Function Test of ACD Electronics Board for External Gamma Target performed on April 11, 2001.

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Following previous investigation (XGT_05Apr2001.pdf and dsl031_bfemxgt.pdf), we tested ACD electronics board for External Gamma Target (XGT) at building 33 on Apr 11, 2001. The test was done by Tsunefumi Mizuno with great help of James Wallace, Bob Schaefer, and Dave Lauben. Main objectives of this test is to do calibration of electronics board and to examine whether the board works in Balloon Flight Engineering Model (BFEM) ACD Crate or not.

1 Calibration of electronics board for XGT

During calibration of electronics board for XGT, the board was powered by laboratory power-supply (and not installed in BFEM Crate). After we have confirmed that XGT board is functional in the same way as described in dsl031_bfemxgt.pdf, we investigated response of mid-amp output, PHA-follow signal, and ACD input on charge injection. We used BNC pulser Model DB-2, set rise time as small as possible (100 ns) and fall time as large as possible (1 ms), and cut pulser output by capacitor of 20 pF. In this way, we can generate narrow charge input. The setup is shown in Figure 1. We injected pulse of 1.6 V into capacitor of 20 pF, so the amount of charge generated is $Q = C \times V \sim 20\ \mathrm{pF} \times 1.6\ \mathrm{V} = 32\ \mathrm{pF}$. This value is consistent with Figure 2a, where we monitored charge injection by oscilloscope with 50 Ω termination. Here, the amount of charge is calculated as $\sim \frac{1}{2} \times 220\ \mathrm{ns} \times 0.3\ \mathrm{mA} = 33\ \mathrm{pC}$. The response of mid-amp output, PHA-follow signal, and ADC input are also given in Figure 2b. By changing the voltage of pulser output, we can calibrate the relation between the amount of injected charge and the voltage level of mid-amp output/PHA-follow signal/ADC input. The results are summarized in Figure 3. Thus, the ratio of mid-amp out : PHA-follow signal : ADC input is about 15:8:20. We can also see that analog circuits of XGT board are saturated at ≤ 40 pC input, where mid-amp output reaches ~ 600 mV and ADC input reaches ~ 800 mV.

We then set pulser output at 1 V (the amount of charge injected is about 20 pC), inputted signal in Channel 0, 1, 2, and 3, and obtained histogram of each Channel. The

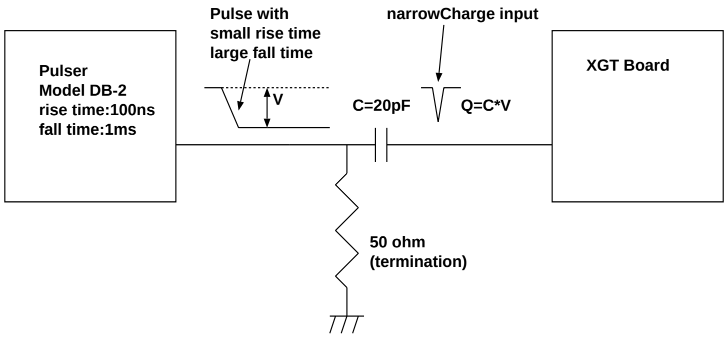

Figure 1: Setup of XGT board calibration.

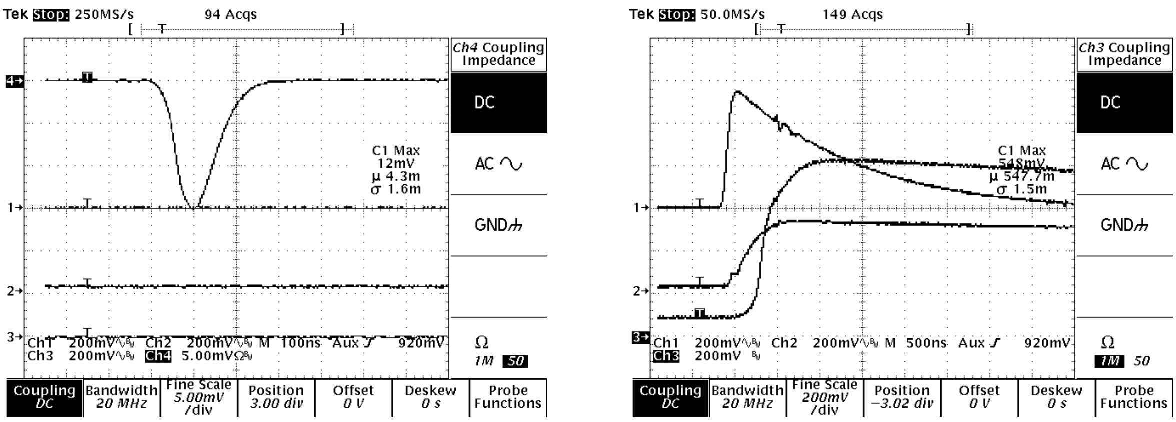

Figure 2: (a) Charge input signal of $Q \sim 32$ pF. Scales are 5 mV/div and 100 ns/div. (b) Response of mid-amp output (trace 1), PHA-follow signal (trace 2), and ADC input (trace 3) of Channel 3, all in a scale of 200 mV/div and 500 ns/div.

