DISCRIMINATOR SETTINGS

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Instrument Science Report CAL/FOS-050
May 25, 1990

I. Introduction

During the period 23-26 February 1988, tests to determine the settings for the discriminator digital to analog converters (disc DACs) of the Red (F12) and Blue (F7) detectors were performed at LMSC. The function of the discriminators is to set a minimum size for an output pulse to be counted as a detected photon. As most pulses caused by fluctuations in the preamps (potentially the dominent source of noise) are small; with a gaussian distribution, the discriminators can be set to pass virtually all real counts, while blocking virtually all pulses due to electron noise in the preamps. By illuminating the detectors and varying the discriminator settings we can determine an integrated pulse height distribution, the distribution of all pulses greater than a given threshold value, set by the discriminator.

The discriminator setting for a given channel is the product of the discriminator reference DAC (REFDAC), which is common to all channels and the individual disc DAC setting. These individual disc DAC settings have been programmed into a PROM. The PROM setting cannot be changed, but can be overridden by command. Changing a disc DAC setting during actual FOS spaceflight operations requires three FOS serial magnitude commands corresponding to 9 NSSC1 words. These commands are required whenever an FOS detector is turned on from "hold mode" or reset.

This report details the status of the discriminator settings and noisy and dead channels during calibration and alignment and documents the process whereby various changes were made in discriminator settings. Other reports update this, based on the results of later tests (CAL/FOS-51 and CAL/FOS-64). The data in this report come from tapes labeled (at UCSD) 1075 and 1077.

II. Lockheed Discriminator Tests
IIa. Data

Under the control of STOL Proc YTDN as modified 23 February, 1988, the data were collected as shown in Table 1 using an internal calibration LED to fully illuminate the photocathodes. All discriminator tests were made with the reference DAC (REFDAC) set at 250 (all DAC values are given as base 10 values). When the PROM DAC values were set, plans were to set the REFDAC to 206 for the Blue side and 212 for the Red side. All tabulated listings of current values and suggested changes are scaled to reflect these REFDAC values, however, most plots are in terms of measured units. Implications of setting the REFDAC to 184, as has been done for much of the laboratory calibration data, will be discussed in Section IX. The suggested REFDAC settings are also given there.

TABLE 1
Discriminator Tests - February 1988

DETECTOR	HIGH VOLTAGE DAC	ILLUMINATION	DISC DAC BEG - END	DISC DAC STEP SIZE	INTEGRA-TION TIME SECONDS
1) RED	512 (12.75kV)	LED	50 — 255	5	10
2) RED	512 (12.75kV)	LED	50 — 255	1	10
3) RED	OFF	ROOM LIGHTS	50 — 180	1	1/2
4) RED	768 (18.95kV)	LED	50 — 255	5	2
5) BLUE	512 (12.75kV)	LED	50 — 255	1	30
6) BLUE	OFF	ROOM LIGHTS	50 — 150	1	1/2

These data yield an integrated pulse height distribution (PHD) for each channel. Examples are shown in Figures 1a and 2a. The main features in the 12kV data are electronic noise ($\sim 100,000$cts/sec) to disc DAC values of ~ 100, a relatively flat region between 100 and 150, and a steeper falloff thereafter, corresponding to the peak of the actual pulse height distribution. The actual pulse height distribution, derived as discussed below, is shown in Figures 1b and 2b. The tests are performed at 12.75kV because the actual peak of the pulse height distribution falls beyond the range of the disc DAC setting when the tubes are used at normal operating voltage (~22kV).

IIb. Analysis Technique

The method used previously to set the FOS discriminators was as follows: The value of the integrated pulse height distribution at disc DAC=125 was found, and the first point with less than half this value was taken as the discriminator setting. This will yield the peak of the pulse height distribution if it is a symmetrical distribution and fairly narrow. This method has two major problems. First, the region around disc DAC=125 is not flat, implying wings on the PHD or extended noise probably due to back scattered electrons. Second, the method may be susceptible to noise at the 1/2 maximum point.

The new data were taken with longer integration times than used previously and analyzed by the old method, as well as by two additional techniques. Our implementation of the original technique on the VAX 11/780 yielded the same answer as the analysis done on the PDP 11/70 on the same data with the original algorithms. Smoothing the data (7 point box car for the Blue, 5 point box car for the Red) yielded almost the identical answer as the original technique, implying that noise is not a significant problem in our data.

We also differentiated the smoothed integrated pulse height distribution with respect to the DAC value to yield the actual pulse height distribution at 12.75kV.

$$y'(x) = \frac{y(x-1)-y(x+1)}{2}$$

This function was fit with a gaussian plus a second order polynomal, and the peak of the pulse height distribution was taken to be the peak of the gaussian. The beginning of the fitted region was between disc DAC values of 100 and 150, depending on noise spikes and the curvature of the data, and the end was at 255. In a few cases in the smoothed data, the gaussian was fit to a noise spike, and the fit was rejected by the program. Others with particularly large values of the polynomial at the gaussian peak (greater than $\sim 1/4$ the gaussian peak) were examined individually. In these cases the region fit was too narrow or else extended into a region where the steep slope region of the electronic noise was present. In most of these cases, the peak of the gaussian was still an acceptable choice; a few were not, however. These tests were also run determining the derivative by fitting a 7 point and 5 point straight line to the Blue and Red data respectively. This yielded similar results, but was more sensitive to noise and failed more often. An improved algorithm for dealing with the noise could be developed, but this is not considered necessary unless it becomes necessary to change all the individual discriminator settings, an option for which there is no forseeable requirement. These tests also enable us to determine dead channels, noisy channels, channels with poor discriminator settings and other peculiar channels. Typical examples of the fits are shown in Figures 1b and 2b.

III. Comparisons

IIIa. Comparison with Old Values

The final version of the program found settings for 505 channels on each side. Histograms are given in Figures 3 and 4. These histograms show the measured values (REFDAC=250) and are not scaled for the REFDAC value which will be used during operations. Histograms of the difference between the new measurements and the scaled PROM values are given in Figures 5 and 6.

Although scaling for different REFDAC values is simple, it is a matter of some confusion, so we will belabor it a bit. If R_{PROM} is the REFDAC value to be used during operations (or whatever REFDAC value will be used), D is the value of a disc DAC measured during our tests, and 250 was the REFDAC value used in our tests, then the optimum disc DAC setting that should be used for operations, D_{opt}, is

$$D_{opt} = \frac{250 \times D}{R_{PROM}}$$

Mean values for the scaled DAC settings are given below in Table 2 for the channels for which the new method worked, as well as values determined using the old method on the new data, and the PROM values with 1σ deviations. (Note that for the Red side, the PROM values were determined with a different detector than the one in use now.) The respective measured values are scaled to REFDAC values of 206 and 212 for Blue and Red detectors respectively.

TABLE 2
Mean DAC Settings

	RED	BLUE
PROM	212.22 +/- 11.2	206.36 +/- 8.60
OLD METHOD	205.73 +/- 8.89	211.18 +/- 8.37
OLD METHOD (SMOOTHED)	205.78 +/- 8.83	211.03 +/- 8.33
NEW METHOD	208.27 +/- 9.89	213.00 +/- 8.96

If we wished to optimize the discriminator settings determined by the method described in Section II without changing the disc DAC values for each individual discriminator, we could adjust the REFDAC settings. If R_{opt} is the new "optimum" REFDAC setting, and the D_{PROM} are the PROM values of the discriminator DACs, then

$$R_{opt} = \frac{250 \times \langle D \rangle}{\langle D_{PROM} \rangle} = \frac{R_{PROM} \times \langle D_{opt} \rangle}{\langle D_{PROM} \rangle}.$$

In this case, we would set the Blue REFDAC value to 213 for the results of the new method (or 211 for the new implementation of the old method). We would set the Red REFDAC to 208 (or 206). These are small changes and easy to implement.

IIIb. Comparison with Optimal Values

An optimum technique for setting the discriminators would be to determine the actual pulse height distribution at operating voltage and to set the discriminators to a value which is 3 times the full width at half maximum (FWHM) of the peak, provided that value is at least 1 FWHM below the peak. This will put the discriminator setting 7σ above 0, for negligible noise, and 2.35 σ below the peak, for loss of less than 1% of the signal. The position of the peak of the distribution (in discriminator DAC units) scales roughly as

$$DAC_{peak}(V) = \frac{(V - V_d)}{(12.75 - V_d)}\ DAC_{peak}(12.75kV)$$

where DAC_{peak} is the discriminator setting at the peak of the pulse height distribution, V is the operating voltage and V_d is the "dead layer" of around 3.5 kV. We meet the criterion that the peak is one FWHM above the discriminator settings for an operating voltage of 18.9kV. This assumes that FWHM=50 (REFDAC=250), which is near the middle of the measured FWHM distribution (see Section VII) for the Blue (F7) detector, and that the discriminator settings are the mean from Table 2 "New Method". This is well below the operating voltage. The mean values of the measured discriminator settings, 175.5 on the Blue side and 176.6 on the Red side, are clearly above 3 FWHM, so both criteria are met for the measured discriminator values. Thus, the mean values of the discriminator settings are acceptable. We will discuss in Section IX more details of this comparison both for the REFDAC settings discussed above and for REFDAC=184.

IV. Dead and Noisy Channels - Blue Side

Dead and noisy channels determined from the discriminator test for the Blue side are given in Table 3. The reference "dead to light" means that counts are detected with a pulse height distribution indicative of electronic noise only.

TABLE 3

Dead & Noisy Channels - Blue (F7)

	BLUE (0-511)
49	DEAD
94	APPARENTLY NOISY
201	NOISY : NOT FIXABLE
218	NOISY : CONCEIVABLY USABLE IF ABSOLUTELY NECESSARY
268	NOISY : NOT FIXABLE
284	DEAD TO LIGHT
409	DEAD
439	APPARENTLY NOISY

Channels 94 and 439 are peculiar. They are not actually noisy, but appear so because the 8 bit on the DAC is not functional. Settings for these channels were estimated from the correct portions of the integrated pulse height distribution. The PROM settings are close to optimal and have the 8 bit zero. No changes are recommended. (Note that for most tests a change was made for channel 439.)

Based on the dark count tests at 18.6 and 22kV, several other channels were identified as noisy. These are given in Table 4.

TABLE 4

Noisy Channels - Blue Side (F7)

225	SLIGHTLY NOISY
256	SLIGHTLY NOISY
415	SLIGHTLY NOISY
451	VERY NOISY
465	SLIGHTLY NOISY

Based on the appearance of the pulse height distribution, we were able to recommend new discrminator settings for 225, 256, and 415. Channels 451 and 465 have normal appearing PHDs, and we had initially recommended no changes. We also noted that channel 22, previously disabled, had an incorrect setting. These channels are noisy enough that they cannot be used without changes. If we cannot send the requisite commands, they must be disabled. Changes are shown in Table 5, below:

TABLE 5

Blue Side (F7) Changes - Incorrect Discriminator Settings

CHANNEL	PROM VALUE	NEW VALUE
22	255	212
225	194	206
256	214	231
415	206	214
439	199	192

V. Dead and Noisy Channels - Red Side

Dead and noisy channels determined from the discriminator test for the Red side are given in Table 6.

TABLE 6

Dead & Noisy Channels - Red (F12)

	RED (0-511)
2	DEAD
6	DEAD
212	DEAD
285	DEAD TO LIGHT
405	NOISY : NOT FIXABLE
409	NOISY : NOT FIXABLE

These determinations agree with the dark count tests taken at the same time for the Red tube at 18.6kV.

VI. Uniformity Corrections

Based on the Red tube data with HV=18.9kV and REFDAC=250, we estimated that a change in the DAC values of 14 ($\sim 2\sigma$) (for REFDAC=250) would cause a change in the gain of 6% (at REFDAC=250, a relative gain change of 0.4% was seen per DAC setting around DAC=170; this is valid between DAC values 130 and 210). We felt that this would reduce the scatter in the data caused by gain variations between the channels.

For the Blue detector, 22 channels were found where the difference between the optimum setting and the PROM setting exceeded 14. These are given in Table 7.

TABLE 7

Blue Side (F7) Discriminator Changes - Uniformity Corrections

CHANNEL	PROM	NEW VALUE
9	191	212
20	193	226
30	195	211
36	194	212
68	190	218
82	204	228
108	199	216
127	214	234
135	207	225
177	195	212
202	195	216
203	191	214
205	185	203
217	222	206
279	195	216
281	191	211
327	193	211
393	198	219
421	195	214
423	184	204
431	200	230
471	190	207

For the Red detector, four channels were found where the difference between the optimum setting and the PROM setting exceeded 14. These are given in Table 8.

TABLE 8

Red Side (F12) Discriminator Changes - Uniformity Corrections

CHANNEL	PROM VALUE	NEW VALUE
290	221	205
317	221	204
490	225	206
500	236	218

These changes were tentative, pending determination of the REFDAC setting, but were used for all calibration exposures. Note that the discriminator settings described above are the optimum settings. Because the PROM values are slightly different from optimum, it might have been desirable to apply the same offset in these changes. However, because of the tests described in Section IXb, we reexamined the data on which we based these determinations and found that the QE gain is much less than that estimated above. We no longer recommend these changes.

