test pulser against the breadboard test pulser but also confirm the linearity of the system. The final result of this calibration is a ratio R for each ADC internal test pulser:

$$R = E/V \tag{1}$$

where E is the energy loss in a detector and V is the voltage from the precision power supply. The estimated accuracy of each calibration step is 0.1%.

B. Normal Calibration

Because of small drifts in the electronics as a function of time or temperature (and to verify that the drifts are not large), the ADC's must be periodically calibrated with internal test pulsers. The procedure was automated with the help of a programmable voltage source and Curt Widdoes' Varian program called CALAN. Using an algorithm described below, the program calculates the thresholds for all ADC's (D0 through D11) and a certain set of individual channel thresholds for D0 through D9. The channels are chosen such that the thresholds of other channels can be interpolated with a high degree of accuracy (typically to better than 0.2 channels for the higher channels). For some reason, which is not understood, the CALAN program does not give a reliable result for the ADC threshold. (It does calibrate the channel thresholds reproducibly however.) Therefore, the initial ADC threshold calibration (Section II-A) is taken as the proper calibration.

The CALAN algorithm for calculating thresholds is now described. The 40% and 60% ADC threshold triggering voltages are obtained with either 1000 or 10000 pulses. Using these 2 points the program computes the ADC threshold and the standard deviation (σ). To calculate the threshold for channel n,

the program finds a voltage between the 40% and 60% triggering points of channel n. It then uses the ADC threshold σ to calculate the 50% point for channel n. The program then multiplies the voltage by the ratio R (see equation 1) to obtain the threshold energy. The assumption that the ADC threshold σ equals the channel σ's gives rise to an error in the threshold estimate of less than 1 Kev.

After calibrating individual channel thresholds, the program calculates three quantities: gain, offset, and linearity, which are defined below. First, it should be noted that in CALAN the threshold of channel n is called channel n-0.5. Thus, channel 100.0 in the CALAN output signifies the midpoint of channel 100, while channel 99.5 signifies the channel 100 threshold. The gain is defined as

$$G \equiv \text{gain} \equiv \frac{E(\text{channel } 999.5) - E(\text{channel } 99.5)}{(999.5 - 99.5)} \qquad (2)$$

where E is the energy corresponding to channels 999.5 and 99.5 (CALAN channel definitions). To determine the offset and linearity, a line is drawn through the thresholds of channels 100 and 1000 on a channel vs. energy graph (see figure 3). The equation of this line is

$$C = \frac{1}{G}\,(E - E(999.5)) + 999.5 \qquad (3)$$

where C is channel, E is energy of channel C, G is gain, and E(999.5) is the energy of the channel 1000 threshold. The offset is defined as the intercept (in channels) of this line with the channel axis. In terms of equation 3, the offset can be expressed as

$$0 = \text{Offset} = 999.5 - \frac{1}{G}\,E(999.5).$$

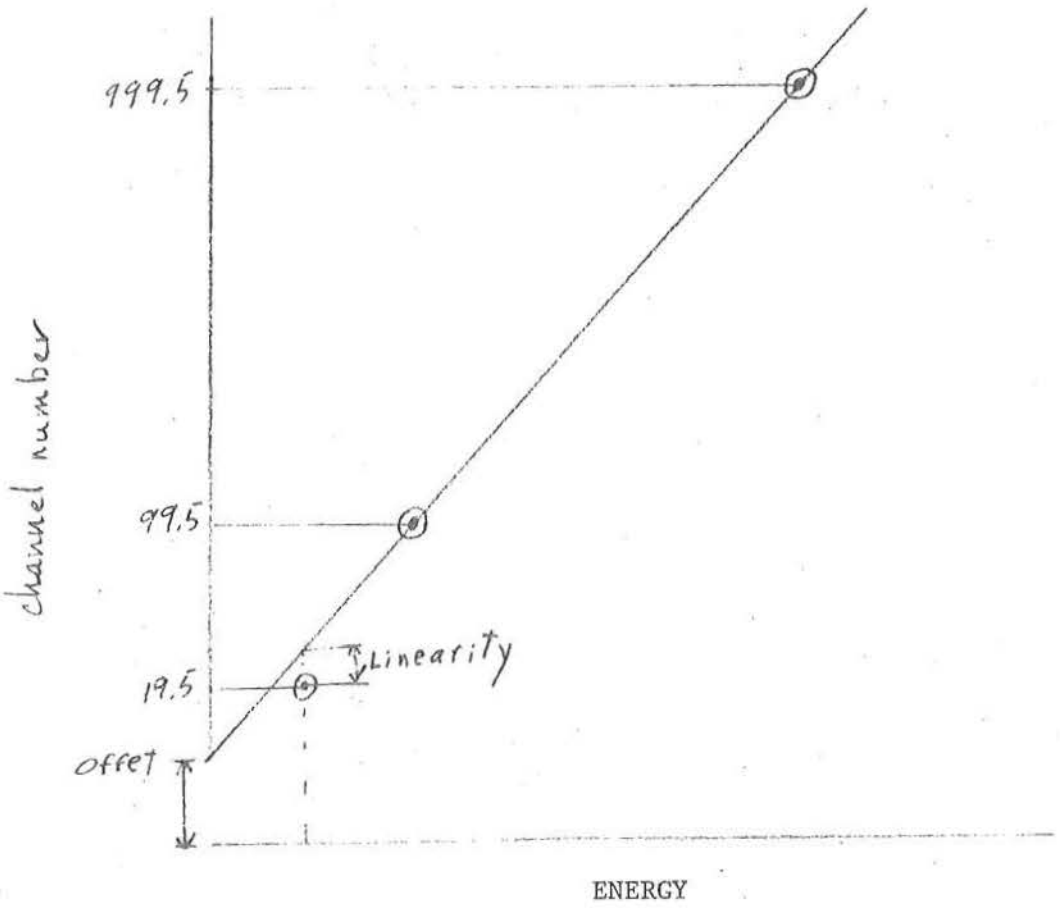


Figure 3

The linearity is defined as the difference (in channels) between channel 19.5 (=channel 20 threshold) and the channel predicted from equation 3 corresponding to the measured channel 20 threshold energy. In terms of equation 3 the linearity is

$$L = 19.5 - \frac{1}{G}\left[E(19.5) - E(999.5)\right] + 999.5$$

$$= - \frac{1}{G}\left[E(19.5) - E(999.5)\right] - 980$$

III. Results of Electronic Calibrations

Appendix A-H (A-J) contains a sample of the IMP-H (IMP-J) CALAN output for selected detectors. The complete set of all IMP-H (IMP-J) CALAN output is stored in a large black (blue) loose leaf notebook. Two calibrations are included for D2 and D5 because of instabilities in the calibration of these detectors (see discussion below). Table #1 lists preflight electronic calibrations performed on IMP-H, and Table #2 gives the corresponding data for IMP-J. Other information in Tables #1 and #2 is discussed below.

The thresholds of channels not calibrated directly can be obtained by linear interpolation between measured thresholds. Gordon Hurford's program ABRET performs this task. Appendix B-H contains the measured and interpolated thresholds for channels 1-100 for all IMP-H detectors. The corresponding data for IMP-J is in Appendix B-J. The CALAN output used for each detector is listed in Tables #1 and #2. The IMP-H D2 and D5 thresholds are based on 2/18/72 CALAN data with a shift of -9 and +10 keV per channel respectively. The thresholds in Appendices A-H and A-J can be used for interpreting flight data (see D2, D5 exceptions below). If highly accurate threshold values for prelaunch

Table 1 - IMP-H ELECTRONIC CALIBRATIONS

DATE	D2 OFFSET (channels)	D2 GAIN (KeV/ch)	D5 OFFSET (channels)	D5 GAIN (KeV/ch)	Source of data for Appendix B-H
6/29/71	6.274	41.146	2.374	41.358	
7/13/71	6.121	41.148	2.023	41.352	
7/19/71	6.205	41.156	4.187	41.367	DØ, D8
2/18/72	6.149	41.148	1.438	41.402	D2*, D5*
2/23/72	12.438	41.225	1.635	41.399	
2/28/72	10.600	41.140	4.354	41.405	
3/2/72	11.887	41.153	4.527	41.408	D3
3/13/72	10.624	41.161	4.249	41.434	D1, D4, D6, D7, D9

*Corrected (see text)

Table 2 - IMP-J ELECTRONIC CALIBRATIONS

DATE	D2 OFFSET (channels)	D2 GAIN (KeV/ch)	D5 OFFSET (channels)	D5 GAIN (channels)	Source of data for Appendix B-J
10/31/72	8.255	40.999	0.887	41.256	
11/6/72	8.250	41.054	0.900	41.319	
11/19/72	8.354	41.011	0.977	41.286	
11/27/72	8.261	41.055	0.844	41.372	
12/11/72	8.330	41.056	0.919	41.366	
12/15/72	8.338	41.028	0.956	41.309	
1/2/73	6.998	41.032	-0.281	41.334	
6/26/73	8.320	40.971	0.956	41.194	All Detectors

data are required the CALAN output for the appropriate period should be consulted (see Tables #1 and #2). However, except for D2 and D5, CALAN threshold values were very stable with time.