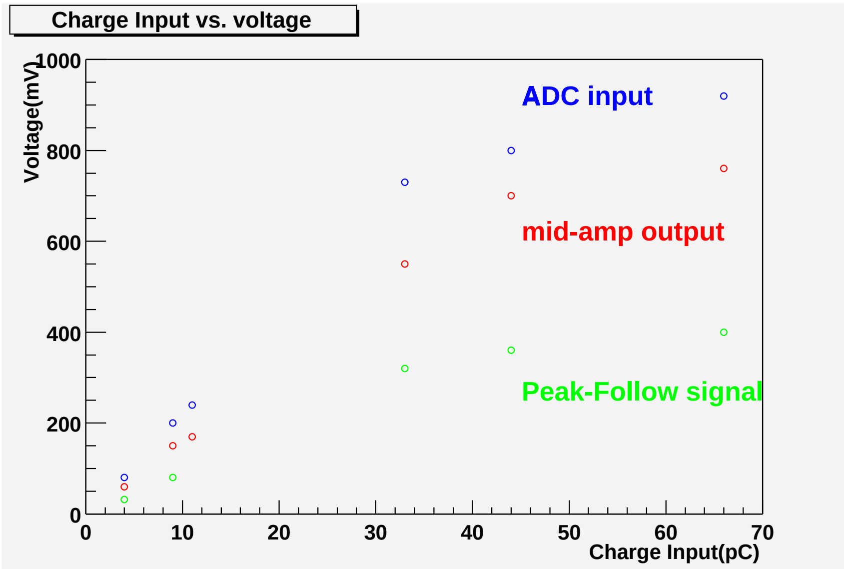

Figure 3: Charge input vs. voltage of mid-amp output, PHA-follow signal, and ADC input of Channel 3 of XGT board. We failed to record PHA-follow signal level for $\sim$ 11 pC input, so the corresponding data isn't plotted in the Figure.

results are shown in Figure 4. The peak channel is 642, 685, 583, and 674 for Channel 0, Channel 1, Channel 2, and Channel 3, respectively. Thus, response of Channel 0, 1, and 3 are the same within 5%, whereas Channel 2 has gain $\sim$15% smaller than that of other three Channels, or the pedestal differs by $\sim$ 100.

We finally scanned the relation between the charge input and channel of ADC. We put charge from 4 pC to 24 pC into Channel 3, acquired the histograms, and measured the peak channel. Results are shown in Figure 5. The ratio of ADC channel to input charge (in units of pC) is $\sim$ 33. Since the voltage of ADC input saturates when the amount of charge injected reaches to $\sim$ 40 pC (see Figure 3), ADC channel is expected to saturate at $\sim$ 1200. This value is consistent with the last Thursday's result (see XGT_05Apr2001.pdf).

2 Function test of XGT board in BFEM crate

We then mounted XGT board in BFEM Crate, inputted charge as we have done so far, and acquired the data. The amount of charge injected is $\sim$ 24 pC. As described in XGT_05Apr2001, only Channel 0 did work on last Thursday. After the Thursday's experiment, it turned out that Channel 1 had problem in solder of surface mount register, and fixing the problem made the Channel functional, as described in dsl031_bremxgt.pdf. Today Dave also found that a bit-assignment of data acquisition software for Channel 3 was incorrect, and fixed it. Therefore not only Channel 0 but also Channel 1 and 3 were expected to work, and they actually did as shown in Figure 6. Channel 2 also did collect the data today, Although we do not have firm idea why the Channel became functional [1]

[1]The difference of setup between today's experiment and last Thursday's one is, we did not installed board #5 today. This board has problem in power-line and may be a electronics noise source. This might