VII. Zero Crossing and Related Tests

Discriminator tests with the voltage off were also performed with Blue and Red detectors. From these we determined a zero crossing (the point at which the count rate becomes zero) and the points at which the count rate is 500, 250 and 100 counts per second. These tests with the high voltage off allow an uncontaminated determination of the distribution of the preamp noise for each channel. Because the noise distribution is gaussian, there is in fact no zero crossing, but with an observation with large numbers of counts we can accurately determine a discriminator setting which will exclude virtually all preamp noise. In our tests we do not have enough counts to determine this zero crossing accurately. Instead we examined the 500 counts per second point to determine if it was, as expected, related to the width of the noise distribution; see below.

Despite the small number of counts, the already detected dead and noisy channels are easily detected in this test. In fact, virtually all of the channels on the Blue side that we recommend in CAL/FOS-51 be turned off for reasons of noise show up here. Channel 223, which appears normal on all other tests, has no counts in this test. Further tests have shown that it is intermittently dead. Histograms of the last zero crossing (one greater than the highest DAC setting where the count is greater than zero), are given in Figures 7 and 8.

Channels where the last zero appears high are given in Table 9.

TABLE 9

Channels with High Zero Crossing

Blue (F7): 31, 201, 218, 222, 225, 249, 256, 268, 427, 451, 472
Red (F12): 49, 158, 218, 230, 405, 409

On the Blue side channels 201, 218, 268, and 451 were already noted as extremely noisy and turned off. Channels 225 and 256 are noted as slightly noisy and had changes suggested for their discriminator settings. Channels 31, 222, 427, and 472 will be discussed below, in the section on 0V Dark Counts. Of the channels noted as having particularly high last 0 crossings, only channel 249 shows no other abnormalities, but its last zero is only barely higher than a large number of others. On the Red side, channels 405 and 409 were already noted as extremely noisy and turned off. Nothing abnormal was noted about the others (but see CAL/FOS-51 for Channel 218).

In principle, the width of the preamp noise should be related to the width of the gaussian distribution that characterizes the data in the PHD. Figures 9 and 10 show the plot of the gaussian σ plotted against the DAC value at which the zero crossing test is less than 500 cts/sec (Y1) for all channels except those which should be turned off or for which our program failed to find a gaussian FWHM (but including 451 and 472 on the Blue side which will be off but show normal PHD). We use the 500 ct/sec point rather than the actual zero crossing, because the low count rates make that point more uncertain. In each case, the probability that a random sample would have as good a correlation as these tests is less than 10^{-5}. Thus we confirm that the 500 ct/sec point is closely related to the width of the noise distribution and may be usable as a measure of the zero crossing, although the errors would be large. Results of fitting a straight line to these data are as follows.

$$\text{Blue (F7)} \quad \text{FWHM} = 0.36\ \text{Y1} + 25.94 \quad (1\sigma = 1.68)$$
$$\text{Red (F12)} \quad \text{FWHM} = 0.46\ \text{Y1} + 12.49 \quad (1\sigma = 1.36)$$

We can also use these tests to characterize a "signal-to-noise" (S/N). For this we use the ratio of the DAC value of the optimum setting as determined above and Y1. This gives us an idea which channels may be noisy. This value was computed for the set of channels for which the correlation above was done, but including also channel 201 (off) on the Blue side. On the Red side no channels stood out as having low S/N. The channel with the lowest S/N, 230, has no abnormal characteristics. On the Blue side, the S/N distribution is considerably broader. The channels with the lowest S/N are given in Table 10. Some were simply noted as extreme points which may merit further scrutiny but do not satisfy any statistical criteria determined a priori; others have an expectation of occurence of less than 0.5 out of a sample of 512 channels.

TABLE 10

Channels with Low Signal-to-Noise

Blue (F7) 110, 129, 134, 201, 225, 256, 301, 357, 472

Of these, channel 201 has been turned off. Channels 225 and 256 were noted as slightly noisy. Channels with low S/N, like those with high Y1, tend to show up as noisy in the 0 volt dark tests (below) and are candidates for discriminator changes. S/N plots are shown in Figures 11 and 12.

VIII. Dark Exposures

Dark exposures with the voltage on were taken during alignment. Exposures with the voltage off were taken during calibration. These will be discussed in more detail in CAL/FOS-51, but are briefly discussed here because certain tentative discriminator changes were recommended as a result of these exposures.

Because dark counts in non-noisy channels can be expected to obey Poission statistics, as demonstrated in Figures 13 and 14, noisy channels can be easily identified. No additional noisy channels were identified from these dark exposures with the voltage on. The 0 volt dark exposures (one each on the Blue and Red sides) as well as the long period of operations during calibration revealed several new intermittently noisy channels. The discriminator changes given in Tables 11 and 12 were recommended to see if they reduced noise in these channels (see CAL/FOS-51).

TABLE 11
Blue Side (F7) Discriminator Changes - Tentative

CHANNEL	PROM VALUE	NEW VALUE
31	212	225
73	214	226
222	198	210
410	211	223
422	206	221
427	190	203
465	195	207
472	210	222

TABLE 12
Red Side (F12) Discriminator Changes - Tentative

CHANNEL	PROM VALUE	NEW VALUE
182	220	232
261	203	213
263	212	222
280	202	211

On the Blue side, 0V darks were taken with and without the tentative changes. These are noted as #2 0V dark and #3 0V dark respectively. Several of these channels were already set to the optimum value or higher, so no great hopes were placed for the success of these changes. This was borne out by the only tests we were able to do during calibration which are summarized in Tables 13 and 14. For example, channel 73 was very noisy in dark #1, but free of noise in *both* dark #2 and #3, while channel 273 was noisy in both #2 and #3, and channel 31 was noisy in all three.

IX. REFDAC Settings
IXa. Rationale for Setting of 184

Because of the lower high voltage used for most of our calibration exposures, the REFDAC was set at 184, rather than the PROM values of 206 (Blue) and 212 (Red). It has been considered that this value (184) should be used for actual flight operations to achieve a gain in quantum efficiency. Based on the data in section VI, it appeared that this change would result in a relative quantum efficiency increase of approximately 9%.

Not only was the original estimate in error, but even the correct determination may be overly optimistic. Ions accelerated into the photocathode can cause the emission of bursts of electrons. These can in principle be detected on the ends of the channels and on the leads as pulses in exactly the region of the pulse height distribution where we measure the presumed quantum efficiency increase. (See letter from E. Beaver to J. Brandt of 2 June, 1982.)

Additionally, with the REFDAC setting of 184, our criterion for setting the discriminators comes close to being violated. In Figures 15 and 16 is shown how with the PROM REFDAC values, the criterion that the discriminators be set 3 FWHM above zero is easily satisfied. On the other hand, Figures 17 and 18 show how at a REFDAC setting of 184, this criterion comes close to being violated. In fact, if all the scatter shown here is not measurement error, as it almost certainly is not, this setting probably violates this criterion for many channels. The criterion is conservative; however, only a small violation could make preamp noise the dominant noise source. If the QE gain is not as large as discussed above, there is no reason to take a chance on causing increased noise.

IXb. Laboratory Tests

In order to more properly assess the gain QE which would be achieved by setting the REFDAC at 184, we performed a discriminator test in May 1990 at UCSD on the F6 Blue flight spare, similar to those described in Section II, but at 23.5 kV and using a slit with a projected width of 35μ. This is smaller than the diode height, and thus should not cause counts on the leads and diode edges. Based on this measurement, we find a relative gain in QE of 2.2% per kV in the wings of the distribution (assuming a 3.5 kV dead layer). This means that using a REFDAC setting of 184 rather than 213 (see IXc) would achieve a relative QE gain of approximately 2.7%.

Interestingly, we performed the same test with full illumination and found a relative gain of 3.25% per kV (only 1.1σ higher). This is similar to the results with the Red F12 flight detector, where we found a relative gain between 2.5% per kV and 4.2% per kV from the slope of the PHD at 18.9 kV (see Section VI). For F12 we also found a relative gain of 4.4% per kV by varying the REFDAC at 21.4 kV.

IXc. Settings

Because the quantum efficiency gain achieved by setting the REFDAC to 184 is minimal, and because this setting leads to a violation of our recipe for proper discriminator settings, we recommend the use of REFDAC settings 213 and 208 for the Blue and Red detectors respectively. These settings result in the average PROM value of the discriminator DAC value occurring at the 12.75 kV peak of the pulse-height distribution.

X. Summary

Tables 13 and 14 show all information on the noise and discriminator characteristics of the Red and Blue detectors as of the end of calibration, along with recommendations as to which channels should be disabled pending future studies. More information is now available, based on the analysis of the dark exposures taken after the end of calibration and is summarized in CAL/FOS-51 and CAL/FOS-64. A summary of suggested discriminator settings is given in Appendix A.

XI. Space Flight Tests

To set the discriminators during actual orbital operations, exposures similar to numbers 2 and 5 of Table 1 are required. As long as the width of the peak is well sampled, (DAC step size ≤ 5) exposure time and step size may be varied as convenient to provide *at least* the same total number of counts as obtained with the Blue detector in these tests. Note that the width of the flat region between the pre-amp noise and the pulse peak is only approximately 50 DAC units, so a step size of 5 yields only 10 points in this region. Finer sampling is better if it can be obtained.

The discriminator tests with the voltage off should not be repeated with these exposure times. Considerably longer exposures (perhaps 10 seconds) should yield a fit to the tail of the preamp noise adequate to improve the setting of discriminators on channels which are predictably noisy. Alternatively, very short exposures to fit the peak of the noise could be tried.

A final test could be made to characterize the quantum efficiency loss at different REF-DAC settings with the actual flight detectors. To perform this test, illuminate the diode array with an aperture which does not extend beyond the channel ends, set the voltage at the operating voltage, and vary the discriminators through the full range at which counts are obtained, using a DAC step size of 5. Perhaps the target acquisition LED with the small aperture would be adequate.

Note that overlight protection should be disabled for these tests.

Appendix A

Based on the results of tests described here and in CAL/FOS-51, and the assumption that the count rate varies as 2.2% per kV as described in Section IX, we recommend the following initial discriminator settings, including settings for channels which will be disabled in tests other than dark counts. Because we estimate a much lower quantum efficiency change with each DAC value than previously, we now recommend that no uniformity corrections be made at this time. We make no recommendations based on tests described in CAL/FOS-64.

F7 Discriminator Changes

CHANNEL	OLD VALUE	NEW VALUE
22	255	212
31	212	225
73	214	226
170	205	219
222	198	210
225	194	206
256	214	231
273	188	200
415	206	214
422	206	221
427	190	203
465	195	207
472	210	222
497	201	211

F12 Discriminator Changes

CHANNEL	OLD VALUE	NEW VALUE
182	220	232
261	203	213
263	212	222
280	202	211

TABLE 13
BLUE (F7) CHANNEL PERFORMANCE

Channel	Dead	Dead to Light	Always Very Noisy	Cts in[d] 18 Kv Dark	Cts in[d] 22 Kv Dark	Low S/N	High 0 Crossing	Broad Peak	Cts in[d] #1 0v Dark	Cts in[d] #2 0v Dark	Cts in[d] #3 0v Dark	Changed Disc After Disc test	Changed Disc After #1 0v Dark	Off	Old Measure-ments	Other Peculiari-ities
31				1	13		✓		37354	187	3		✓			
47				off	off									✓		cross-wired
49	✓			off	off									✓		
55				off	off									✓		cross-wired
57				5	15			✓								
73				11[a]	12				43031				✓	✓		
94				2	13										3	Bad disc DAC
110				4	14	✓										
129				0	15	✓		✓								
134				4	14	✓		✓								
170				2	14					4	6			✓	2	
201			✓	1463	1480	✓[c]	✓		2358	1947	1684			✓	2	
218			✓	503	848		✓		330	288	292			✓	2	
222				9	20		✓		3	3	1		✓	✓	2	
223				3	10									✓	2	0 in 0v disc test
225				23	57	✓[c]	✓				17[b]	✓			2	
249				5	8		✓	✓								
256				10	32	✓[c]	✓		1			✓			2	
268			✓	off	off		✓		519355	12204	566960			✓		
273				3	12					19	11			✓		
284		✓		off	off									✓	3	
301				3	10	✓										
357				0	11	✓										
409	✓			off	off									✓		
415				2	27							✓			2	
422				3	16				20	13			✓	✓	2	
427				4	20		✓		109337	0			✓			
439				10	12							✓		✓		Bad disc DAC
451			✓	1594	1496		✓		4528	2779	2057			✓		
465				82	76				6	29	36		✓	✓		
472				7	22	✓	✓		2	2	1		✓	✓		
497				5	14					3						

[a] = highest value not exceeding threshold
[b] = all in one slice
[c] = expectation ≤ 0.5 per 512 channels
[d] = 1008s

Table 14
RED (F12) CHANNEL PERFORMANCE

Channel	Dead	Dead to Light	Always Very Noisy	Cts in[a] 21Kv Dark	High 0 Crossing	Cts in[a] 0v Dark	Off	Old Measurements
2	√						√	3
6	√						√	3
49				21	√	0		
158				31	√	0		
182				28		55	√	
212	√						√	
218				30	√	1		
230				29	√	0		
261				32		5	√	1
263				19		2	√	
280				22		3	√	1
285		√					√	
405			√	off		141927	√	
409			√	off		132451	√	