IV. The Calibration of D2 and D5

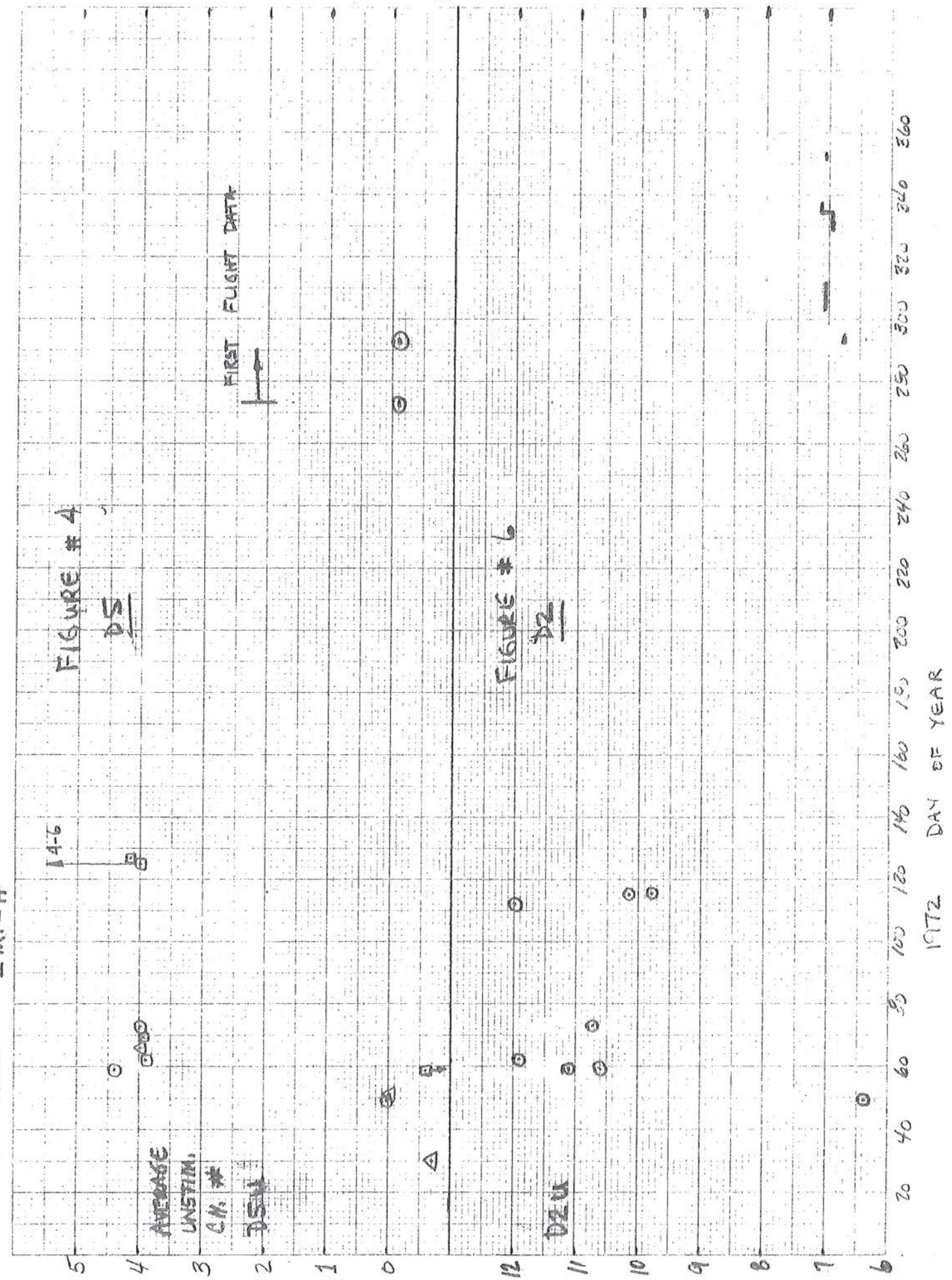
Both the pre-flight calibrations and post-launch data contain examples of sudden shifts in the threshold of the individual channels of D2 and D5. (the only detectors with 16 MHz ADC's). These calibration shifts appear to involve a sudden shift in the ADC offset by $\pm \lesssim 3$ channels, while the ADC gain remains essentially unchanged. (See, for example, the IMP-H CALAN output of 2/23/72 and 2/28/72 in Appendix A-H.) The cause of this problem is not understood. The few examples available indicate that it is possible to use the unstimulated output of the detector involved to monitor the occurence and magnitude of these shifts. The D5 unstimulated output (D5U) is read out during PLO and NEUTRAL events, while the D2 unstimulated output for IMP-H (D2U) is read out during D5 single events. Figures 4 and 5 show D5U for IMP-H as a function of time, and figures 6 and 7 show D2U as a function of time. This data is also summarized in Table 3. Note that D2U has undergone at least 2 major shifts since the launch of IMP-H.

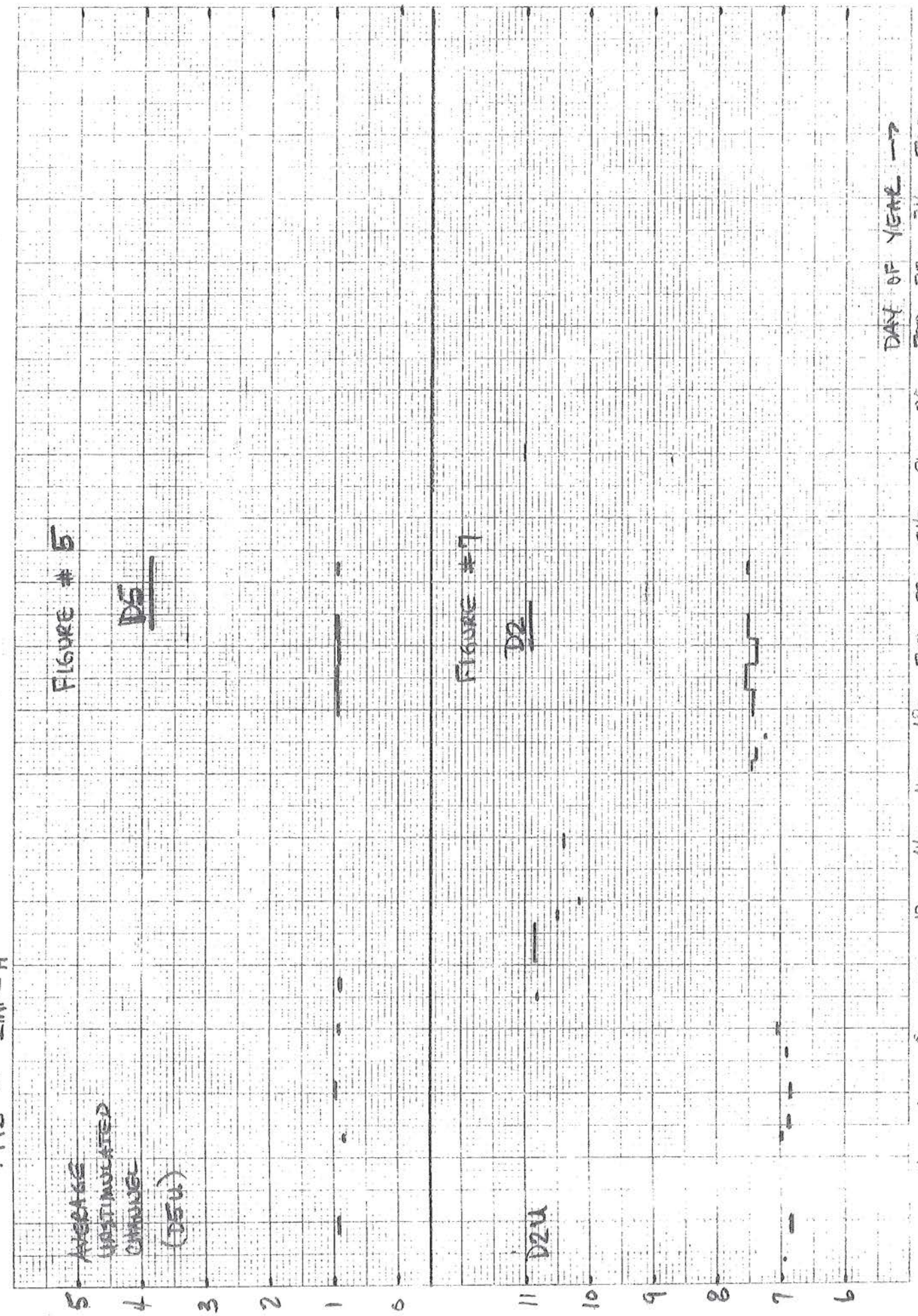
We consider now D5 on IMP-H in some detail. Figure 8 shows a cross-plot of the CALAN D5 offset (D50) vs the mean D5U channel # obtained from either PARET or particle calibration (β, γ) data taken on the same or a nearby day. The few examples available suggest that there is a close correspondence between D50 and D5U.

Table 3. - D2 and D5 Unstimulated Pulse Heights - IMP-H

Dates	Source of Data	Mean D2 Unstim. Ch.#	Mean D5 Unstim. Ch.#	Comments
6/27	PARET	6.60	-	
6/29/71	PARET	6.92	1.93	
71:293	PARET	6.24		
:355	PARET	6.45		
1/30/72	γ-DATA		.29	
2/18	PARET	6.36	1.02	
2/20	γ		.97	
2/26	β		<.4	
2/27-28	β		4.34	
2/28	PARET	10.6,11.12	4.39	Unstable
3/2	PARET	11.91	3.90	
3/2-3	γ		3.93	
3/6	γ		3.98	
3/6-8	β		4.00	
3/9-10	β		3.94	
3/12-13	γ		3.91	
3/13	PARET	10.72	3.97	
4/21/72	PARET	11.98		
4/24/72	PARET	10.15		
4/25	β		4-6	D5 Double Valued at Times
4/26	β		4.15	
	Launch 9/25/72			
72:273	Flight Data		.9	
293		6.76	.90	
303-12		7.05		
329-32		6.94		
333-36		7.13		
351-52		7.06		
73:007		6.88		
16-19		6.85	.90	
20-21		6.85	.91	
45-46		6.91	.84	
48-53		6.84	.97	
71-73		6.88		
78-81		7.04	.92	
89-91		10.79		
101-112		10.86	.90	Note: No change in D5U when D2U changes
114-116		10.49		
119-120		10.32		
137-141		10.40		
73:141-144		10.36		
161-163		7.46		
164-168		7.38		
171		7.44		

Note: A second shift of D2U occurs at about 75:100.


1972 - IMP-H
FIGURE # 4
D5
FIGURE # 6
D2
FIRST FLIGHT DATA
4-6
AVERAGE UNSTIM. CM #
DSU
D2U
1972 DAY OF YEAR


1973 - IMP-H
Figure # 5
D5
AVERAGE (UNTIMULATED) CHANNEL (DEU)
5
4
3
2
1
0
Figure #7
D2
D2U
11
10
9
8
7
6
0
40
80
120
140
160
180
200
220
240
260
280
300
320
340
360
DAY OF YEAR — 7
1973