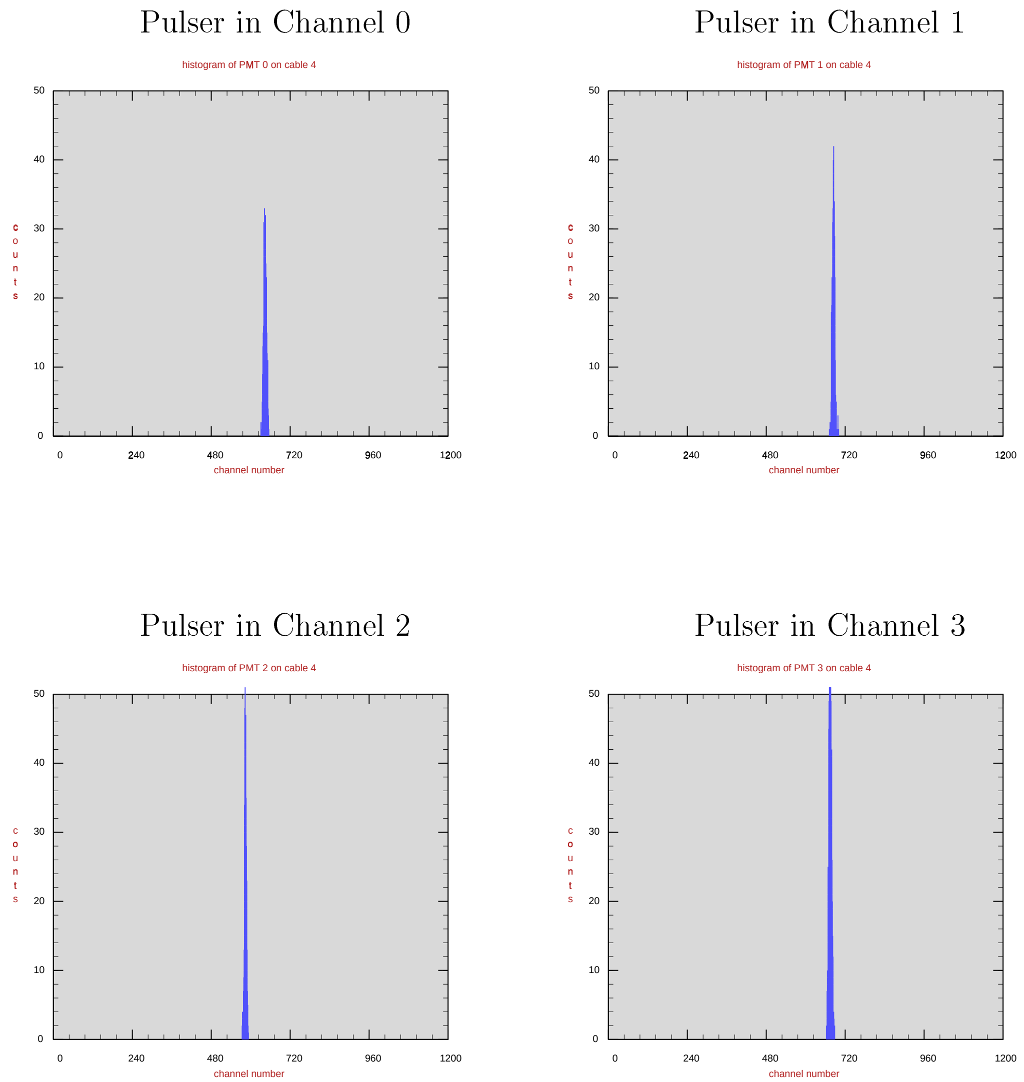

Figure 4: Histogram of each Channel of XGT board, before being installed in BFEM Crate. The amount of charge inputted is ∼20 pC.

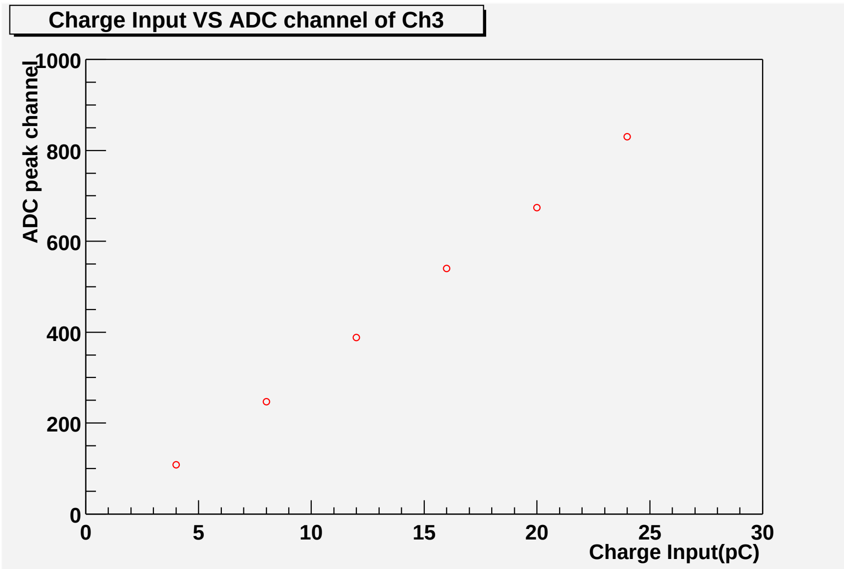

Figure 5: Charge input vs. ADC peak channel of Channel 3.