[a] = 1008 s

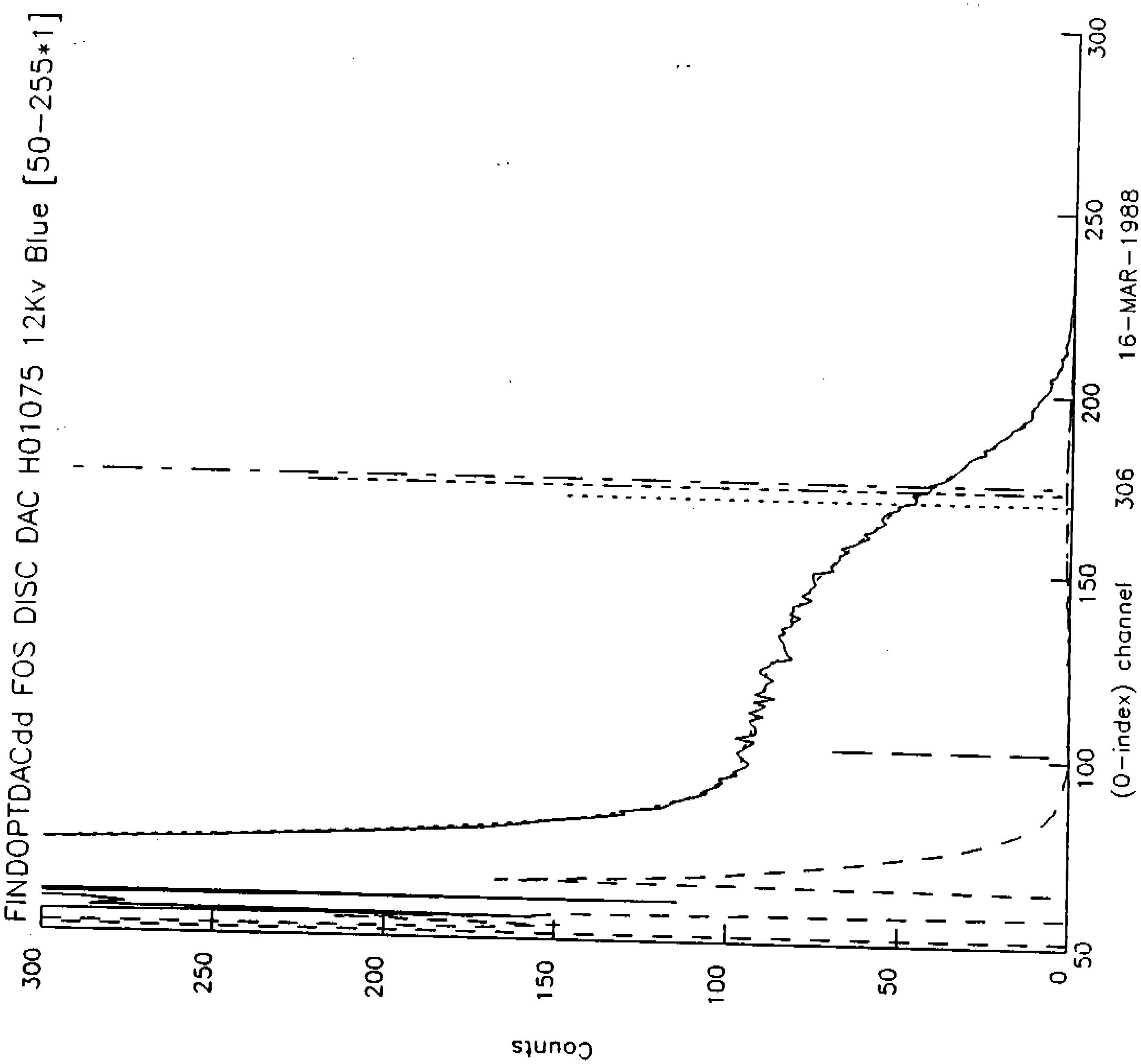

Figure 1a - Counts vs DAC setting for diode 306 of the Blue F7 detector. The solid line is the integrated PHD; the short dashed line the smoothed data. The long dashed vertical line (— - - —) marks the DAC setting determined with the new algorithm. The alternating dashed vertical line (— - - - - —) marks the DAC setting determined by the old algorithm, while the short dashed vertical line (- - -) marks the PROM value (scaled to REFDAC=250). The long vertical dashed line near 100 marks the edge of the fitted region of the actual PHD (shown in the lower curve (long dash) and Figure 1b).

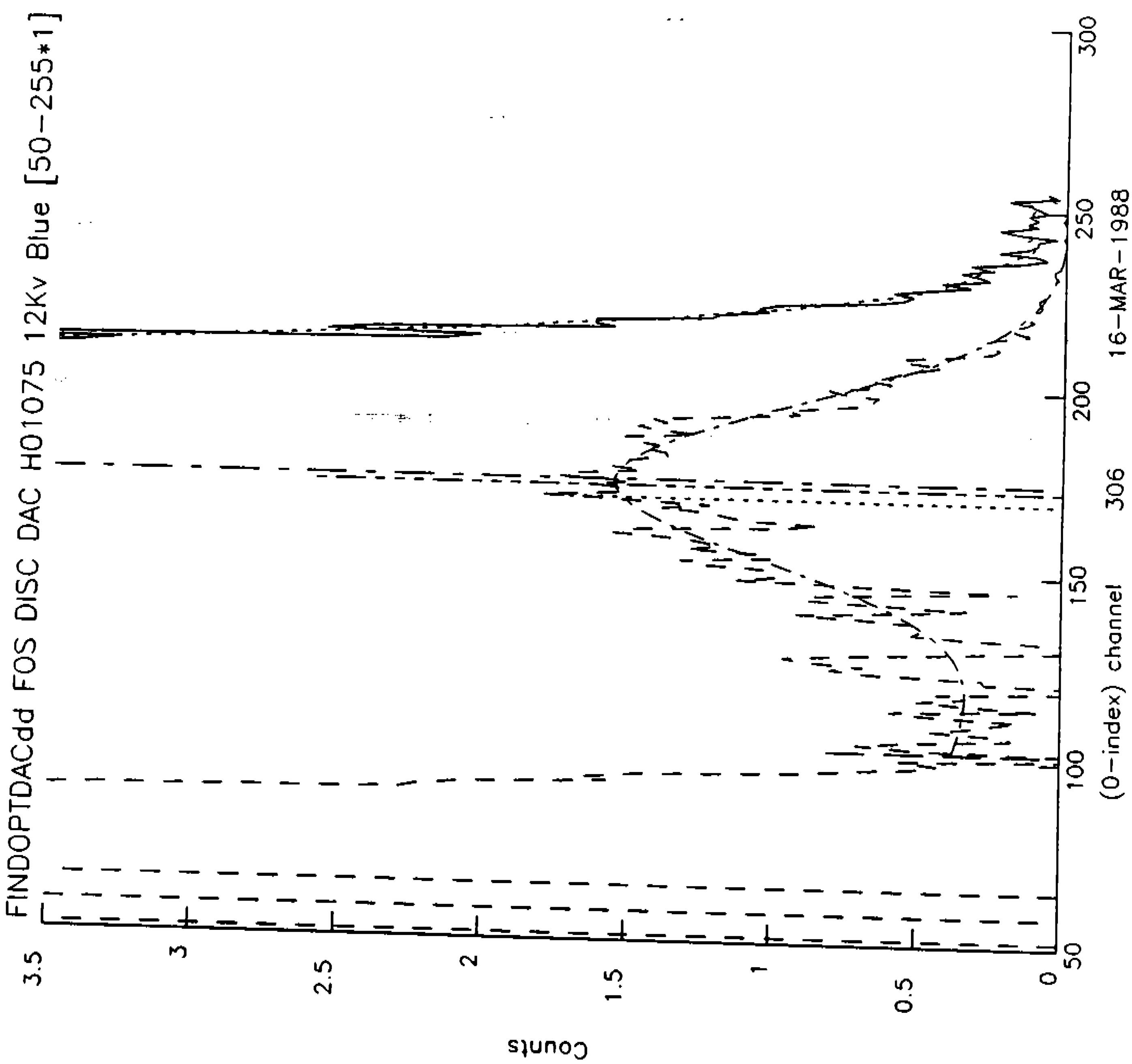

Figure 1b - Like figure 1a, but expanded to show the actual PHD. The long dashed line shows the PHD and the alternating dashed line (— - —) shows the fit.

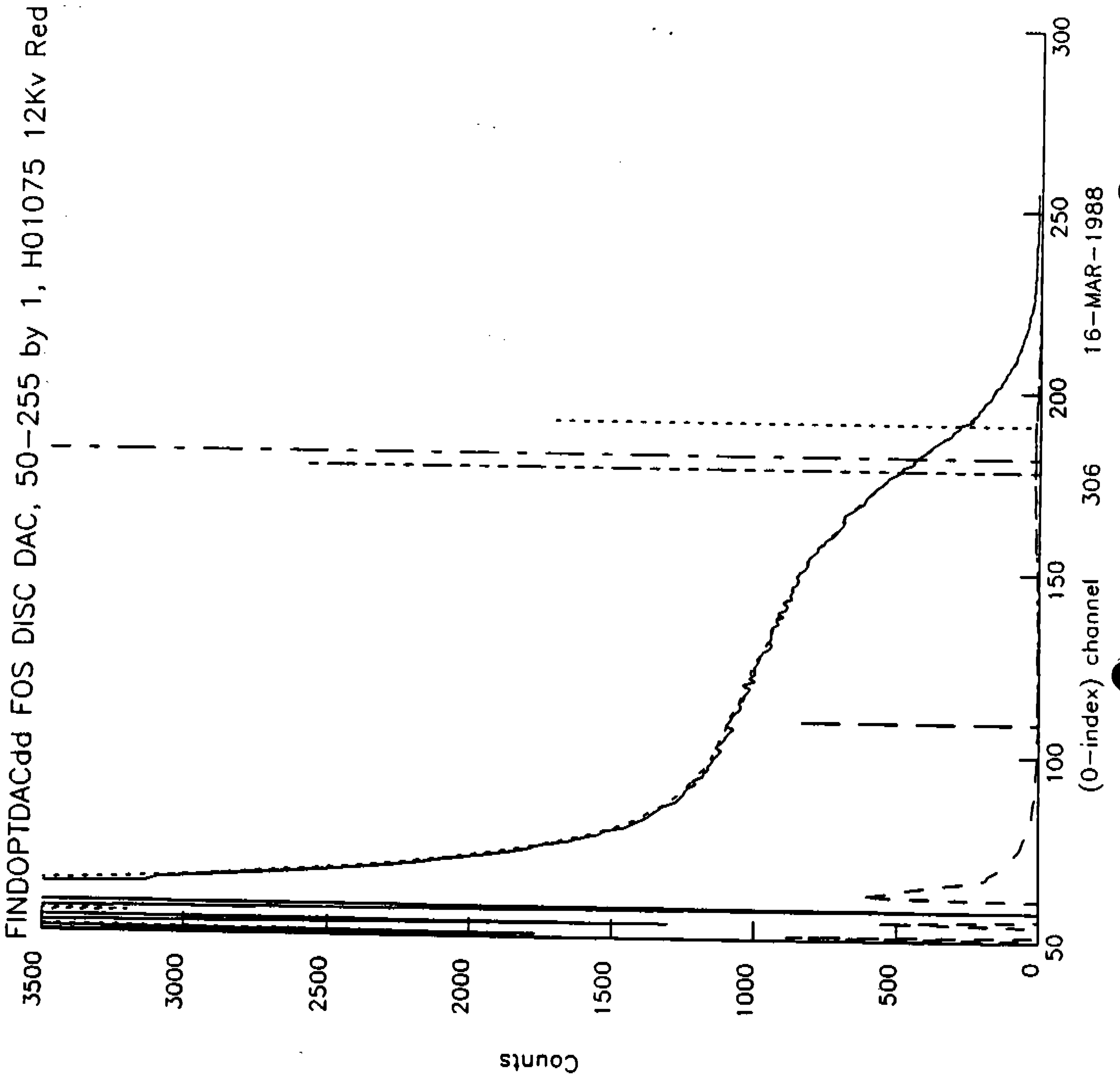

Figure 2a - Counts vs DAC setting for diode 306 of the Red F12 detector. The solid line is the integrated PHD; the short dashed line the smoothed data. The long dashed vertical line (— - —) marks the DAC setting determined with the new algorithm. The alternating dashed vertical line (— - - - —) marks the DAC setting determined by the old algorithm, while the short dashed vertical line (- - -) marks the PROM value (scaled to REFDAC=250). The long vertical dashed line near 100 marks the edge of the fitted region of the actual PHD (shown in the lower curve (long dash) and Figure 2b).