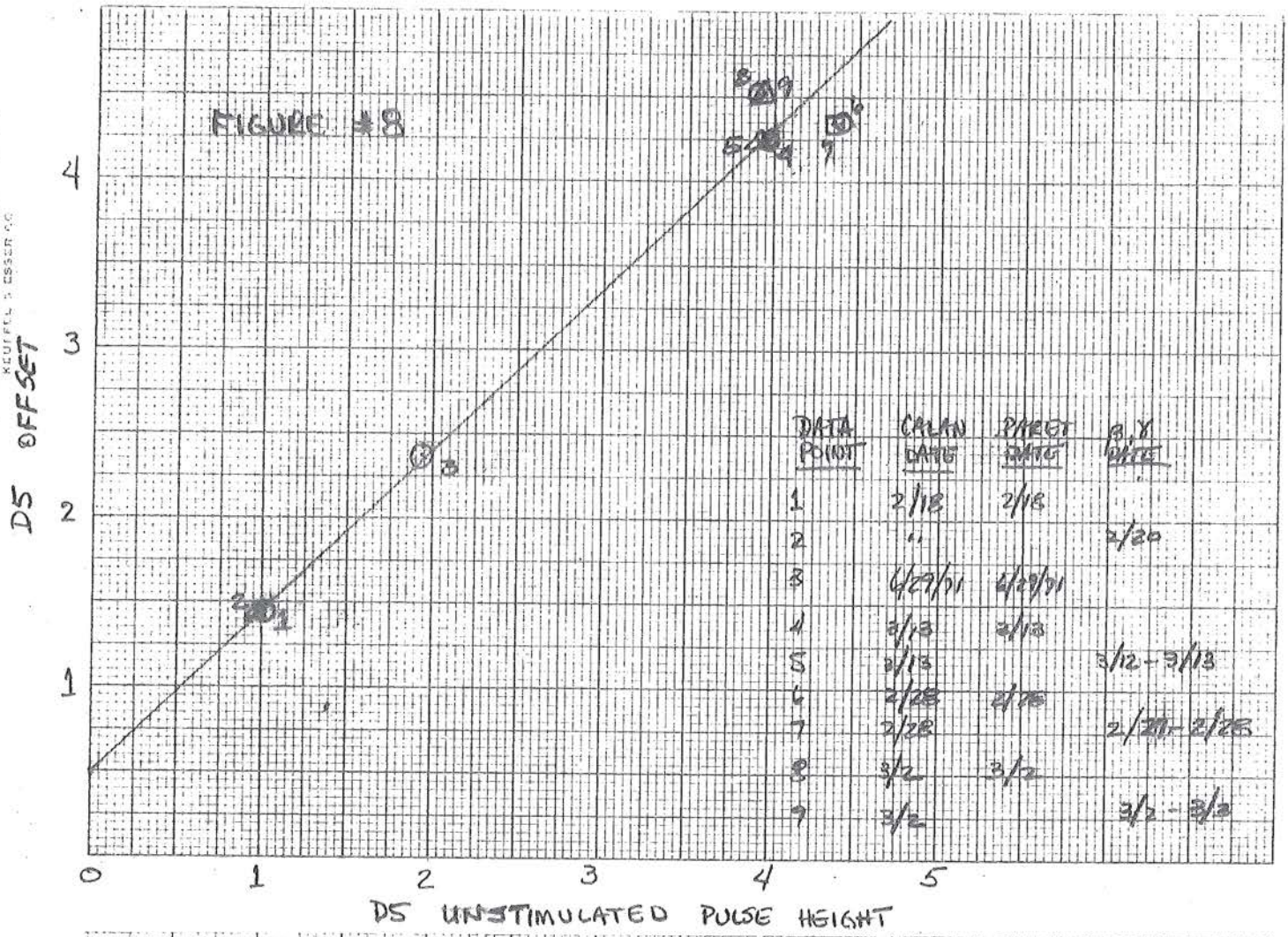
It has been found empirically that it is possible to a good approximation to map preflight CALAN channel thresholds taken on different dates onto each other by simply shifting the calibrations by the # of channels that D5U has shifted. This procedure is necessary to obtain corrected channel thresholds for flight time periods when there is evidence of a drift in D5U. The recommended procedure is to select the CALAN output corresponding to a D5U value similar to that on the day in question. For example, on 2/18/73 we have $D5U_o$ = 1.02 channels (PARET output, Table 3) and the D5 CALAN output in Appendix A-H. To obtain individual channel calibrations for day x when D5U = $D5U_x$ we define

$$\Delta U_x = D5U_x - 1.02$$

and the threshold $E_x(n)$ of channel n on day x is given by $E_x(n) = E_o(n-\Delta U_x)$ where $E_o(n-\Delta U_x)$ is the interpolated threshold of channel $n-\Delta U_x$ in the 2/18/73 CALAN output. Because of the nonlinearity of low D5 channels, channel by channel interpolation is necessary. This simple algorithm leads to errors of $\lesssim$ 10 KeV for channels #'s $n < 100$ in all cases where direct comparison with other CALAN output is possible. For $n > 100$ the error is $< .3\%$. This level of accuracy should be sufficient for almost all uses.

Application of this procedure to IMP H D5 electron pulse height spectra from β-spectrometer data taken during periods of different D5U levels (ΔU = 4 channels) gave consistent measurements of the beam energy to within 20 KeV for .25 and .50 MeV electrons. Uncertainties in the β-spectrometer magnet calibration are of this order.

FIGURE #8



DATA POINT	CALAN DATE	PREDICT DATE	8,X DATE
1	2/18	2/18	
2	"		2/20
3	4/29/91	4/29/91	
4	3/13	3/13	
5	3/13		3/12 - 3/13
6	2/28	2/28	
7	2/28		2/27 - 2/28
8	3/2	3/2	
9	3/2		3/2 - 3/2

FIGURE #9

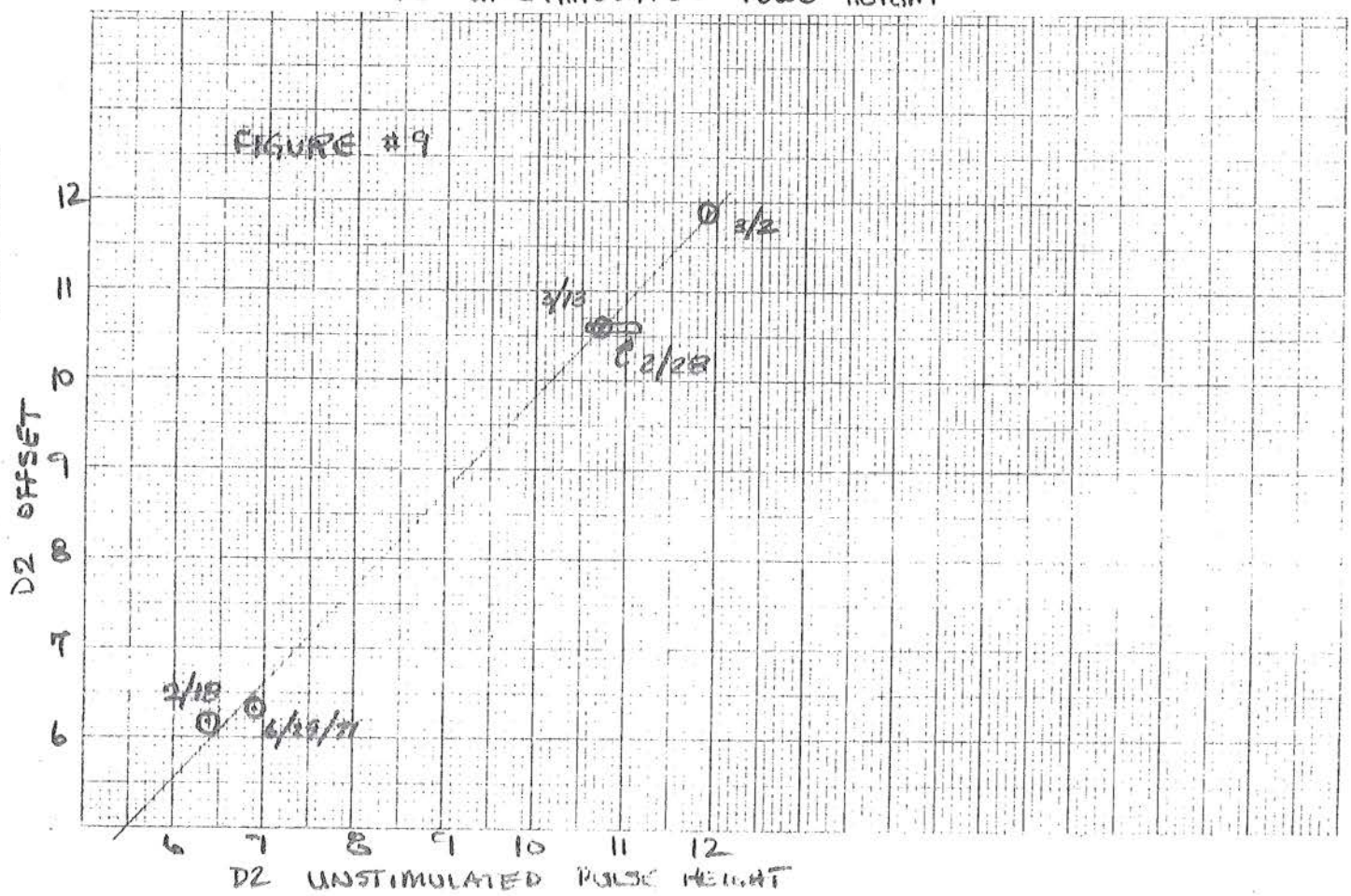


Figure 9 shows a comparison of the D2U and D20 values measured on the same days. The discrepancies are of the order of a few tenths of a channel. From Table 3 and Figures 6 and 7 it is apparent that D2U is typically in either the range 6-8 or 10-12. D2 channel thresholds accurate to < 10 KeV can be obtained for any time period using the interpolation procedure described for D5. For D2U $\sim$ 7 the 2/18/73 CALAN output (D2U = 6.36) should be used, while for D2U $\sim$ 11 the 3/13/72 CALAN output (D2U = 10.72) would be appropriate.

The numbers in Table 3 and Figures 4 to 7 should be used only as a guide to offset shifts that have been observed. If accurate thresholds are desired when working with D2 or D5 data from either instrument, the D2U and D5U levels within that data set should be determined and the appropriate corrections made on as fine a time scale as is necessary.

With IMPJ the D2U value is lost. Therefore, some other technique, such as end of range proton channel #'s would have to be used to determine if any calibration shift occurs in post-launch data.

V. Problems in Interpreting Data

In this section three problems related to the use of calibrations in interpreting real data will be discussed. They are 1) overflows, 2) underflows, and 3) rundown not reaching an accumulator.

An overflow occurs when the energy loss in a detector saturates the pulse height analyzer (PHA). For all detectors except D2 and D5, when this happens the final state is either channel 1022 or 1023 (scale of 0 to 1023). The final states for D2 and D5 are 3 and 4092 respectively (scale of 0 to 1023 and 0 to 4092). (Note that D2's high channels are ...1022, 1023, 0, 1, 2, 3.) Since the D2H

threshold is channel 16, and the D2 offset for a typical calibration is + 10 channels, the first 3 channels of D2 correspond to overflows only, and not to small pulse heights.

An underflow occurs when the ADC rundown signal is shorter than the nominally allowed value. The reason for this malfunction isn't understood although it may be a pulse shape or timing problem. All accumulators are preset to some small negative value (equivalent to a large positive value in the binary code) (see tables 4 and 5). The minimum rundown should be long enough for the PHA to count to channel 0. When a shorter rundown is accepted, the PHA is in a large positive (or equivalently, a small negative) channel. The most common channel is -1 for all detectors except D2. This is read out as (is equivalent to) channel 4092 for D5 (D5 channels are multiples of 4 above 1024). A priori such an event is indistinguishable from an overflow. Although channel -1 is the most common underflow channel, other values have been observed (see tables 4 and 5).

Occasionally, for some unknown reason, a rundown signal doesn't reach the appropriate accumulator. In this case the channel in the PHA corresponds to the preset value in the accumulator. For some even less understood reason, some spurious counts are often added to this preset value. For example, the D6 accumulator is preset to channel 1011, but according to the phenomenon described above channel 1012 may be read out. Table 4 lists the observed occurrences of this phenomenon.

Table 4. - IMP-H Underflows and Overflows

Detector	Negative Preset Value	Unstim. Ch.#.	Observed Preset Ch.#'s	Observed Underflows	Range Possibly Affected by Underflows	Overflow Ch.#'s
DØ	1012(-12)	0,1*	1012	1020 - 1023	1013 - 1023	1022,1023
D2	979(-45)	See Fig. 4-5	979		980 - 1023	3 +
D5‡	4048(-48)	See Fig. 6-7	4048	4064,4068, 4088, 4092	4052 - 4092 in multiples of 4	4092
D7	1011(-13)	0	1011	1012 - 1014 1020 - 1023	1012 - 1023	1022,1023
All others	1011(-13)	0			1012 - 1023	1022,1023

NOTES:

*Channel Ø equivalent to channel 1 in detector DØ

+For D2 only, interpret channel 0 as 1024
1 as 1025
2 as 1026
3 as > 1026

‡Channel Ø in D5H is equivalent to an overflow

Miscellaneous

For lack of better place to put it, some information pertaining to channel calibrations is given in this section.