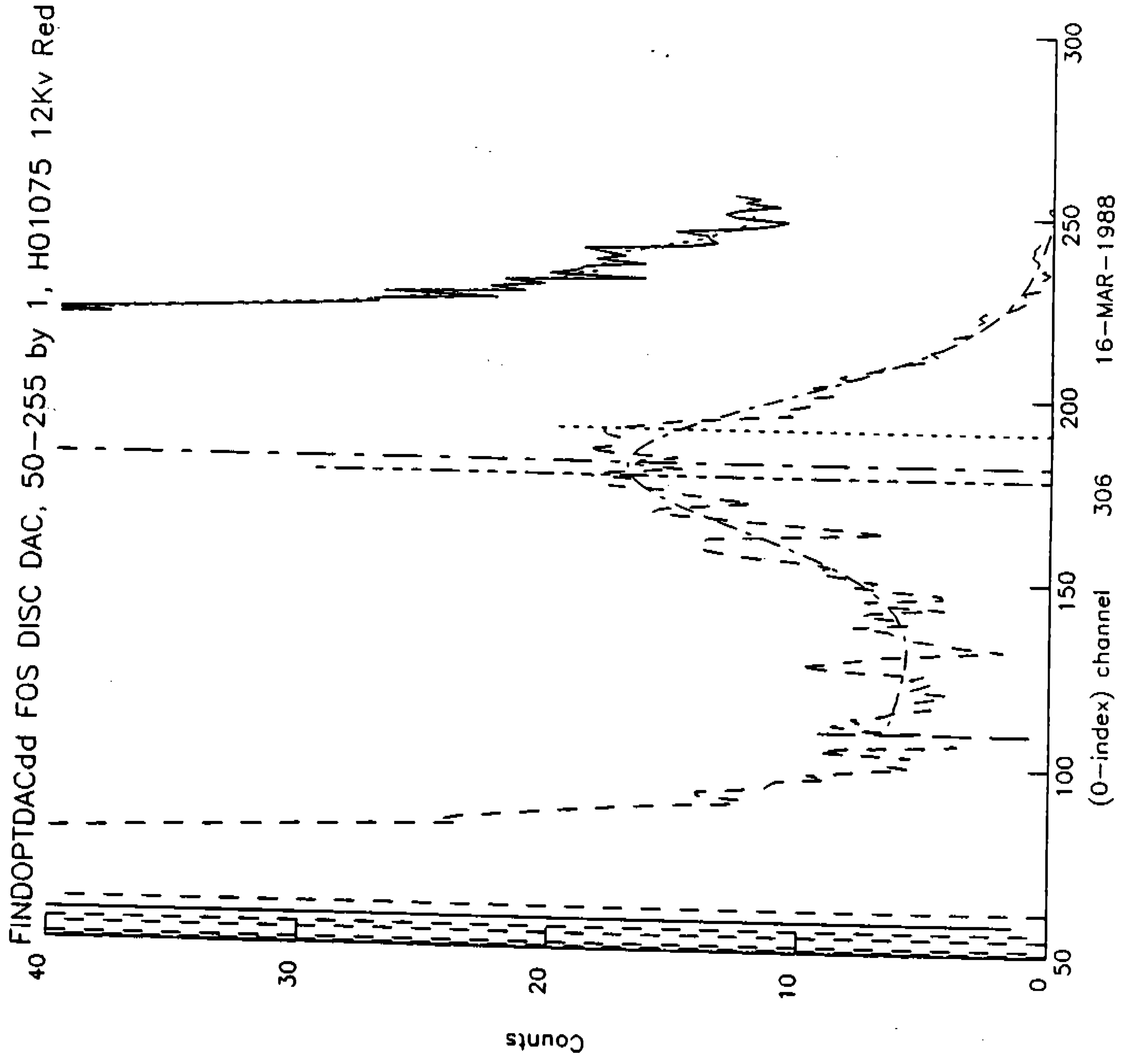

Figure 2b - Like figure 2a, but expanded to show the actual PHD. The long dashed line shows the PHD and the alternating dashed line (— - - —) shows the fit.

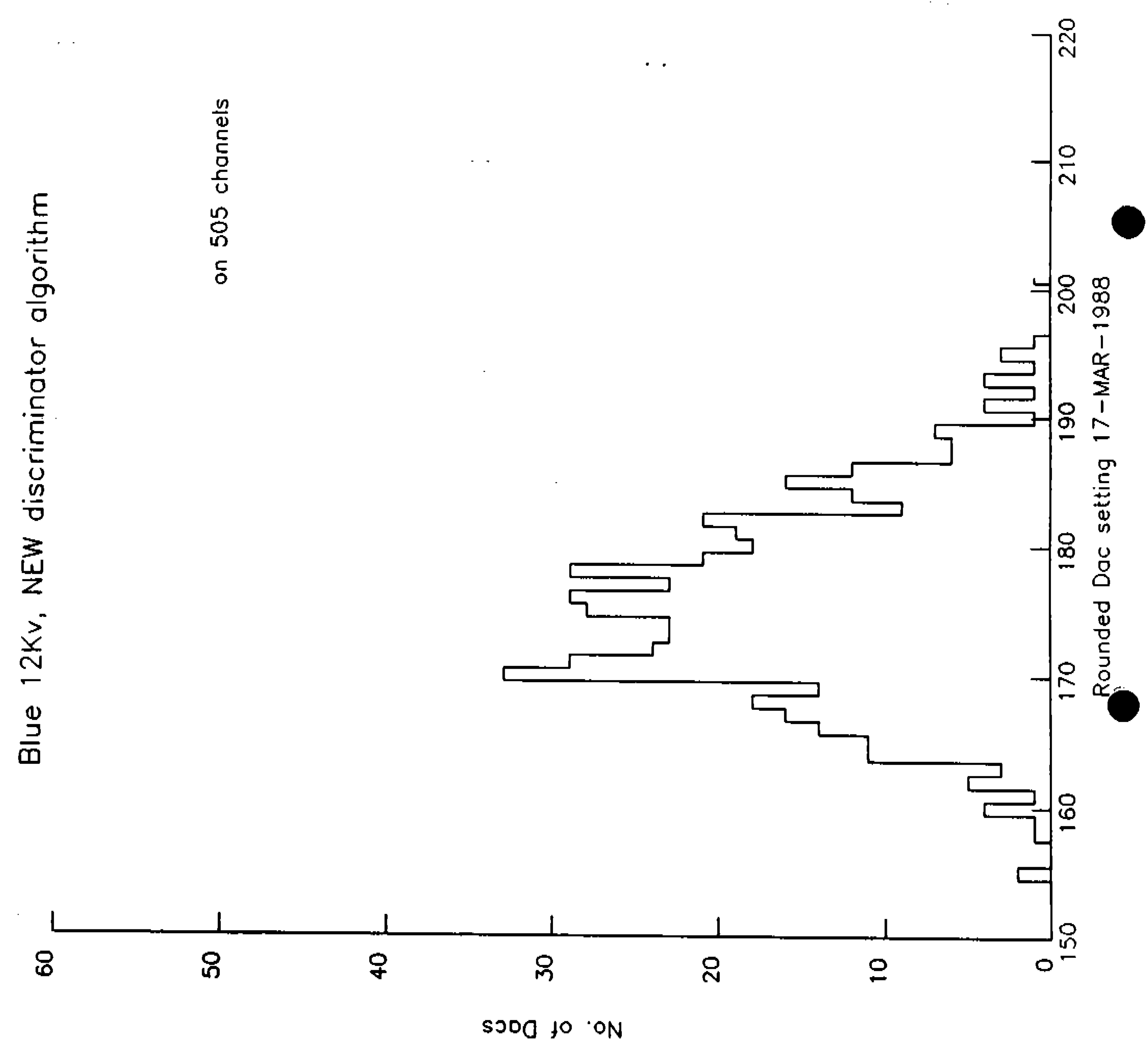

Figure 3 - A histogram of DAC settings (for REFDAC=250) for the new algorithm on the Blue side (F7).

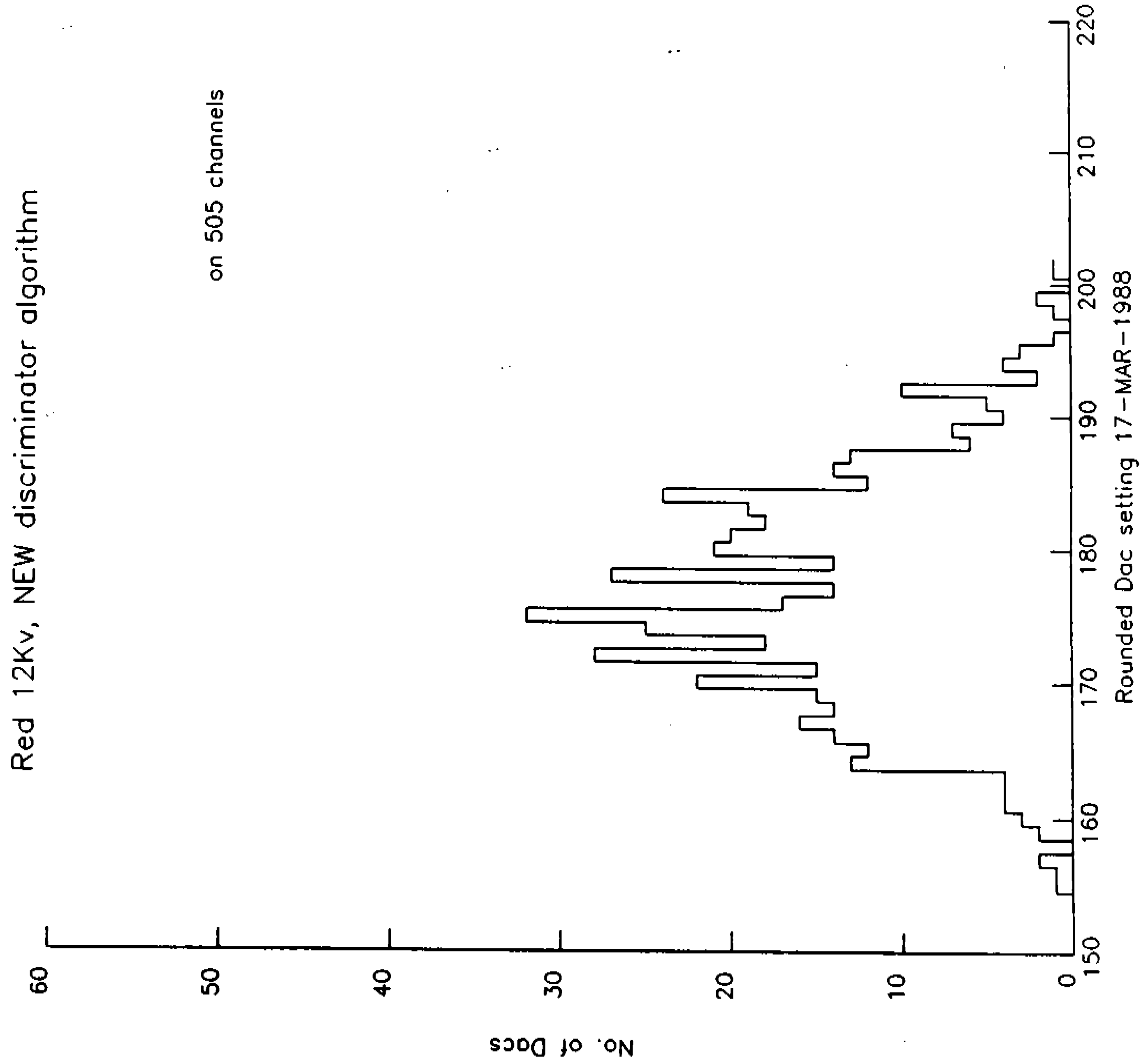

Figure 4 - A histogram of DAC settings (for REFDAC=250) for the new algorithm on the Red side (F12).

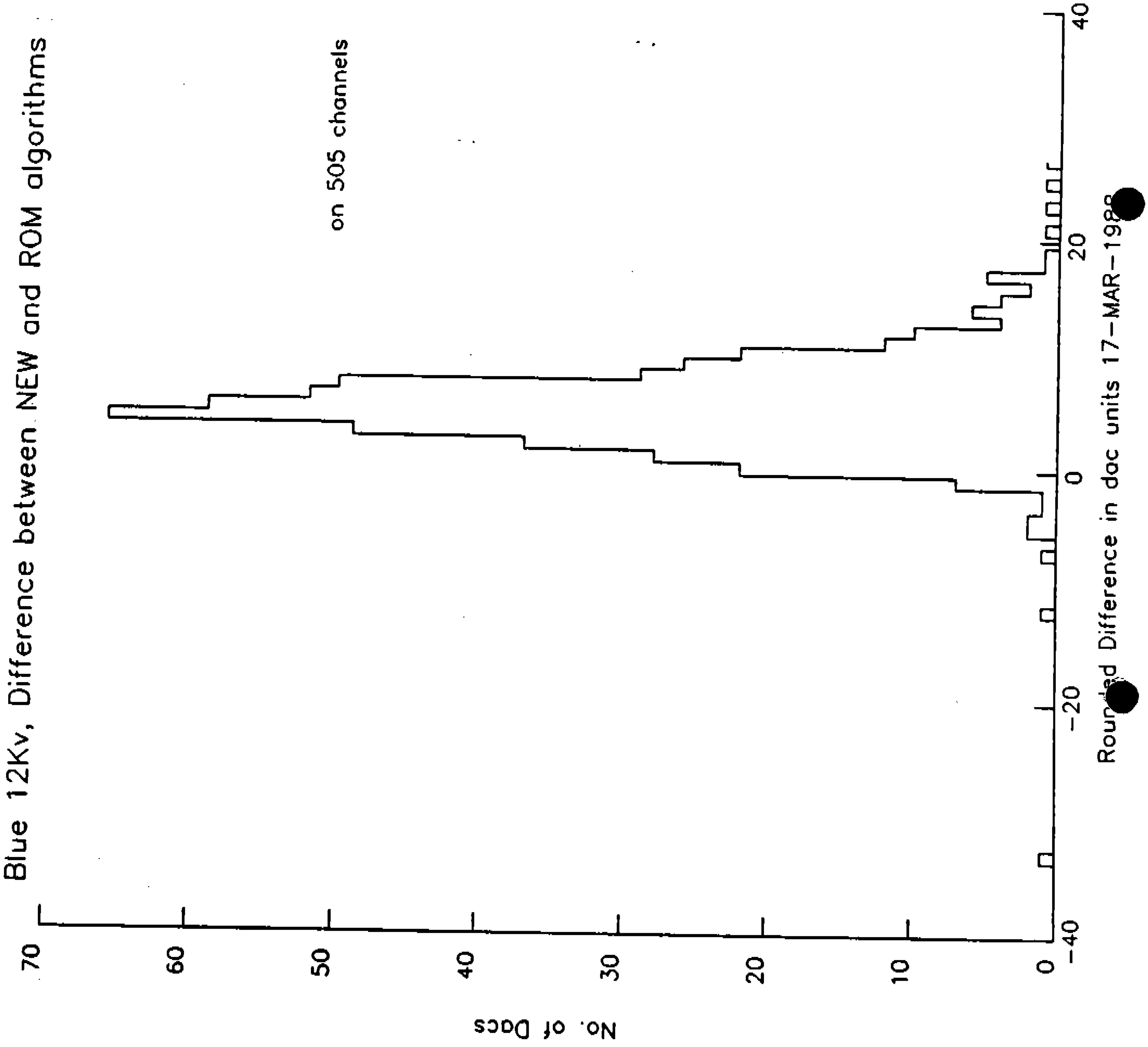

Figure 5 - The difference between the new algorithm settings and the PROM values on the Blue side (F7), scaled for REFDAC=250.

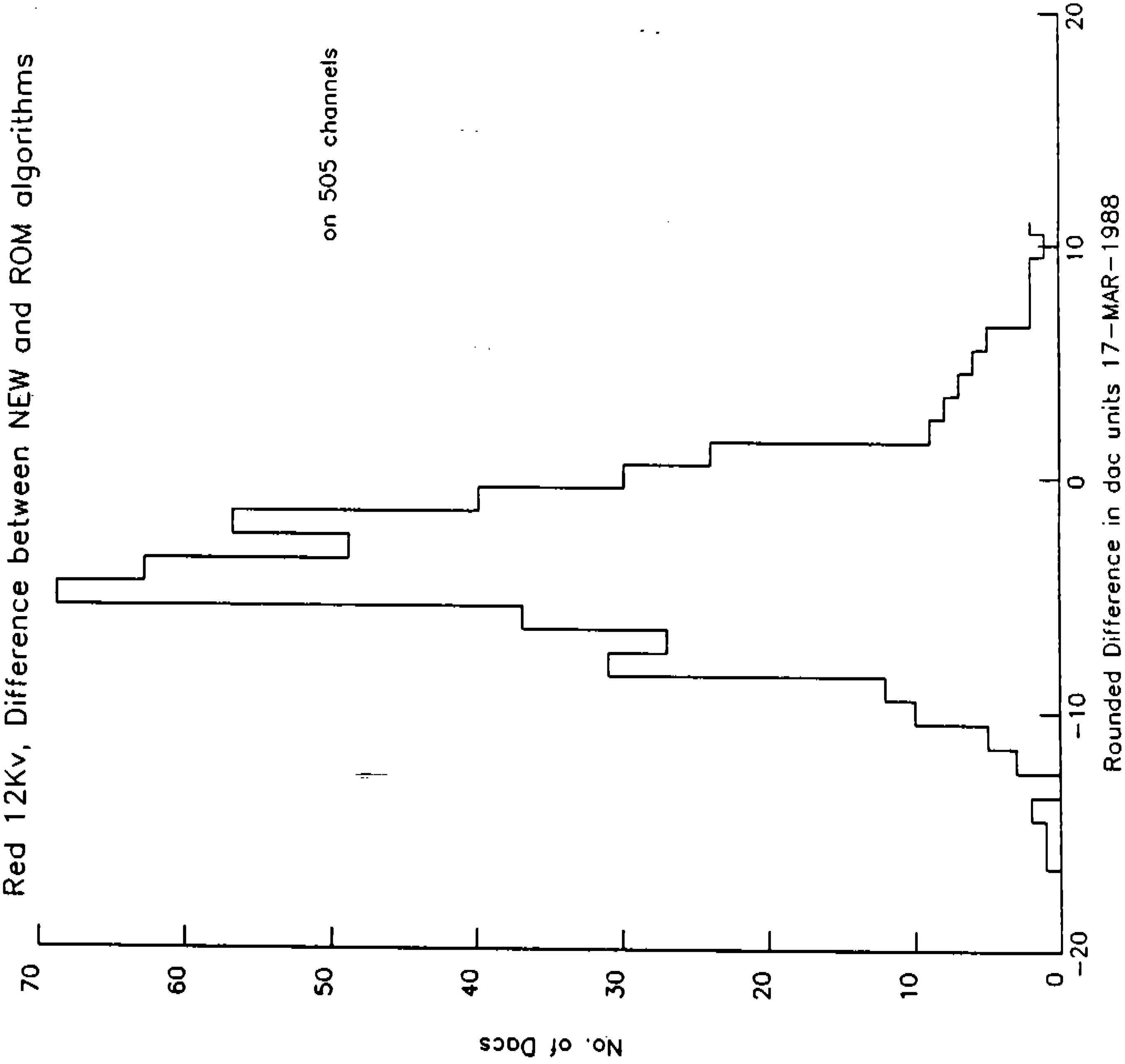

Figure 6 - The difference between the new algorithm settings and the PROM values on the Red side (F12), scaled for REFDAC=250.

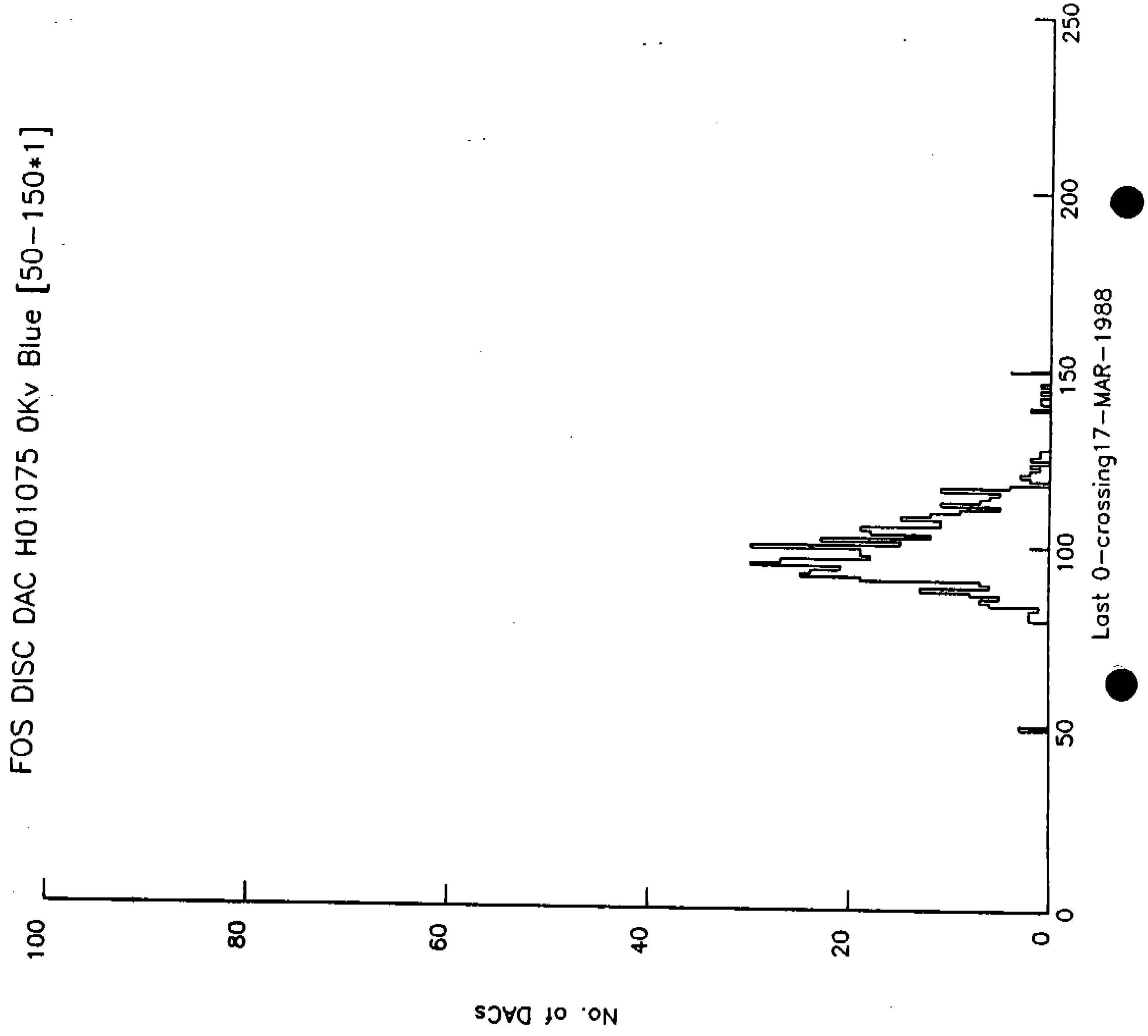

Figure 7 - Histogram of the last zero crossing on the Blue side (F7) from the 0V discriminator test.

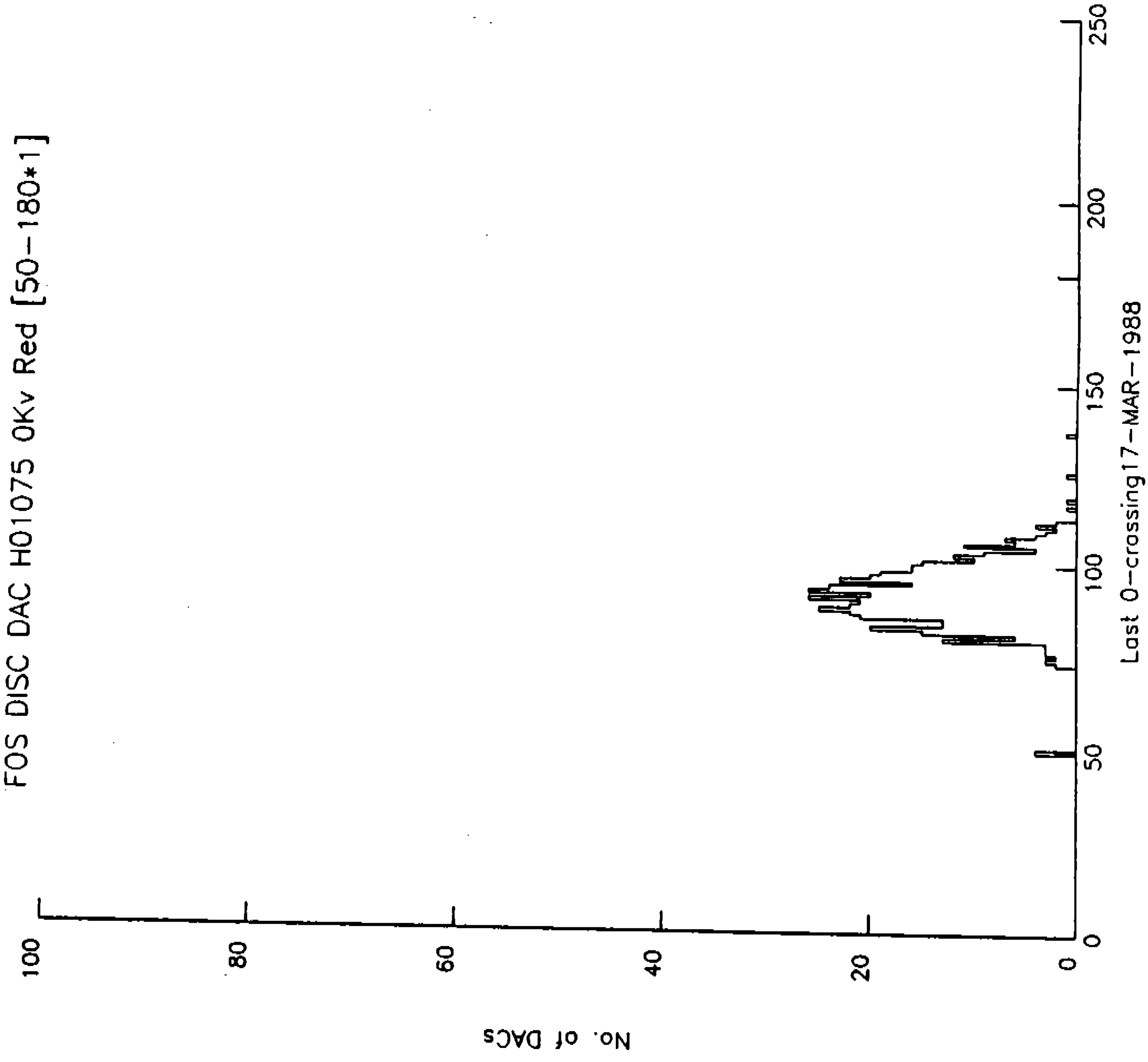

Figure 8 - Histogram of the last zero crossing on the Red side (F12) from the 0V discriminator test.