D2 and D5 have a second threshold called D2H and D5H (H stands for high), which are important for the priority and rate equations. The D2H threshold is channel 16. The D6H threshold, as determined from calibration data, is approximately channel 80. Because of timing uncertainties, the D5H threshold can vary by several channels.

Except for errors, such as underflows, the PHA channel for each detector should be at least as great as a certain minimum value. Tables 4 and 5 list the channel numbers that are read out for detectors that have not been triggered. Note that on IMPJ, DO is never channel 0, and for D5 is seldom channel 0. (See internal report #50 for detailed explanation.) The IMPJ unstimulated value for D2 is unknown since the D2 channel is read out only if D2H triggers.

Table 5. - IMPJ Underflows and Overflows

Detector	Preset Value	Unstim. Ch.#	Observed Preset Ch.#'s	Observed Underflows	Range Possbily Affected by Underflows	Overflow Ch.#
D0	1013(-11)	1,2			1014 - 1023	1022,1023
D2	979(-45)		979		980-1023	3
D5*	4048(-48)	0-4	4048	4056,4092	4052-4092 in multiples of 4	4092
D7	1011(-13)	0			1012-1023	1022,1023
all others	1011(-13)	0		1013	1012-7023	1022,1023

*Channel 0 in D5H is equivalent to an overflow.

APPENDIX A-H

SELECTED IMP-H CALAN OUTPUT

This appendix contains selected CALAN output for IMP-H detectors, including gain offset, and linearity values, and calibrated channel thresholds in MeV. The ADC threshold values should be disregarded (see Section I-B). Prelaunch calibration dates are summarized in Table 1. Two calibrations are included for D2 and D5 as discussed in Section IV. Thresholds for intermediate channels can be found in Appendix B-H.

H DETECTOR #00

7-19-71 POST THERMAL VACUUM CALIBRATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01563 VOLTS 158.5 KEV

SIGMA = 0.00229 VOLTS 22.4 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
2	0.03370	0.3257
3	0.04716	0.4574
4	0.06320	0.6145
5	0.07966	0.7756
6	0.09612	0.9368
7	0.11292	1.1013
8	0.12965	1.2651
9	0.14659	1.4309
10	0.16365	1.5980
20	0.33242	3.2503
30	0.50130	4.9038
40	0.66949	6.5505
50	0.83798	8.2001
60	1.00620	9.8471
70	1.17408	11.4908
80	1.34234	13.1382
90	1.51020	14.7816
100	1.67834	16.4278
200	3.35977	32.8902
300	5.04132	49.3538
400	6.72220	65.8108
500	8.40334	82.2703
600	10.08421	98.7273
700	11.76451	115.1786
800	13.44516	131.6333
900	15.12653	148.0951
1000	16.80903	164.5680

GAIN 164.600 KEV/CHANNEL

OFFSET -0.305 CHANNELS (ENERGY)

LINEARITY +0.058 CHANNELS (ENERGY)

H DETECTOR #01

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01691 VOLTS 160.8 KEV

SIGMA = 0.00240 VOLTS 22.9 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03160	0.3075
2	0.04705	0.4552
3	0.06390	0.6163
4	0.08071	0.7770
5	0.09808	0.9430
6	0.11523	1.1070
7	0.13281	1.2750
8	0.14980	1.4375
9	0.16715	1.6033
19	0.34086	3.2639
29	0.51420	4.9209
39	0.68716	6.5743
49	0.85979	8.2245
59	1.03237	9.8743
69	1.20515	11.5259
79	1.37777	13.1761
89	1.55024	14.8248
99	1.72308	16.4770
199	3.45029	32.9880
299	5.17824	49.5062
399	6.90627	66.0250
499	8.63413	82.5423
599	10.36233	99.0628
699	12.09088	115.5866
799	13.81997	132.1156
899	15.55087	148.6619
999	17.28332	165.22[illegible]0

GAIN 165.273 KEV/CHANNEL

OFFSET -1.196 CHANNELS (ENERGY)

LINEARITY -0.053 CHANNELS (ENERGY)

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H DETECTOR #02

18 FEB 1972 D7 DISCONNECTED; D3 DISABLED FOR ALL BUT D3

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01797 VOLTS 158.5 KEV

SIGMA = 0.00259 VOLTS 24.5 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
9	0.02211	0.1932
10	0.02392	0.2103
11	0.02615	0.2314
12	0.02920	0.2602
13	0.03248	0.2912
23	0.07235	0.6682
33	0.11535	1.0748
43	0.15897	1.4873
53	0.20240	1.8980
63	0.24640	2.3141
73	0.28984	2.7248
83	0.33350	3.1377
93	0.37727	3.5516
103	0.42096	3.9647
203	0.85626	8.0809
303	1.29131	12.1947
403	1.72629	16.3079
503	2.16144	20.4227
603	2.59658	24.5373
703	3.03160	28.6509
803	3.46683	32.7664
903	3.90220	36.8833
1003	4.33738	40.9983

GAIN 41.148 KEV/CHANNEL

OFFSET +6.149 CHANNELS (ENERGY)

LINEARITY +0.111 CHANNELS (ENERGY)

H DETECTOR #02

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01743 VOLTS 153.4 KEV

SIGMA = 0.00275 VOLTS 26.0 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
15	0.02400	0.2110
16	0.02702	0.2396
17	0.03024	0.2700
18	0.03391	0.3048
19	0.03743	0.3380
20	0.04139	0.3755
21	0.04551	0.4144
22	0.04964	0.4535
23	0.05377	0.4925
33	0.09642	0.8958
43	0.13978	1.3059
53	0.18325	1.7169
63	0.22712	2.1317
73	0.27057	2.5426
83	0.31436	2.9567
93	0.35817	3.3710

GAIN INSUFFICIENT DATA

OFFSET INSUFFICIENT DATA

LINEARITY INSUFFICIENT DATA

ER 07D7

H DETECTOR #03

3-2-72 POST VIBRATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01795 VOLTS 165.1 KEV

SIGMA = 0.00237 VOLTS 22.9 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03484	0.3163
2	0.04733	0.4368
3	0.06211	0.5795
4	0.07833	0.7360
5	0.09520	0.8987
6	0.11224	1.0631
7	0.12923	1.2271
8	0.14649	1.3936
9	0.16363	1.5590
19	0.33529	3.2153
29	0.50686	4.8707
39	0.67788	6.5208
49	0.84897	8.1715
59	1.01969	9.8187
69	1.19047	11.4665
79	1.36134	13.1152
89	1.53203	14.7621
99	1.70273	16.4091
199	3.41099	32.8914
299	5.11824	49.3640
399	6.82456	65.8275
499	8.52945	82.2773
599	10.23300	98.7142
699	11.93517	115.1377
799	13.63701	131.5580
899	15.33844	147.9744
999	17.03930	164.3854

GAIN 164.418 KEV/CHANNEL

OFFSET -1.301 CHANNELS (ENERGY)

LINEARITY +0.246 CHANNELS (ENERGY)

H DETECTOR #04

3-13-72 NEW DI INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01567 VOLTS 163.0 KEV

SIGMA = 0.00234 VOLTS 22.3 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03401	0.3329
2	0.04985	0.4842
3	0.06665	0.6446
4	0.08404	0.8107
5	0.10149	0.9773
6	0.11931	1.1475
7	0.13665	1.3131
8	0.15447	1.4833
9	0.17206	1.6513
19	0.34853	3.3366
29	0.52491	5.0211
39	0.70068	6.6997
49	0.87647	8.3786
59	1.05171	10.0521
69	1.22759	11.7318
79	1.40303	13.4073
89	1.57858	15.0838
99	1.75415	16.7606
199	3.51118	33.5405
299	5.26908	50.3288
399	7.02699	67.1172
499	8.78465	83.9032
599	10.54177	100.6840
699	12.29756	117.4521
799	14.05303	134.2172
899	15.80759	150.9736
999	17.56048	167.7140

GAIN 167.726 KEV/CHANNEL

OFFSET -1.428 CHANNELS (ENERGY)

LINEARITY +0.035 CHANNELS (ENERGY)

H DETECTOR #05

18 FEB 1972 D7 DISCONNECTED

1000 COUNT CALIBRATION.

ADC THRESHOLD = 0.01597 VOLTS 159.5 KEV

SIGMA = 0.00166 VOLTS 15.6 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
7	0.02606	0.2582
8	0.02930	0.2886
9	0.03285	0.3219
10	0.03663	0.3574
20	0.07831	0.7483
30	0.12215	1.1595
40	0.16648	1.5753
50	0.21060	1.9892
60	0.25501	2.4057
70	0.29947	2.8227
80	0.34373	3.2379
90	0.38791	3.6523
100	0.43225	4.0682
200	0.87381	8.2098
300	1.31484	12.3465
400	1.75559	16.4806
500	2.19701	20.6210
600	2.63828	24.7599
700	3.07956	28.8990
800	3.52062	33.0360
900	3.96185	37.1746
1000	4.40317	41.3140
2000	8.81626	82.7072
3000	13.22929	124.0999
4000	17.64615	165.5284

GAIN 41.402 KEV/CHANNEL

OFFSET +1.438 CHANNELS (ENERGY)

LINEARITY -0.197 CHANNELS (ENERGY)

H. DETECTOR #05

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01673 VOLTS 166.7 KEV

SIGMA = 0.00168 VOLTS 15.8 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
8	0.02069	0.2079
9	0.02324	0.2318
10	0.02625	0.2600
11	0.02950	0.2905
12	0.03324	0.3256
13	0.03708	0.3616
14	0.04107	0.3990
15	0.04519	0.4377
16	0.04934	0.4766
17	0.05349	0.5155
18	0.05781	0.5560
19	0.06197	0.5951
20	0.06631	0.6358
30	0.10994	1.0450
40	0.15412	1.4594
50	0.19843	1.8750
60	0.24268	2.2901
70	0.28707	2.7064
80	0.33140	3.1222
90	0.37542	3.5351
100	0.41978	3.9512
200	0.86205	8.0995
300	1.30335	12.2388
400	1.74451	16.3767
500	2.18615	20.5191
600	2.62761	24.6599
1000	4.39403	41.2283
2000	8.81050	82.6532
4000	17.64714	165.5377

GAIN 41.434 KEV/CHANNEL

OFFSET +4.249 CHANNELS (ENERGY)

LINEARITY -0.111 CHANNELS (ENERGY)

H DETECTOR #06

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01856 VOLTS 164.2 KEV

SIGMA = 0.00216 VOLTS 20.4 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03877	0.3467
2	0.05224	0.4740
3	0.06786	0.6217
4	0.08476	0.7814
5	0.10186	0.9431
6	0.11948	1.1096
7	0.13680	1.2733
8	0.15451	1.4407
9	0.17188	1.6049
19	0.34752	3.2652
29	0.52260	4.9202
39	0.69734	6.5719
49	0.87204	8.2233
59	1.04638	9.8713
69	1.22086	11.5206
79	1.39531	13.1696
89	1.56993	14.8202
99	1.74447	16.4701
199	3.49027	32.9725
299	5.23695	49.4833
399	6.98392	65.9968
499	8.73145	82.5155
599	10.47894	99.0339
699	12.22726	115.5602
799	13.97652	132.0953
899	15.72775	148.6491
999	17.48046	165.2168