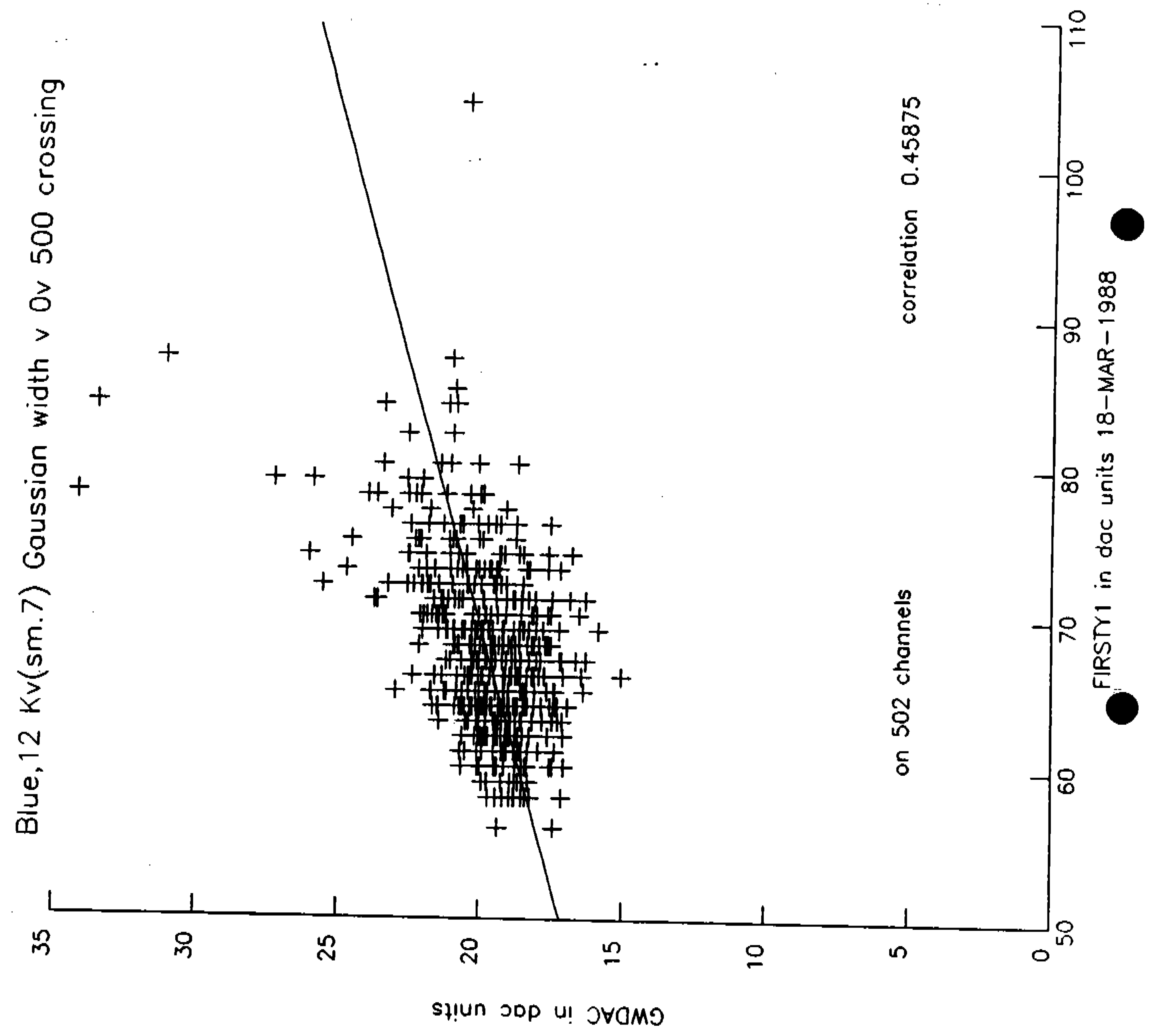

Figure 9 - The gaussian σ of the peak in the 12kV discriminator setting (GWDAC) vs the 500 ct/s point in the 0V discriminator setting (FIRSTY1) on the Blue side (F7). FWHM=2.35σ. The line is a straight line fit.

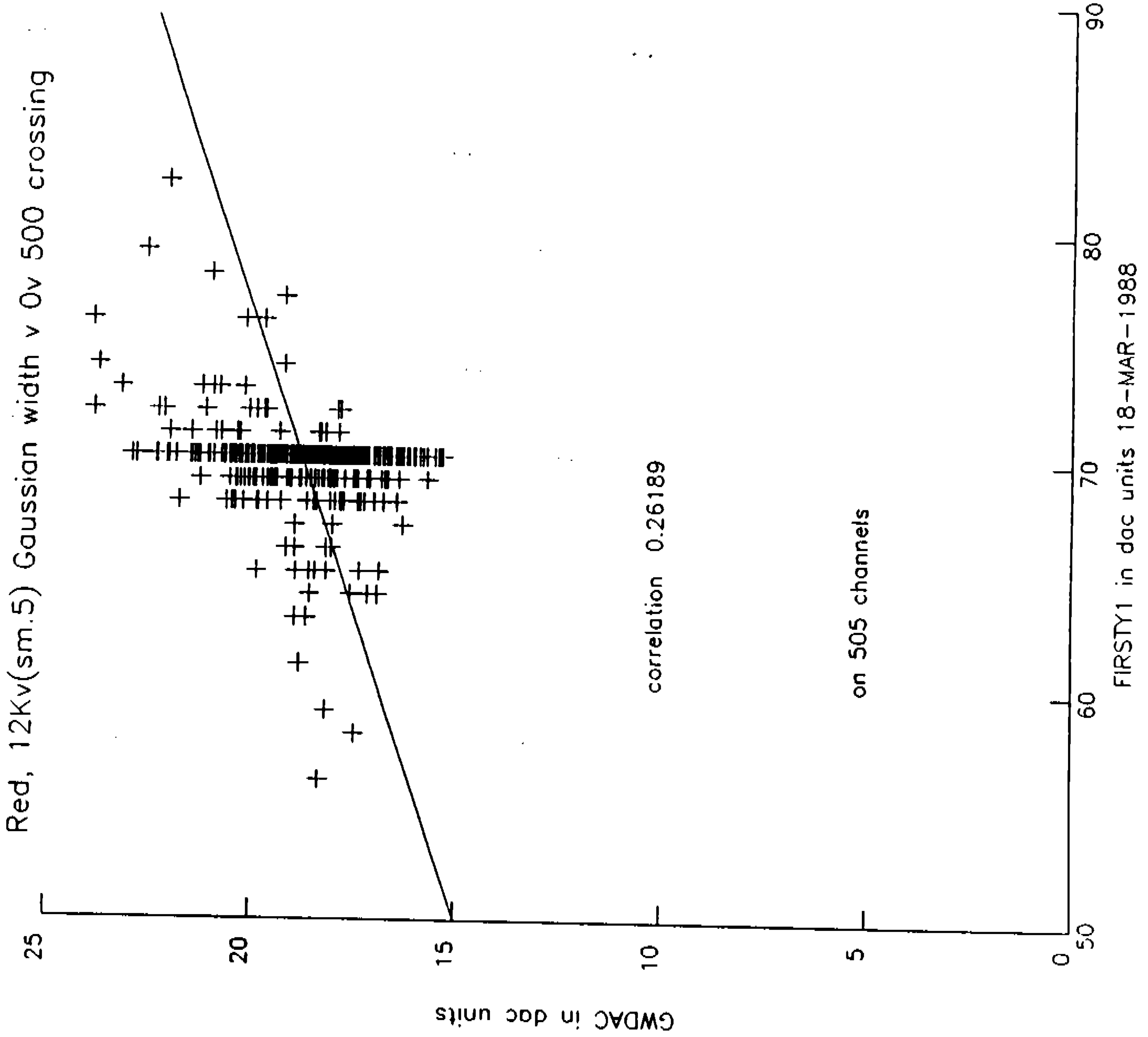

Figure 10 - The gaussian σ of the peak in the 12kV discriminator setting (GWDAC) vs the 500 ct/s point in the 0V discriminator setting (FIRSTY1) on the Red side (F12). FWHM=2.35σ. The line is a straight line fit.

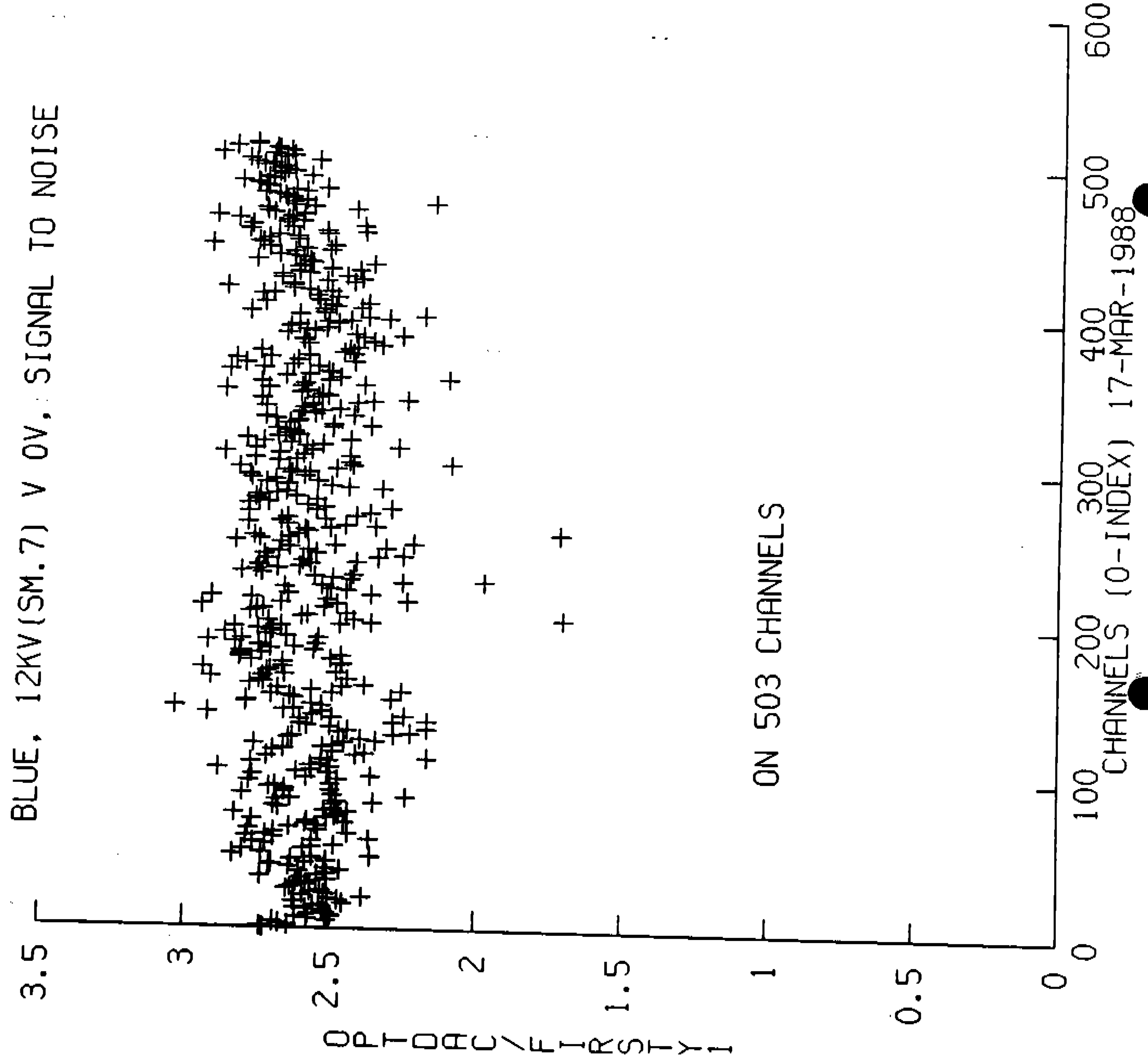

Figure 11 - The signal-to-noise on the Blue side (F7). S/N is defined as the new algorithm DAC setting divided by the 500 ct/s point in the 0V discriminator test.