GAIN 165.274 KEV/CHANNEL

OFFSET -1.153 CHANNELS (ENERGY)

LINEARITY -0.103 CHANNELS (ENERGY)

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DETECTOR #07

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01235 VOLTS 143.6 KEV

SIGMA = 0.00188 VOLTS 18.0 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.01911	0.2063
2	0.03362	0.3454
3	0.04926	0.4954
4	0.06616	0.6575
5	0.08321	0.8210
6	0.10033	0.9852
7	0.11738	1.1487
8	0.13460	1.3139
9	0.15206	1.4813
19	0.32524	3.1422
29	0.49795	4.7986
39	0.67052	6.4536
49	0.84287	8.1065
59	1.01515	9.7588
69	1.18720	11.4088
79	1.35943	13.0606
89	1.53162	14.7120
99	1.70365	16.3618
199	3.42576	32.8776
299	5.14781	49.3929
399	6.86890	65.8990
499	8.58901	82.3956
599	10.30837	98.8851
699	12.02692	115.3668
799	13.74534	131.8472
899	15.46438	148.33[illegible]5
999	17.18265	164.8127

GAIN 164.945 KEV/CHANNEL

OFFSET -0.695 CHANNELS (ENERGY)

LINEARITY +0.145 CHANNELS (ENERGY)

H DETECTOR #08

7-13-71 POST COLD SOAK D3 DISABLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01713 VOLTS 138.8 KEV

SIGMA = 0.00237 VOLTS 22.4 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03804	0.3526
2	0.05070	0.4723
3	0.06549	0.6121
4	0.08208	0.7690
5	0.09917	0.9306
6	0.11663	1.0958
7	0.13416	1.2615
8	0.15190	1.4293
9	0.16913	1.5922
19	0.34499	3.2552
29	0.52016	4.9117
39	0.69538	6.5687
49	0.87006	8.2206
59	1.04480	9.8730
69	1.21949	11.5249
79	1.39405	13.1757
89	1.56877	14.8279
99	1.74342	16.4795
199	3.49082	33.0037
299	5.23873	49.5328
399	6.98658	66.0613
499	8.73420	82.5877
599	10.48224	99.1180
699	12.23006	115.6463
799	13.97813	132.1769
899	15.72703	148.7153
999	17.47752	165.2688

GAIN 165.322 KEV/CHANNEL

OFFSET -1.181 CHANNELS (ENERGY)

LINEARITY -0.009 CHANNELS (ENERGY)

DETECTOR #09

3-13-72 NEW D1 INSTALLED

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01205 VOLTS 97.2 KEV

SIGMA = 0.00218 VOLTS 20.8 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03342	0.3029
2	0.04689	0.4315
3	0.06227	0.5784
4	0.07880	0.7363
5	0.09585	0.8991
6	0.11310	1.0638
7	0.13047	1.2297
8	0.14779	1.3951
9	0.16514	1.5608
19	0.33889	3.2201
29	0.51246	4.8777
39	0.68571	6.5322
49	0.85862	8.1835
59	1.03166	9.8360
69	1.20426	11.4844
79	1.37711	13.1351
89	1.54990	14.7852
99	1.72271	16.4355
199	3.45116	32.9422
299	5.17973	49.4499
399	6.90797	65.9545
499	8.63591	82.4563
599	10.36344	98.9541
699	12.09151	115.4571
799	13.82013	131.9654
899	15.55027	148.4882
999	17.28111	165.0176

GAIN 165.091 KEV/CHANNEL

OFFSET -1.054 CHANNELS (ENERGY)

LINEARITY +0.049 CHANNELS (ENERGY)

APPENDIX A-J

SELECTED IMP-J CALAN OUTPUT

This appendix contains selected CALAN output for IMP-J detectors, including gain offset, and linearity values, and calibrated channel thresholds in MeV. The ADC threshold values should be disregarded (see Section I-B). Prelaunch calibration dates are summarized in Table 1. Thresholds for intermediate channels can be found in Appendix B-J.

DETECTOR #00

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01781 VOLTS 172.3 KEV

SIGMA = 0.00164 VOLTS 15.5 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
3	0.02960	0.2846
4	0.04534	0.4330
5	0.06212	0.5912
6	0.07946	0.7546
7	0.09683	0.9184
9	0.13158	1.2460
20	0.32435	3.0635
100	1.72171	16.2377
1000	17.42906	164.3260

GAIN 164.542 KEV/CHANNEL

OFFSET + 0.816 CHANNELS (ENERGY)

LINEARITY +0.016 CHANNELS (ENERGY)

DETECTOR #01

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01768 VOLTS 168.0 KEV

SIGMA = 0.00165 VOLTS 15.2 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03304	0.3145
2	0.04962	0.4674
3	0.06728	0.6302
4	0.08505	0.7941
5	0.10310	0.9606
6	0.12116	1.1271
7	0.13911	1.2926
8	0.15740	1.4613
9	0.17554	1.6286
20	0.37501	3.4680
100	1.82101	16.8026
1000	18.05638	166.5203

GAIN 166.353 KEV/CHANNEL

OFFSET - 1.506 CHANNELS (ENERGY)

LINEARITY +0.158 CHANNELS (ENERGY)

DETECTOR #02

6-26-73 POST DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01498 VOLTS 162.7 KEV

SIGMA = 0.00264 VOLTS 24.8 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
17	0.03281	0.3443
18	0.03675	0.3813
19	0.04082	0.4196
20	0.04494	0.4583
21	0.04915	0.4979
22	0.05332	0.5371
23	0.05746	0.5760
25	0.06607	0.6569
100	0.39364	3.7357
1000	4.31681	40.6098

GAIN 40.971 KEV/CHANNEL

OFFSET + 8.320 CHANNELS (ENERGY)

LINEARITY +0.122 CHANNELS (ENERGY)

DETECTOR #03

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01767 VOLTS 172.3 KEV

SIGMA = 0.00159 VOLTS 15.0 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03020	0.2910
2	0.04612	0.4407
3	0.06330	0.6023
4	0.08057	0.7647
5	0.09813	0.9299
6	0.11573	1.0954
7	0.13350	1.2625
8	0.15122	1.4292
9	0.16887	1.5952
20	0.36392	3.4295
100	1.77711	16.7200
1000	17.68728	166.3486

GAIN 166.254 KEV/CHANNEL

OFFSET - 1.069 CHANNELS (ENERGY)

LINEARITY -0.059 CHANNELS (ENERGY)

DETECTOR #04

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01641 VOLTS 172.3 KEV

SIGMA = 0.00151 VOLTS 14.0 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03180	0.3210
2	0.04816	0.4731
3	0.06529	0.6323
4	0.08292	0.7962
5	0.10044	0.9591
6	0.11826	1.1247
7	0.13599	1.2895
8	0.15360	1.4541
9	0.17145	1.6198
20	0.36789	3.4452
100	1.79278	16.6908
1000	17.90143	166.4338

GAIN 166.381 KEV/CHANNEL

OFFSET - 0.816 CHANNELS (ENERGY)

LINEARITY -0.391 CHANNELS (ENERGY)

J DETECTOR #05

6-26-73 POST DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01790 VOLTS 193.4 KEV

SIGMA = 0.00191 VOLTS 17.9 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
5	0.02135	0.2219
6	0.02344	0.2415
7	0.02648	0.2700
8	0.02997	0.3028
9	0.03370	0.3378
10	0.03759	0.3742
11	0.04151	0.4110
12	0.04564	0.4497
13	0.04975	0.4883
14	0.05402	0.5283
15	0.05817	0.5673
20	0.07966	0.7688
100	0.43175	4.0709
400	1.74822	16.4177
4000	17.56061	164.7166

GAIN 41.194 KEV/CHANNEL

OFFSET + 0.956 CHANNELS (ENERGY)

LINEARITY -0.279 CHANNELS (ENERGY)

J DETECTOR #06

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01742 VOLTS 173.5 KEV

SIGMA = 0.00162 VOLTS 15.5 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.02976	0.2887
2	0.04541	0.4386
3	0.06198	0.5974
4	0.07891	0.7595
5	0.09594	0.9227
6	0.11326	1.0886
7	0.13048	1.2536
8	0.14771	1.4186
9	0.16500	1.5843
20	0.35527	3.4070
100	1.73349	16.6102
1000	17.23298	165.0928

GAIN 164.981 KEV/CHANNEL

OFFSET - 1.179 CHANNELS (ENERGY)

LINEARITY +0.028 CHANNELS (ENERGY)

J DETECTOR #07

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01676 VOLTS 183.3 KEV

SIGMA = 0.00164 VOLTS 15.7 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03138	0.3221
2	0.04716	0.4730
3	0.06372	0.6313
4	0.08056	0.7923
5	0.09784	0.9575
6	0.11498	1.1213
7	0.13219	1.2859
8	0.14937	1.4501
9	0.16660	1.6148
20	0.35677	3.4329
100	1.73556	16.6146
1000	17.25227	164.9591

GAIN 164.827 KEV/CHANNEL

OFFSET - 1.300 CHANNELS (ENERGY)

LINEARITY -0.027 CHANNELS (ENERGY)

J DETECTOR #08

6-26-73 POST - DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01728 VOLTS 159.1 KEV

SIGMA = 0.00171 VOLTS 16.0 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03339	0.3082
2	0.04980	0.4620
3	0.06701	0.6232
4	0.08435	0.7857
5	0.10199	0.9510
6	0.11952	1.1152
7	0.13747	1.2834
8	0.15512	1.4488
9	0.17299	1.6162
20	0.36852	3.4482
100	1.78293	16.7004
1000	17.69723	165.8081

GAIN 165.675 KEV/CHANNEL

OFFSET - 1.302 CHANNELS (ENERGY)

LINEARITY -0.011 CHANNELS (ENERGY)

J DETECTOR #09

6-26-73 POST DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

ADC THRESHOLD = 0.01596 VOLTS 172.3 KEV

SIGMA = 0.00169 VOLTS 16.2 KEV

CHANNEL #	THRESHOLD (VOLTS)	THRESHOLD (MEV)
1	0.03091	0.3161
2	0.04680	0.4682
3	0.06348	0.6279
4	0.08039	0.7897
5	0.09751	0.9536
6	0.11493	1.1204
7	0.13206	1.2843
8	0.14955	1.4517
9	0.16666	1.6155
20	0.35741	3.4415
100	1.73807	16.6576
1000	17.25339	165.1757

GAIN 165.020 KEV/CHANNEL

OFFSET - 1.443 CHANNELS (ENERGY)

LINEARITY +0.088 CHANNELS (ENERGY)

DETECTOR #10

6-26-73 POST DETECTOR RECONFIGURATION

1000 COUNT CALIBRATION

DISC. THRESH. = 0.01399 VOLTS 132.6 KEV

SIGMA = 0.00129 VOLTS 12.2 KEV

APPENDIX B-H

IMP-H MEASURED AND INTERPOLATED CHANNEL THRESHOLDS

This appendix contains measured and interpolated channel thresholds obtained from ABRET (see Section III) for channels 1-114. These thresholds are appropriate for analyzing flight data. Notice that the thresholds for D2 and D5 have been shifted. (See Section IV.) Thresholds for channels >100 can be extrapolated from channel 100 using the gain and offset relationship (Section I).

IMP-H

CALIBRATION DATA FOR INDIVIDUAL ADC'S

CHAN	D0	D1	D2	D3	D4	D5(III)	D6	C7	D8	D9	D5(I OR II)
SHIFT	0.0	0.0	−0.009	0.0	0.0	+0.010	0.0	0.0	0.0	0.0	+0.010
EFSET	−0.032	0.115	−0.265	0.132	0.156	−0.049	0.108	0.032	0.117	0.091	−0.090
GAIN	0.164600	0.165273	0.041148	0.164418	0.167726	0.165608	0.165274	0.164945	0.165330	0.165091	0.041402
0	0.158	0.161	0.158	0.165	0.163	0.160C	0.164	0.144	0.140	0.160	0.160
1	0.158A	0.306	0.158A	0.316	0.333	0.160C	0.347	0.206	0.346	0.303	0.160A
2	0.326	0.455	0.158A	0.437	0.484	0.332C	0.474	0.345	0.468	0.432	0.160A
3	0.457	0.616	0.158A	0.580	0.645	0.484C	0.622	0.495	0.607	0.578	0.160A
4	0.614	0.777	0.158A	0.736	0.811	0.641C	0.781	0.658	0.764	0.736	0.160A
5	0.776	0.943	0.158A	0.899	0.977	0.799C	0.943	0.821	0.925	0.899	0.160A
6	0.937	1.107	0.158A	1.063	1.148	0.964C	1.110	0.985	1.090	1.064	0.160A
7	1.101	1.275	0.158A	1.227	1.313	1.129C	1.273	1.149	1.255	1.230	0.268
8	1.265	1.438	0.158A	1.394	1.483	1.294C	1.441	1.314	1.421	1.395	0.299
9	1.431	1.603	0.184	1.559	1.651	1.460C	1.605	1.481	1.588	1.561	0.332
10	1.598	1.769I	0.201	1.725I	1.820I	1.626C	1.771I	1.647I	1.754I	1.727I	0.367
11	1.763I	1.935I	0.222	1.890I	1.988I	1.792C	1.937I	1.813I	1.920I	1.893I	0.406I
12	1.928I	2.101I	0.251	2.056I	2.157I	1.958C	2.103I	1.979I	2.086I	2.059I	0.445I
13	2.094I	2.267I	0.282	2.221I	2.325I	2.124C	2.269I	2.145I	2.252I	2.225I	0.484I
14	2.259I	2.433I	0.320I	2.387I	2.494I	2.291C	2.435I	2.311I	2.418I	2.390I	0.523I
15	2.424I	2.600I	0.357I	2.553I	2.663I	2.458C	2.601I	2.478I	2.585I	2.556I	0.562I
16	2.589I	2.766I	0.395I	2.718I	2.831I	2.624C	2.767I	2.644I	2.751I	2.722I	0.602I
17	2.754I	2.932I	0.433I	2.884I	3.000I	2.791C	2.933I	2.810I	2.917I	2.888I	0.641I
18	2.920I	3.098I	0.470I	3.049I	3.168I	2.957C	3.099I	2.976I	3.083I	3.054I	0.680I
19	3.085I	3.264	0.508I	3.215	3.337	3.123C	3.265	3.142	3.249	3.220	0.719I
20	3.250	3.430I	0.546I	3.381I	3.505I	3.289C	3.430I	3.308I	3.415I	3.386I	0.758
21	3.415I	3.595I	0.584I	3.546I	3.674I	3.455C	3.596I	3.473I	3.581I	3.552I	0.799I
22	3.581I	3.761I	0.621I	3.712I	3.842I	3.621C	3.761I	3.639I	3.746I	3.717I	0.840I
23	3.746I	3.927I	0.659	3.877I	4.011I	3.787C	3.927I	3.805I	3.912I	3.883I	0.882I
24	3.912I	4.092I	0.700I	4.043I	4.179I	3.953C	4.092I	3.970I	4.078I	4.049I	0.923I
25	4.077I	4.258I	0.740I	4.209I	4.347I	4.119C	4.258I	4.136I	4.244I	4.215I	0.964I
26	4.242I	4.424I	0.781I	4.374I	4.516I	4.285C	4.423I	4.302I	4.410I	4.381I	1.005I
27	4.408I	4.590I	0.822I	4.540I	4.684I	4.451C	4.589I	4.468I	4.575I	4.546I	1.046I
28	4.573I	4.755I	0.862I	4.705I	4.853I	4.616C	4.754I	4.633I	4.741I	4.712I	1.088I
29	4.739I	4.921	0.903I	4.871	5.021	4.782C	4.920	4.799	4.907	4.878	1.129I
30	4.904	5.086I	0.944I	5.036I	5.189I	4.948C	5.085I	4.964I	5.072I	5.043I	1.170
31	5.069I	5.252I	0.985I	5.201I	5.357I	5.113C	5.250I	5.130I	5.238I	5.209I	1.211I
32	5.233I	5.417I	1.025I	5.366I	5.525I	5.279C	5.416I	5.295I	5.403I	5.374I	1.253I
33	5.398I	5.582I	1.066	5.531I	5.693I	5.445C	5.581I	5.461I	5.569I	5.540I	1.294I
34	5.562I	5.747I	1.107I	5.696I	5.860I	5.611C	5.746I	5.626I	5.734I	5.705I	1.336I
35	5.727I	5.913I	1.148I	5.861I	6.028I	5.776C	5.911I	5.792I	5.899I	5.870I	1.377I
36	5.892I	6.078I	1.190I	6.026I	6.196I	5.942C	6.076I	5.957I	6.065I	6.036I	1.419I
37	6.056I	6.243I	1.231I	6.191I	6.364I	6.108C	6.242I	6.123I	6.230I	6.201I	1.460I
38	6.221I	6.409I	1.272I	6.356I	6.532I	6.273C	6.407I	6.288I	6.396I	6.367I	1.502I
39	6.385I	6.574	1.313I	6.521	6.700	6.439C	6.572	6.454	6.561	6.532	1.543I
40	6.550	6.739I	1.354I	6.686I	6.868I	6.605C	6.737I	6.619I	6.726I	6.697I	1.585
41	6.715I	6.904I	1.396I	6.851I	7.036I	6.770C	6.902I	6.784I	6.892I	6.862I	1.626I
42	6.880I	7.069I	1.437I	7.016I	7.204I	6.936C	7.067I	6.950I	7.057I	7.028I	1.668I
43	7.045I	7.234I	1.478	7.181I	7.372I	7.102C	7.232I	7.115I	7.222I	7.193I	1.709I
44	7.210I	7.399I	1.519I	7.346I	7.539I	7.267C	7.397I	7.280I	7.387I	7.358I	1.751I
45	7.375I	7.564I	1.560I	7.512I	7.707I	7.433C	7.563I	7.445I	7.553I	7.523I	1.792I
46	7.540I	7.729I	1.601I	7.677I	7.875I	7.599C	7.728I	7.610I	7.718I	7.688I	1.833I
47	7.705I	7.894I	1.642I	7.842I	8.043I	7.764C	7.893I	7.776I	7.883I	7.854I	1.875I
48	7.870I	8.059I	1.683I	8.007I	8.211I	7.930C	8.058I	7.941I	8.049I	8.019I	1.916I
49	8.035I	8.224	1.725I	8.172	8.379	8.096C	8.223	8.106	8.214	8.184	1.958I
50	8.200	8.389I	1.766I	8.337I	8.546I	8.261C	8.388I	8.271I	8.379I	8.349I	1.999
51	8.365I	8.554I	1.807I	8.501I	8.714I	8.427C	8.553I	8.437I	8.545I	8.514I	2.041I
52	8.529I	8.719I	1.848I	8.666I	8.881I	8.592C	8.717I	8.602I	8.710I	8.680I	2.082I