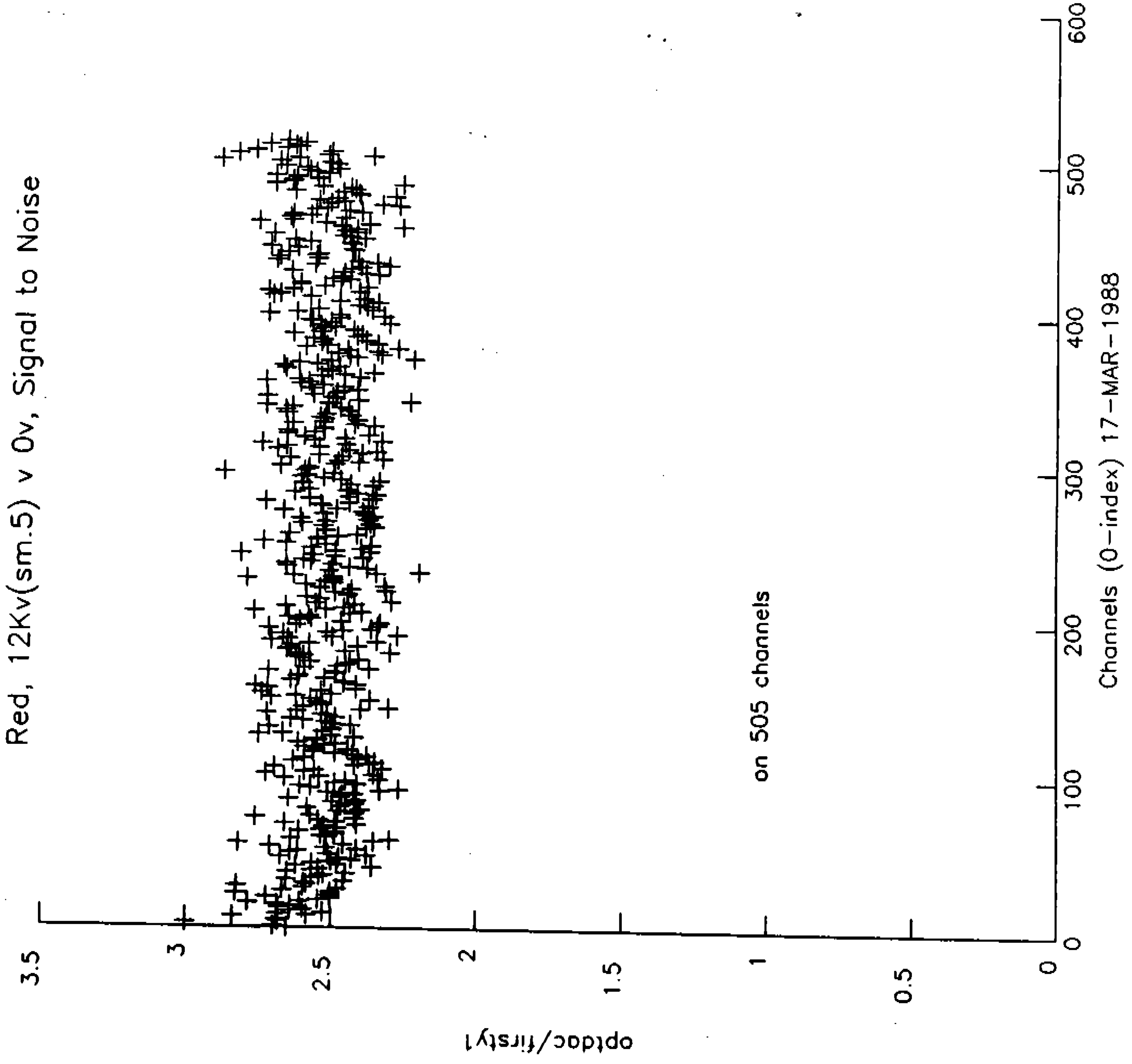

Figure 12 - The signal-to-noise on the Red side (F12). S/N is defined as the new algorithm DAC setting divided by the 500 ct/s point in the 0V discriminator test.

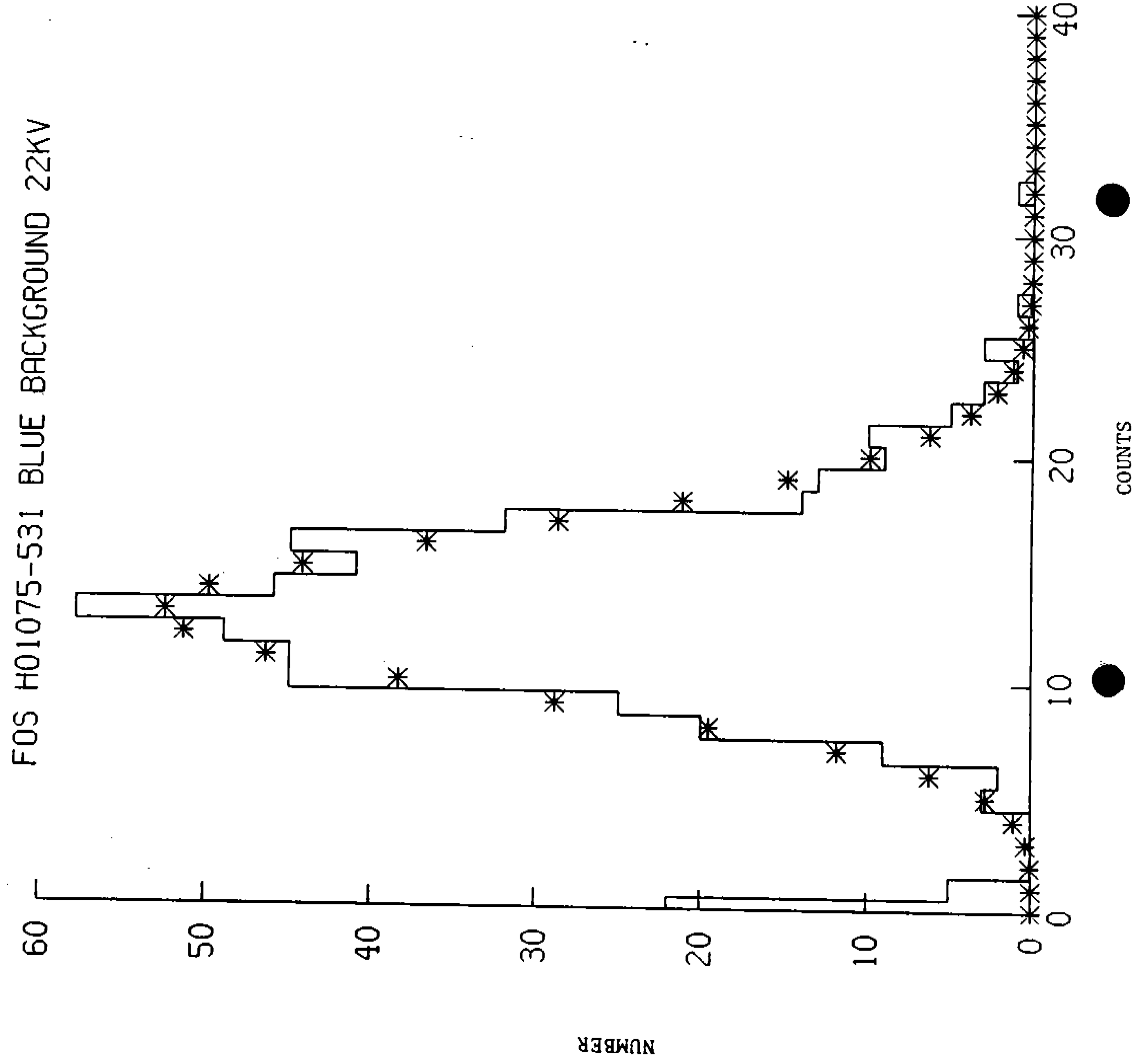

Figure 13 - A histogram of numbers of counts in the Blue detector background (F7) at 22kV. Expected values of counts are shown by the asterisks. Counts of 0 and 1 are dead or disabled channels and those under the mask.

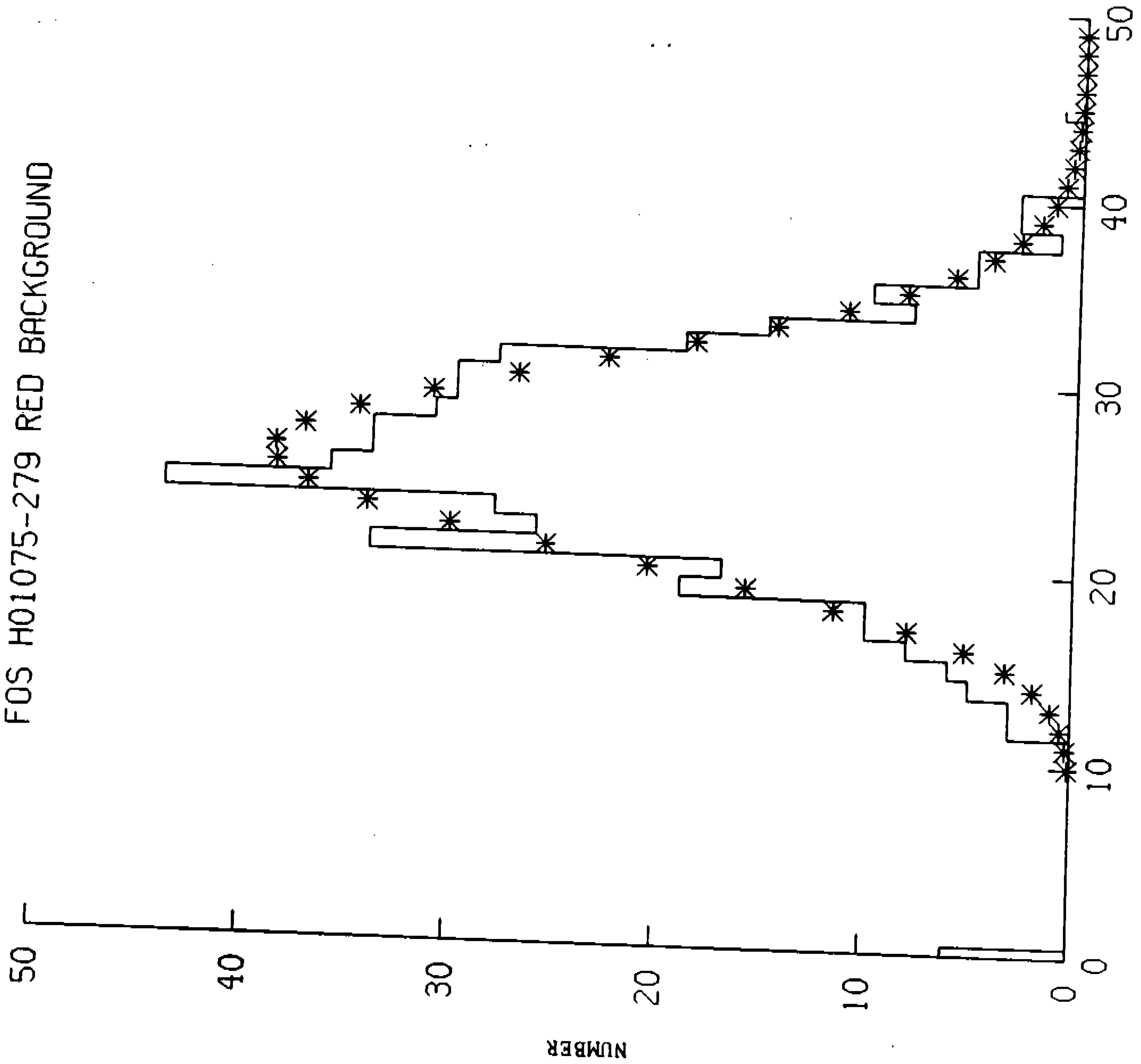

Figure 14 - A histogram of numbers of counts in the Red detector (F12) background at 21kV. Expected values of counts are shown by asterisks. Counts of 0 are dead or disabled channels.

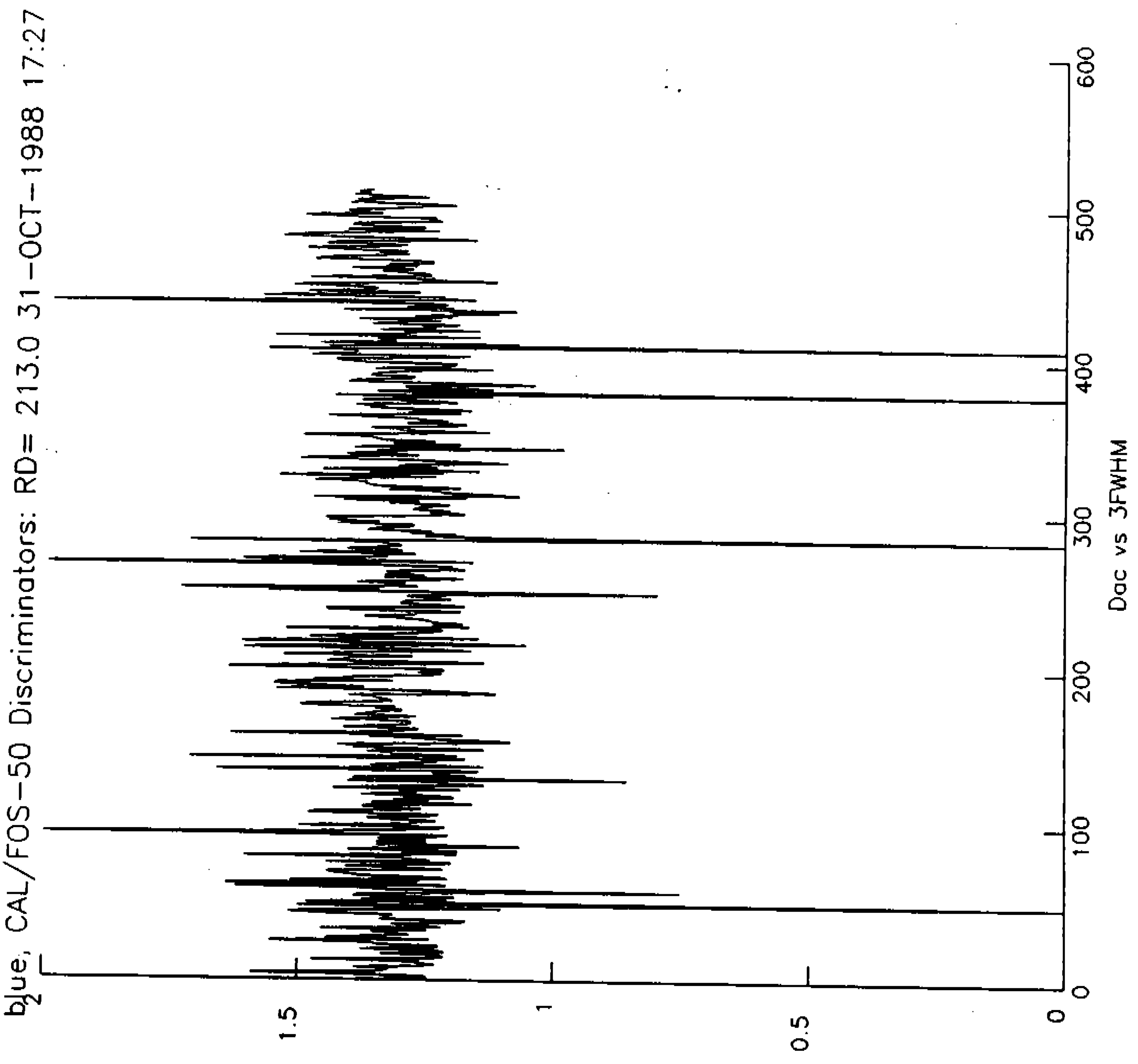

Figure 15 - The ratio for each channel of the optimal discriminator setting to three times the FWHM of the electronic noise for the Blue F7 detector and the optimal REFDAC setting (213).

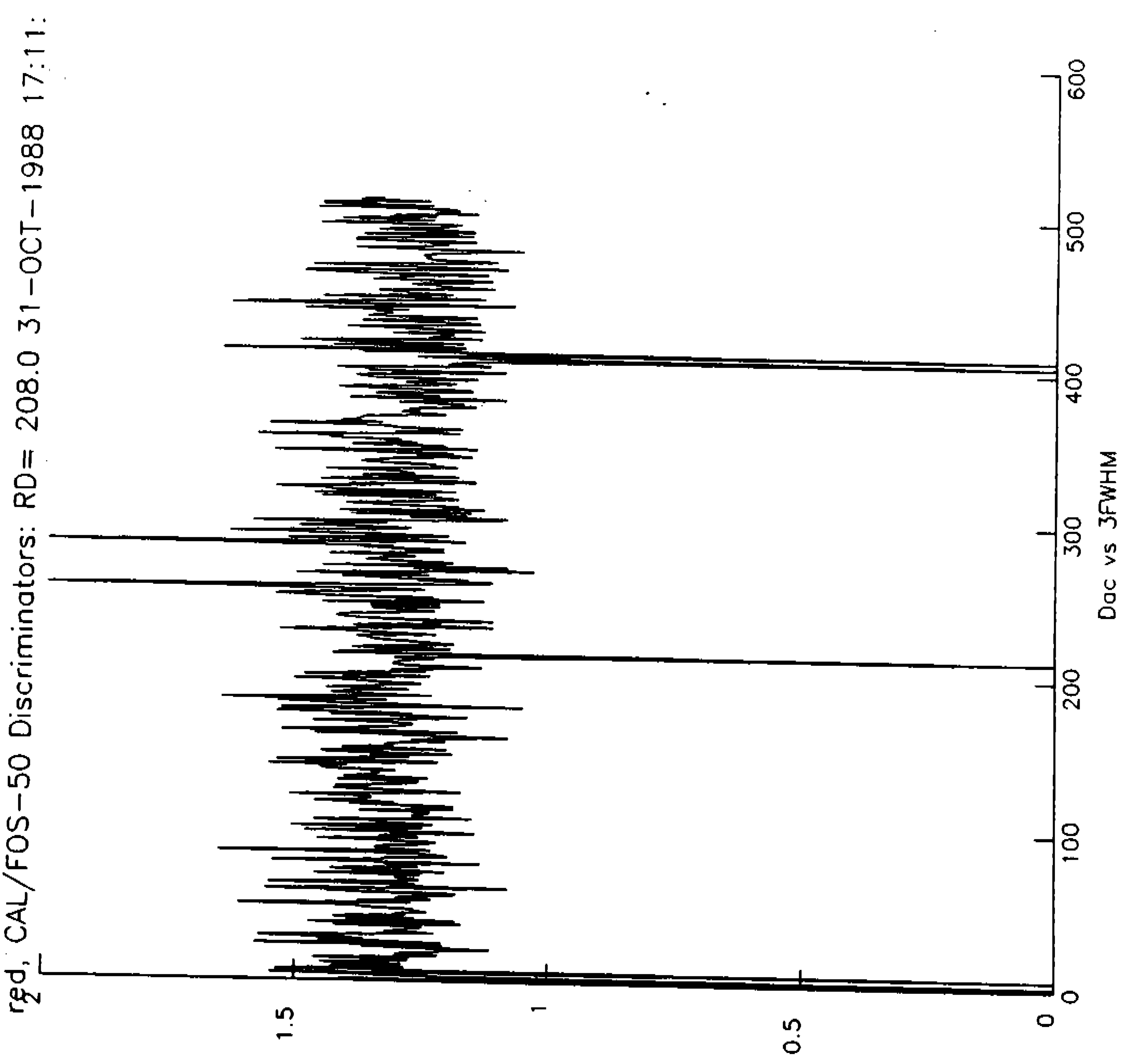

Figure 16 - The ratio for each channel of the optimal discriminator setting to three times the FWHM of the electronic noise for the Red F12 detector and the optimal REFDAC setting (208).

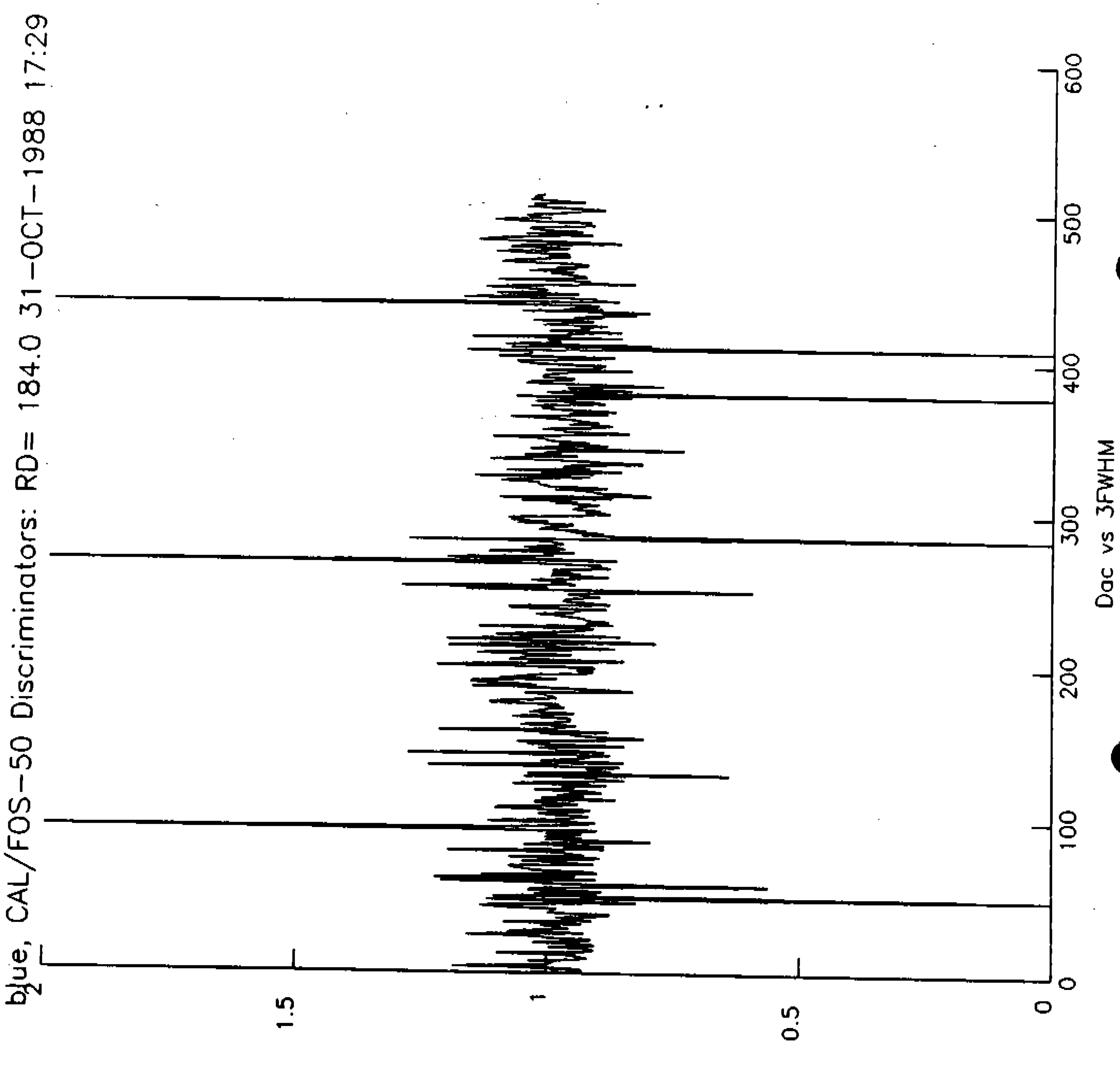

Figure 17 - The ratio for each channel of the optimal discriminator setting to three times the FWHM of the electronic noise for the Blue F7 detector and a REFDAC setting of 184.

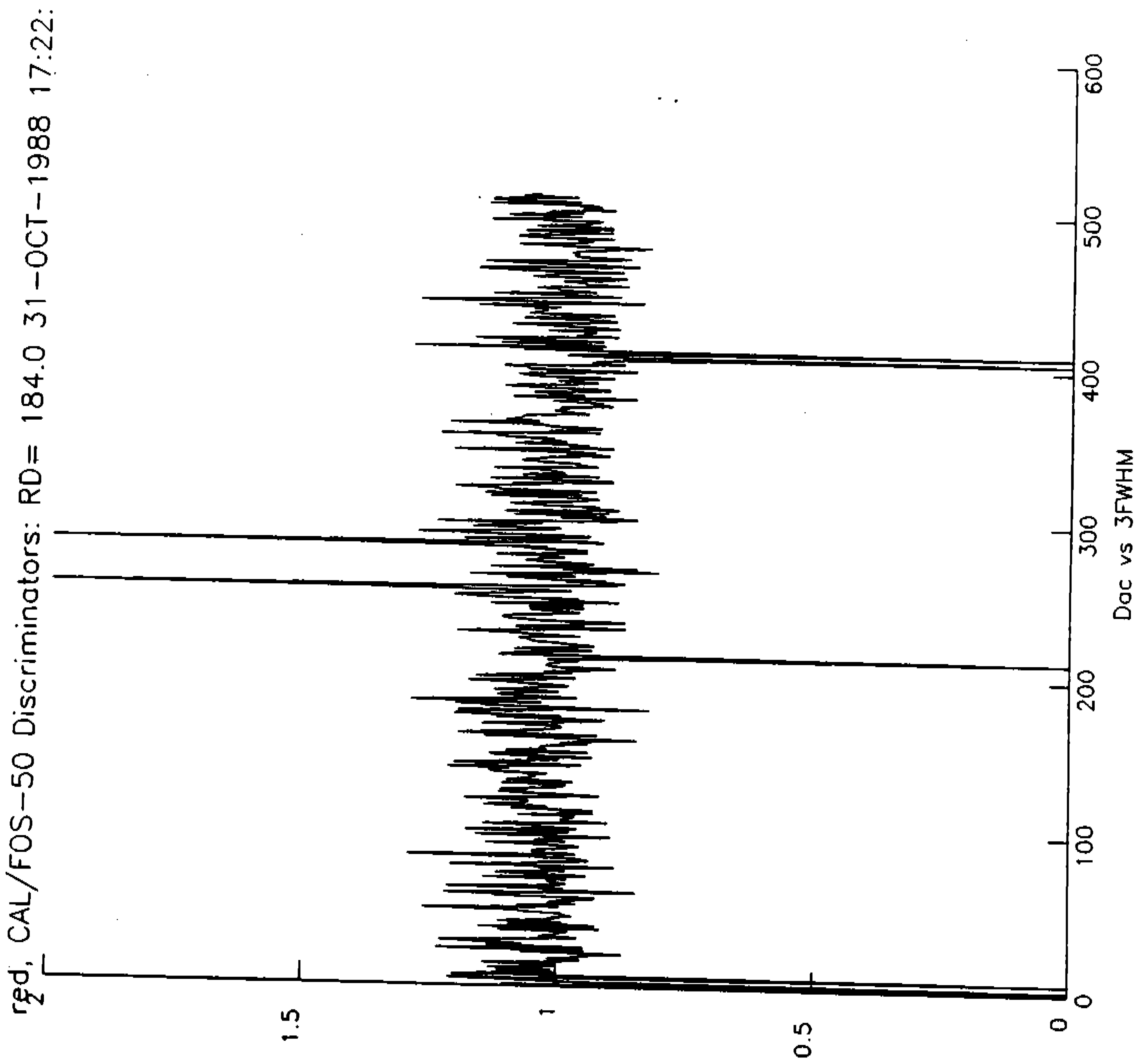

Figure 18 - The ratio for each channel of the optimal discriminator setting to three times the FWHM of the electronic noise for the Red F12 detector and a REFDAC setting of 184.