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53	8.694I	8.884I	1.839	8.831I	9.048I	8.758C	8.882I	8.767I	8.876I	8.845I	2.124I
54	8.859I	9.049I	1.911I	8.995I	9.215I	8.923C	9.047I	8.932I	9.041I	9.010I	2.166I
55	9.023I	9.214I	1.972I	9.160I	9.383I	9.089C	9.212I	9.098I	9.206I	9.175I	2.207I
56	9.188I	9.379I	2.014I	9.325I	9.550I	9.254C	9.377I	9.263I	9.372I	9.340I	2.249I
57	9.353I	9.544I	2.055I	9.490I	9.717I	9.419C	9.541I	9.428I	9.537I	9.506I	2.291I
58	9.518I	9.709I	2.097I	9.654I	9.885I	9.585C	9.706I	9.594I	9.703I	9.671I	2.333I
59	9.682I	9.874	2.139I	9.819	10.052	9.750C	9.871	9.759	9.868	9.836	2.374I
60	9.847	10.039I	2.180I	9.984I	10.220I	9.916C	10.036I	9.924I	10.033I	10.001I	2.416
61	10.011I	10.204I	2.222I	10.148I	10.388I	10.081C	10.201I	10.089I	10.199I	10.166I	2.458I
62	10.176I	10.370I	2.263I	10.313I	10.556I	10.247C	10.366I	10.254I	10.364I	10.330I	2.499I
63	10.340I	10.535I	2.305	10.475I	10.724I	10.412C	10.531I	10.419I	10.530I	10.495I	2.541I
64	10.505I	10.700I	2.346I	10.642I	10.892I	10.578C	10.696I	10.584I	10.695I	10.660I	2.583I
65	10.669I	10.865I	2.387I	10.807I	11.060I	10.743C	10.861I	10.749I	10.860I	10.825I	2.624I
66	10.833I	11.030I	2.428I	10.972I	11.228I	10.908C	11.026I	10.914I	11.026I	10.990I	2.666I
67	10.998I	11.196I	2.469I	11.137I	11.396I	11.074C	11.191I	11.079I	11.191I	11.154I	2.708I
68	11.162I	11.361I	2.510I	11.301I	11.564I	11.239C	11.356I	11.244I	11.357I	11.319I	2.750I
69	11.327I	11.526	2.552I	11.466	11.732	11.405C	11.521	11.409	11.522	11.484	2.791I
70	11.491	11.691I	2.593I	11.631I	11.899I	11.570C	11.686I	11.574I	11.687I	11.649I	2.833
71	11.656I	11.856I	2.634I	11.796I	12.067I	11.736C	11.851I	11.739I	11.853I	11.814I	2.874I
72	11.820I	12.021I	2.675I	11.961I	12.234I	11.901C	12.016I	11.905I	12.018I	11.979I	2.916I
73	11.985I	12.186I	2.716	12.126I	12.402I	12.066C	12.181I	12.070I	12.183I	12.144I	2.957I
74	12.150I	12.351I	2.757I	12.290I	12.569I	12.232C	12.345I	12.235I	12.348I	12.309I	2.999I
75	12.314I	12.516I	2.799I	12.455I	12.737I	12.397C	12.510I	12.400I	12.514I	12.475I	3.040I
76	12.479I	12.681I	2.840I	12.620I	12.904I	12.563C	12.675I	12.565I	12.679I	12.640I	3.082I
77	12.644I	12.846I	2.881I	12.785I	13.072I	12.728C	12.840I	12.731I	12.844I	12.805I	3.123I
78	12.809I	13.011I	2.922I	12.950I	13.239I	12.894C	13.005I	12.896I	13.010I	12.970I	3.165I
79	12.973I	13.176	2.964I	13.115	13.407	13.059C	13.170	13.061	13.175	13.135	3.206I
80	13.138	13.341I	3.005I	13.280I	13.575I	13.224C	13.335I	13.226I	13.340I	13.300I	3.248
81	13.302I	13.506I	3.046I	13.444I	13.742I	13.390C	13.500I	13.391I	13.505I	13.465I	3.289I
82	13.467I	13.671I	3.088I	13.609I	13.910I	13.555C	13.665I	13.556I	13.669I	13.630I	3.331I
83	13.631I	13.836I	3.129	13.774I	14.078I	13.721C	13.830I	13.721I	13.834I	13.795I	3.372I
84	13.796I	14.000I	3.170I	13.938I	14.245I	13.886C	13.995I	13.886I	13.999I	13.960I	3.414I
85	13.960I	14.165I	3.212I	14.103I	14.413I	14.051C	14.160I	14.052I	14.164I	14.125I	3.455I
86	14.124I	14.330I	3.253I	14.268I	14.581I	14.217C	14.325I	14.217I	14.329I	14.290I	3.496I
87	14.289I	14.495I	3.295I	14.433I	14.749I	14.382C	14.490I	14.382I	14.493I	14.455I	3.538I
88	14.453I	14.660I	3.336I	14.597I	14.916I	14.548C	14.655I	14.547I	14.658I	14.620I	3.579I
89	14.618I	14.825	3.377I	14.762	15.084	14.713C	14.820	14.712	14.823	14.785	3.621I
90	14.782	14.990I	3.419I	14.927I	15.252I	14.879C	14.985I	14.877I	14.989I	14.950I	3.662
91	14.947I	15.155I	3.460I	15.091I	15.419I	15.044C	15.150I	15.042I	15.155I	15.115I	3.704I
92	15.111I	15.321I	3.502I	15.256I	15.587I	15.209C	15.315I	15.207I	15.321I	15.280I	3.745I
93	15.276I	15.486I	3.543	15.421I	15.755I	15.375C	15.480I	15.372I	15.487I	15.445I	3.787I
94	15.440I	15.651I	3.584I	15.585I	15.922I	15.540C	15.645I	15.537I	15.653I	15.610I	3.828I
95	15.605I	15.816I	3.626I	15.750I	16.090I	15.705C	15.810I	15.702I	15.820I	15.776I	3.870I
96	15.770I	15.981I	3.667I	15.915I	16.258I	15.871C	15.975I	15.867I	15.986I	15.941I	3.912I
97	15.934I	16.147I	3.708I	16.080I	16.426I	16.036C	16.140I	16.032I	16.152I	16.106I	3.953I
98	16.099I	16.312I	3.749I	16.244I	16.593I	16.202C	16.305I	16.197I	16.318I	16.271I	3.995I
99	16.263I	16.477	3.791I	16.409	16.761	16.367C	16.470	16.362	16.484	16.426	4.036I
100	16.428	16.642I	3.832I	16.574I	16.929I	16.532C	16.635I	16.527I	16.649I	16.601I	4.078
101	16.593I	16.807I	3.873I	16.739I	17.097I	16.698C	16.800I	16.692I	16.814I	16.766I	4.119I
102	16.757I	16.972I	3.915I	16.903I	17.264I	16.864C	16.965I	16.857I	16.980I	16.931I	4.161I
103	16.922I	17.137I	3.956	17.068I	17.432I	17.029C	17.130I	17.023I	17.145I	17.096I	4.202I
104	17.086I	17.303I	3.997I	17.233I	17.600I	17.195C	17.295I	17.188I	17.310I	17.261I	4.244I
105	17.251I	17.468I	4.038I	17.398I	17.768I	17.360C	17.460I	17.353I	17.475I	17.426I	4.285I
106	17.416I	17.633I	4.079I	17.563I	17.936I	17.526C	17.625I	17.518I	17.640I	17.591I	4.327I
107	17.580I	17.798I	4.121I	17.728I	18.103I	17.692C	17.790I	17.683I	17.806I	17.756I	4.368I
108	17.745I	17.963I	4.162I	17.892I	18.271I	17.857C	17.955I	17.848I	17.971I	17.922I	4.409I
109	17.910I	18.128I	4.203I	18.057I	18.439I	18.023C	18.120I	18.014I	18.136I	18.087I	4.451I
110	18.074I	18.293I	4.244I	18.222I	18.607I	18.188C	18.285I	18.179I	18.301I	18.252I	4.492I
111	18.239I	18.458I	4.285I	18.387I	18.774I	18.354C	18.450I	18.344I	18.466I	18.417I	4.534I
112	18.403I	18.623I	4.326I	18.552I	18.942I	18.520C	18.615I	18.509I	18.631I	18.582I	4.575I
113	18.568I	18.789I	4.368I	18.716I	19.110I	18.685C	18.780I	18.674I	18.797I	18.747I	4.616I
114	18.733I	18.954I	4.409I	18.881I	19.278I	18.851C	18.945I	18.839I	18.962I	18.912I	4.658I

APPENDIX B-J

IMP-J MEASURED AND INTERPOLATED CHANNEL THRESHOLDS

This appendix contains measured and interpolated channel thresholds obtained from ABRET (see Section III) for channels 1-114. These thresholds are appropriate for analyzing flight data. Thresholds for channels >100 can be extrapolated from channel 100 using the gain and offset relationship (Section I).

Imp-J

CALIBRATION DATA FOR INDIVIDUAL AEC'S

CHAN	D0	D1	D2	D3	C4	C5(III)	C6	C7	D8	C9	C5(I OR II)
SHIFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFFSET	-0.217	0.167	-0.261	0.095	0.053	-0.019	0.112	0.132	0.133	0.156	-0.060
GAIN	0.164542	0.166353	0.040971	0.166254	0.166381	0.164776	0.164581	0.164827	0.165675	0.165020	0.041194
0	0.168	0.164	0.150	0.160	0.164	0.163C	0.159	0.166	0.157	0.161	0.163
1	0.168A	0.314	0.150A	0.291	0.321	0.222C	0.289	0.322	0.308	0.316	0.163A
2	0.168A	0.467	0.150A	0.441	0.473	0.338C	0.439	0.473	0.462	0.466	0.163A
3	0.285	0.630	0.150A	0.602	0.632	0.488C	0.597	0.631	0.623	0.628	0.163A
4	0.433	0.794	0.150A	0.765	0.796	0.648C	0.759	0.792	0.786	0.790	0.163A
5	0.591I	0.961	0.150A	0.930	0.959	0.810C	0.923	0.957	0.951	0.954	0.222
6	0.755	1.127	0.150A	1.095	1.125	0.975C	1.085	1.121	1.115	1.120	0.241
7	0.918	1.293	0.150A	1.262	1.289	1.140C	1.254	1.286	1.283	1.284	0.270
8	1.082I	1.461	0.150A	1.429	1.454	1.305C	1.419	1.450	1.449	1.452	0.303
9	1.246	1.629	0.150A	1.595	1.619	1.470C	1.584	1.615	1.616	1.615	0.338
10	1.411I	1.796I	0.150A	1.762I	1.785I	1.636C	1.750I	1.780I	1.783I	1.781I	0.374
11	1.576I	1.963I	0.150A	1.929I	1.951I	1.801C	1.916I	1.945I	1.949I	1.947I	0.411
12	1.742I	2.130I	0.150A	2.095I	2.117I	1.966C	2.081I	2.111I	2.116I	2.113I	0.450
13	1.907I	2.297I	0.150A	2.262I	2.283I	2.131C	2.247I	2.276I	2.282I	2.279I	0.488
14	2.072I	2.465I	0.150A	2.429I	2.449I	2.296C	2.413I	2.441I	2.449I	2.445I	0.528
15	2.237I	2.632I	0.150A	2.596I	2.615I	2.461C	2.578I	2.606I	2.615I	2.611I	0.567
16	2.403I	2.799I	0.308	2.762I	2.781I	2.626C	2.744I	2.772I	2.782I	2.777I	0.608I
17	2.568I	2.966I	0.344	2.929I	2.947I	2.791C	2.910I	2.937I	2.949I	2.943I	0.648I
18	2.733I	3.134I	0.381	3.096I	3.113I	2.956C	3.076I	3.102I	3.115I	3.109I	0.688I
19	2.898I	3.301I	0.420	3.263I	3.279I	3.122C	3.241I	3.268I	3.282I	3.275I	0.728I
20	3.063	3.468	0.458	3.429	3.445	3.287C	3.407	3.433	3.448	3.441	0.769
21	3.228I	3.635I	0.498	3.596I	3.611I	3.452C	3.572I	3.598I	3.614I	3.607I	0.810I
22	3.393I	3.801I	0.537	3.762I	3.776I	3.617C	3.737I	3.762I	3.780I	3.772I	0.851I
23	3.558I	3.968I	0.576	3.928I	3.942I	3.782C	3.902I	3.927I	3.945I	3.937I	0.893I
24	3.722I	4.135I	0.616I	4.094I	4.107I	3.947C	4.067I	4.092I	4.111I	4.102I	0.934I
25	3.887I	4.301I	0.657	4.260I	4.273I	4.112C	4.232I	4.257I	4.276I	4.266I	0.975I
26	4.052I	4.468I	0.698I	4.426I	4.439I	4.277C	4.397I	4.422I	4.442I	4.432I	1.016I
27	4.216I	4.635I	0.739I	4.592I	4.604I	4.441C	4.562I	4.586I	4.608I	4.598I	1.058I
28	4.381I	4.801I	0.780I	4.759I	4.770I	4.606C	4.727I	4.751I	4.773I	4.763I	1.099I
29	4.546I	4.968I	0.821I	4.925I	4.935I	4.771C	4.892I	4.916I	4.939I	4.928I	1.140I
30	4.710I	5.135I	0.862I	5.091I	5.101I	4.935C	5.057I	5.081I	5.105I	5.094I	1.182I
31	4.875I	5.302I	0.902I	5.257I	5.266I	5.100C	5.222I	5.245I	5.270I	5.259I	1.223I
32	5.040I	5.468I	0.944I	5.423I	5.432I	5.264C	5.387I	5.410I	5.436I	5.424I	1.264I
33	5.204I	5.635I	0.985I	5.589I	5.598I	5.429C	5.553I	5.575I	5.602I	5.589I	1.305I
34	5.369I	5.802I	1.026I	5.755I	5.763I	5.594C	5.718I	5.740I	5.767I	5.754I	1.347I
35	5.534I	5.968I	1.067I	5.921I	5.929I	5.758C	5.883I	5.904I	5.933I	5.920I	1.388I
36	5.698I	6.135I	1.108I	6.088I	6.094I	5.923C	6.048I	6.069I	6.099I	6.085I	1.429I
37	5.863I	6.302I	1.150I	6.254I	6.260I	6.088C	6.213I	6.234I	6.264I	6.250I	1.470I
38	6.028I	6.468I	1.191I	6.420I	6.425I	6.252C	6.378I	6.399I	6.430I	6.415I	1.512I
39	6.192I	6.635I	1.232I	6.586I	6.591I	6.417C	6.543I	6.564I	6.598I	6.580I	1.553I
40	6.357I	6.802I	1.273I	6.752I	6.757I	6.581C	6.708I	6.728I	6.761I	6.746I	1.594I
41	6.522I	6.968I	1.314I	6.918I	6.922I	6.746C	6.873I	6.893I	6.927I	6.911I	1.636I
42	6.686I	7.135I	1.355I	7.084I	7.088I	6.911C	7.038I	7.058I	7.093I	7.076I	1.677I
43	6.851I	7.302I	1.396I	7.251I	7.253I	7.075C	7.203I	7.223I	7.258I	7.241I	1.718I
44	7.016I	7.468I	1.437I	7.417I	7.419I	7.240C	7.368I	7.387I	7.424I	7.406I	1.759I
45	7.180I	7.635I	1.478I	7.583I	7.584I	7.405C	7.533I	7.552I	7.590I	7.572I	1.801I
46	7.345I	7.802I	1.519I	7.749I	7.750I	7.569C	7.698I	7.717I	7.755I	7.737I	1.842I
47	7.510I	7.968I	1.560I	7.915I	7.916I	7.734C	7.863I	7.882I	7.921I	7.902I	1.883I
48	7.674I	8.135I	1.601I	8.081I	8.081I	7.898C	8.028I	8.046I	8.086I	8.067I	1.925I
49	7.839I	8.302I	1.642I	8.247I	8.247I	8.063C	8.193I	8.211I	8.252I	8.232I	1.966I
50	8.004I	8.468I	1.683I	8.413I	8.412I	8.228C	8.358I	8.376I	8.418I	8.398I	2.007I
51	8.168I	8.635I	1.724I	8.580I	8.578I	8.392C	8.523I	8.541I	8.583I	8.563I	2.048I
52	8.333I	8.802I	1.765I	8.746I	8.743I	8.557C	8.688I	8.706I	8.749I	8.728I	2.090I

IMP-I

53	8.4981	8.5691	1.8061	8.9121	8.5091	8.722C	8.8531	8.8701	8.9151	8.8931	2.1311
54	8.6631	9.1351	1.8671	9.0781	9.0751	8.8860	9.0181	9.0351	9.0801	9.0581	2.1721
55	8.8271	9.3021	1.8881	9.2441	9.2401	9.051C	9.1831	9.2001	9.2461	9.2241	2.2131
56	8.9921	9.4691	1.9291	9.4101	9.4001	9.2150	9.3481	9.3651	9.4121	9.3891	2.2551
57	9.1571	9.6351	1.9711	9.5761	9.5711	9.3800	9.5131	9.5291	9.5771	9.5541	2.2961
58	9.3211	9.8021	2.0121	9.7421	9.7371	9.5450	9.6791	9.6941	9.7431	9.7191	2.3371
59	9.4861	9.9691	2.0531	9.9091	9.9021	9.7090	9.8441	9.8591	9.9091	9.8841	2.3791
60	9.6511	10.1351	2.0941	10.0751	10.0681	9.8740	10.0091	10.0241	10.0741	10.0501	2.4201
61	9.8151	10.3021	2.1351	10.2411	10.2341	10.0390	10.1741	10.1891	10.2401	10.2151	2.4611
62	9.9801	10.4691	2.1761	10.4071	10.3991	10.2030	10.3391	10.3531	10.4061	10.3801	2.5021
63	10.1451	10.6351	2.2171	10.5731	10.5651	10.3680	10.5041	10.5181	10.5711	10.5451	2.5441
64	10.3091	10.8021	2.2581	10.7391	10.7301	10.5320	10.6691	10.6831	10.7371	10.7101	2.5851
65	10.4741	10.9691	2.2991	10.9051	10.8961	10.6970	10.8341	10.8481	10.9031	10.8761	2.6261
66	10.6391	11.1351	2.3401	11.0721	11.0611	10.8620	10.9991	11.0121	11.0681	11.0411	2.6681
67	10.8031	11.3021	2.3811	11.2381	11.2271	11.0260	11.1641	11.1771	11.2341	11.2061	2.7091
68	10.9681	11.4691	2.4221	11.4041	11.3931	11.1910	11.3291	11.3421	11.4001	11.3711	2.7501
69	11.1331	11.6351	2.4631	11.5701	11.5581	11.3560	11.4941	11.5071	11.5651	11.5361	2.7911
70	11.2971	11.8021	2.5041	11.7361	11.7241	11.5200	11.6591	11.6711	11.7311	11.7021	2.8331
71	11.4621	11.9691	2.5451	11.9021	11.8891	11.6850	11.8241	11.8361	11.8961	11.8671	2.8741
72	11.6271	12.1351	2.5861	12.0681	12.0551	11.8490	11.9891	12.0011	12.0621	12.0321	2.9151
73	11.7911	12.3021	2.6271	12.2341	12.2201	12.0140	12.1541	12.1661	12.2281	12.1971	2.9561
74	11.9561	12.4691	2.6681	12.4011	12.3861	12.1790	12.3191	12.3311	12.3931	12.3621	2.9981
75	12.1211	12.6361	2.7091	12.5671	12.5521	12.3430	12.4841	12.4951	12.5591	12.5281	3.0391
76	12.2851	12.8021	2.7501	12.7331	12.7171	12.5080	12.6491	12.6601	12.7251	12.6931	3.0801
77	12.4501	12.9691	2.7921	12.8991	12.8831	12.6720	12.8141	12.8251	12.8901	12.8581	3.1221
78	12.6151	13.1361	2.8331	13.0651	13.0481	12.8370	12.9791	12.9901	13.0561	13.0231	3.1631
79	12.7791	13.3021	2.8741	13.2311	13.2141	13.0020	13.1441	13.1541	13.2221	13.1881	3.2041
80	12.9441	13.4691	2.9151	13.3971	13.3791	13.1660	13.3091	13.3191	13.3871	13.3541	3.2451
81	13.1091	13.6361	2.9561	13.5631	13.5451	13.3310	13.4741	13.4841	13.5531	13.5191	3.2871
82	13.2731	13.8021	2.9971	13.7301	13.7111	13.4960	13.6391	13.6491	13.7191	13.6841	3.3281
83	13.4381	13.9691	3.0381	13.8961	13.8761	13.6600	13.8051	13.8131	13.8841	13.8491	3.3691
84	13.6031	14.1361	3.0791	14.0621	14.0421	13.8250	13.9701	13.9781	14.0501	14.0141	3.4101
85	13.7681	14.3021	3.1201	14.2281	14.2071	13.9890	14.1351	14.1431	14.2161	14.1801	3.4521
86	13.9321	14.4691	3.1611	14.3941	14.3731	14.1540	14.3001	14.3081	14.3811	14.3451	3.4931
87	14.0971	14.6361	3.2021	14.5601	14.5381	14.3190	14.4651	14.4731	14.5471	14.5101	3.5341
88	14.2621	14.8021	3.2431	14.7261	14.7041	14.4830	14.6301	14.6371	14.7131	14.6751	3.5761
89	14.4261	14.9691	3.2841	14.8931	14.8701	14.6480	14.7951	14.8021	14.8781	14.8401	3.6171
90	14.5911	15.1361	3.3251	15.0591	15.0351	14.8130	14.9601	14.9671	15.0441	15.0061	3.6581
91	14.7561	15.3021	3.3661	15.2251	15.2011	14.9770	15.1251	15.1321	15.2101	15.1711	3.6991
92	14.9201	15.4691	3.4071	15.3911	15.3661	15.1420	15.2901	15.2961	15.3751	15.3361	3.7411
93	15.0851	15.6361	3.4481	15.5571	15.5321	15.3060	15.4551	15.4611	15.5411	15.5011	3.7821
94	15.2501	15.8021	3.4891	15.7231	15.6971	15.4710	15.6201	15.6261	15.7061	15.6661	3.8231
95	15.4141	15.9691	3.5301	15.8891	15.8631	15.6360	15.7851	15.7911	15.8721	15.8321	3.8651
96	15.5791	16.1361	3.5711	16.0551	16.0291	15.8000	15.9501	15.9561	16.0381	15.9971	3.9061
97	15.7441	16.3031	3.6131	16.2221	16.1941	15.9650	16.1151	16.1201	16.2031	16.1621	3.9471
98	15.9081	16.4691	3.6541	16.3881	16.3601	16.1300	16.2801	16.2851	16.3691	16.3271	3.9881
99	16.0731	16.6361	3.6951	16.5541	16.5251	16.2940	16.4451	16.4501	16.5351	16.4921	4.0301
100	16.238	16.803	3.736	16.720	16.691	16.459C	16.610	16.615	16.700	16.658	4.071
101	16.4021	16.9691	3.7771	16.8861	16.8571	16.6240	16.7751	16.7791	16.8661	16.8231	4.1121
102	16.5671	17.1351	3.8181	17.0521	17.0241	16.7880	16.9401	16.9441	17.0321	16.9881	4.1531
103	16.7311	17.3021	3.8591	17.2191	17.1901	16.9530	17.1051	17.1091	17.1971	17.1531	4.1941
104	16.8961	17.4681	3.9001	17.3851	17.3561	17.1180	17.2701	17.2741	17.3631	17.3181	4.2361
105	17.0601	17.6341	3.9411	17.5511	17.5221	17.2830	17.4351	17.4391	17.5291	17.4831	4.2771
106	17.2251	17.8011	3.9821	17.7171	17.6891	17.4480	17.6001	17.6041	17.6941	17.6481	4.3181
107	17.3891	17.9671	4.0221	17.8841	17.8551	17.6120	17.7651	17.7681	17.8601	17.8131	4.3591
108	17.5541	18.1331	4.0631	18.0501	18.0221	17.7770	17.9301	17.9331	18.0261	17.9781	4.4001
109	17.7191	18.3001	4.1041	18.2161	18.1881	17.9420	18.0951	18.0981	18.1911	18.1431	4.4411
110	17.8831	18.4661	4.1451	18.3831	18.3551	18.1070	18.2601	18.2631	18.3571	18.3081	4.4821
111	18.0481	18.6321	4.1861	18.5491	18.5211	18.2710	18.4251	18.4281	18.5231	18.4731	4.5241
112	18.2121	18.7991	4.2271	18.7151	18.6871	18.4360	18.5901	18.5931	18.6881	18.6381	4.5651
113	18.3771	18.9651	4.2681	18.8811	18.8541	18.6010	18.7551	18.7571	18.8541	18.8031	4.6061
114	18.5421	19.1321	4.3091	19.0481	19.0201	18.7660	18.9201	18.9221	19.0201	18.9681	4.6471