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We finally turned on XGT sensors and acquired data. The obtained histograms are given in Figure 7, where we can see peak of MIP particle for each Channel. The peak channel look differ with each other; Channel 1 and 2 exhibited ∼50% higher channels. Since the response of four Channels are the same within ∼15% (see Figure 4 and 6), this difference my be due to XGT sensors. To investigate this hypothesis, we exchanged input into Channel 0 and 1, and Channel 2 and 3, and acquired the data again. The results are shown in Figure 8. This time Channel 0 and Channel 3 showed higher channels, so XGT sensors of ID 1 and 2 may have higher gain comparing with other two. We also noticed that a discriminator of Channel 2 did not work (see Figure 7 and 8).

3 Remaining issues

- Find out why the PHA discriminator of Channel 2 did not seem to work.
- Examine both the PHA and low-level discriminator of each Channel.
- Measure gain and pedestal for each Channel.
- Adjust high-voltage of XGT PMTs, so that each system of XGT sensor plus electronics board has similar gain.

explain why Channel 2 did not work last week in BFEM Crate, although we are not sure this is the real reason.

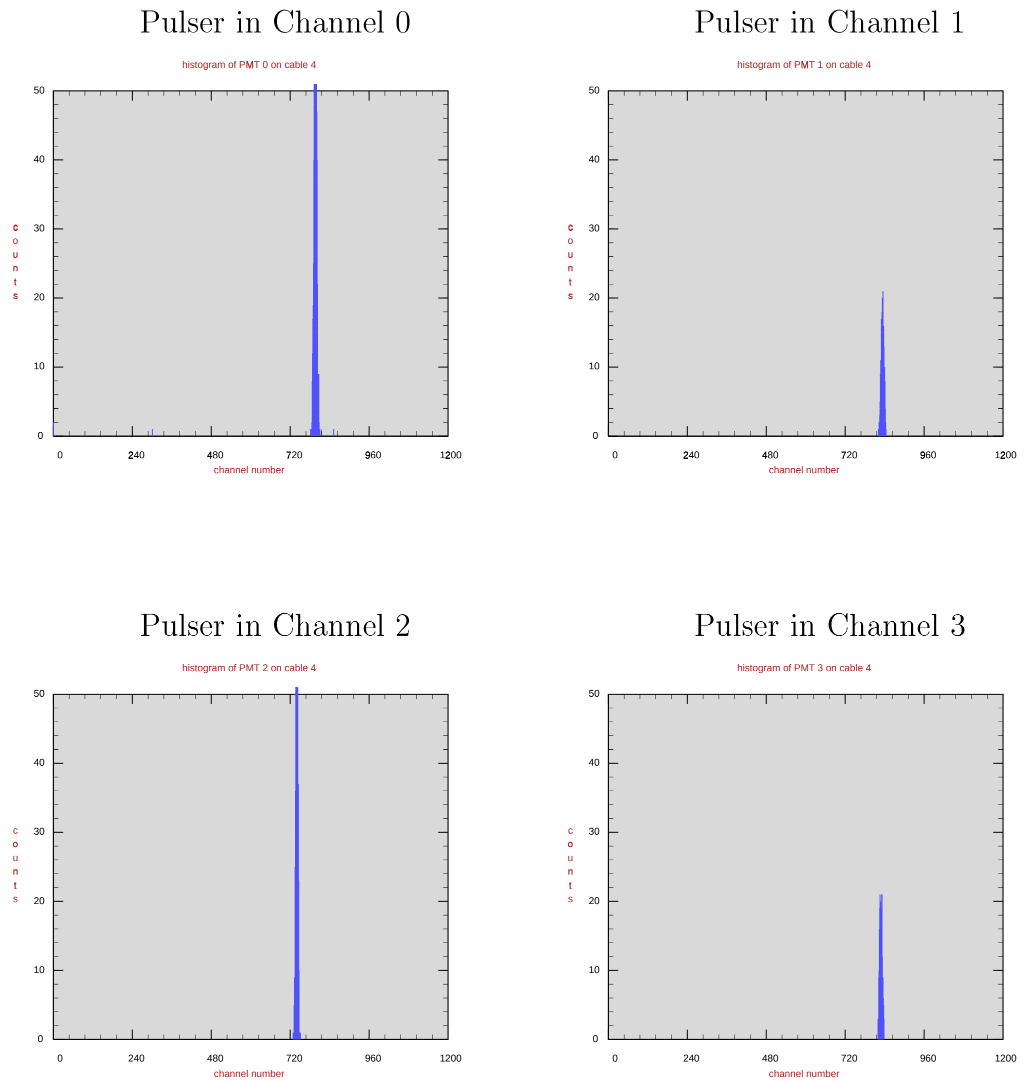

Figure 6: Histograms of each Channel of XGT board mounted in BFEM Crate. The amount of charge injected is ∼24 pC.

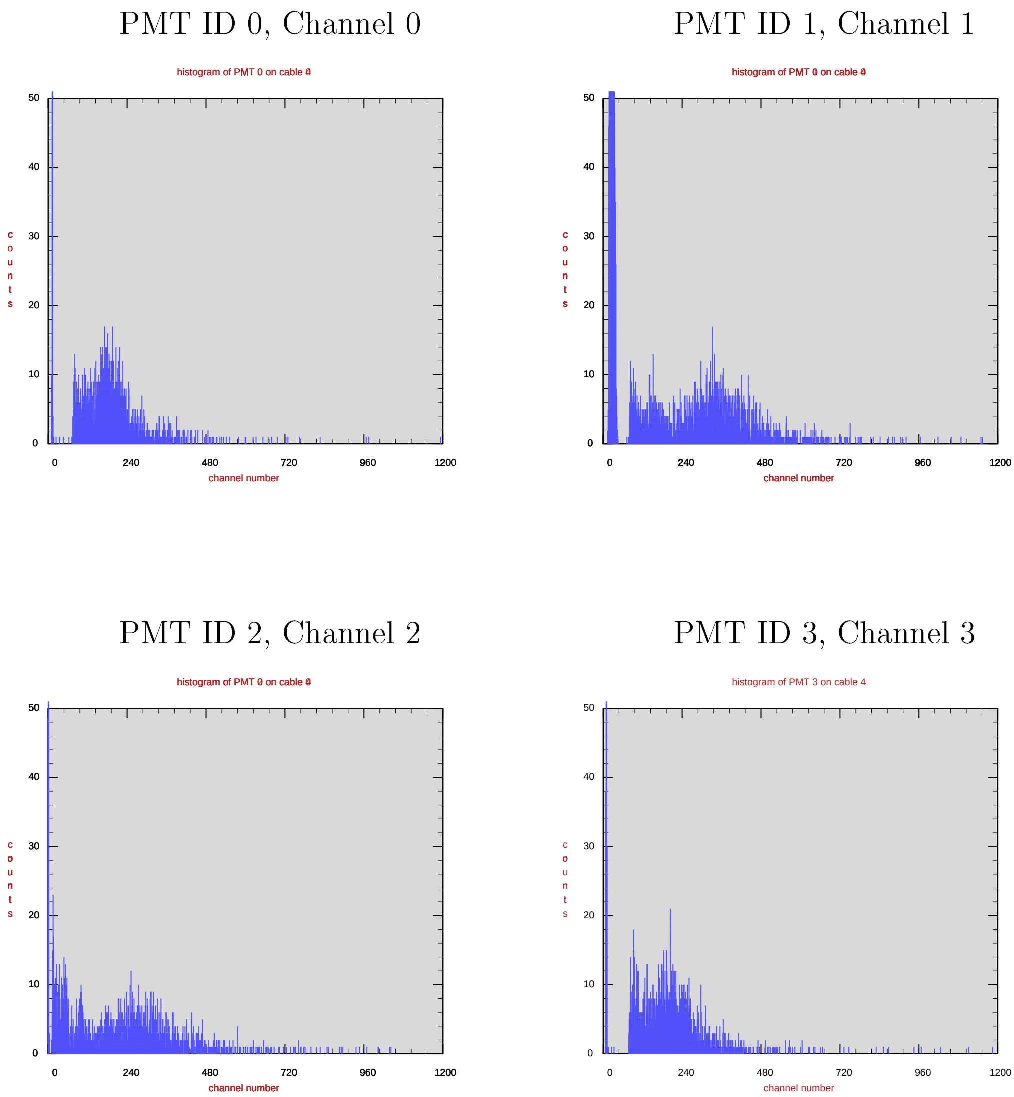

Figure 7: Histograms of each Channel for XGT sensor input. High voltage of each PMT is 520 V.

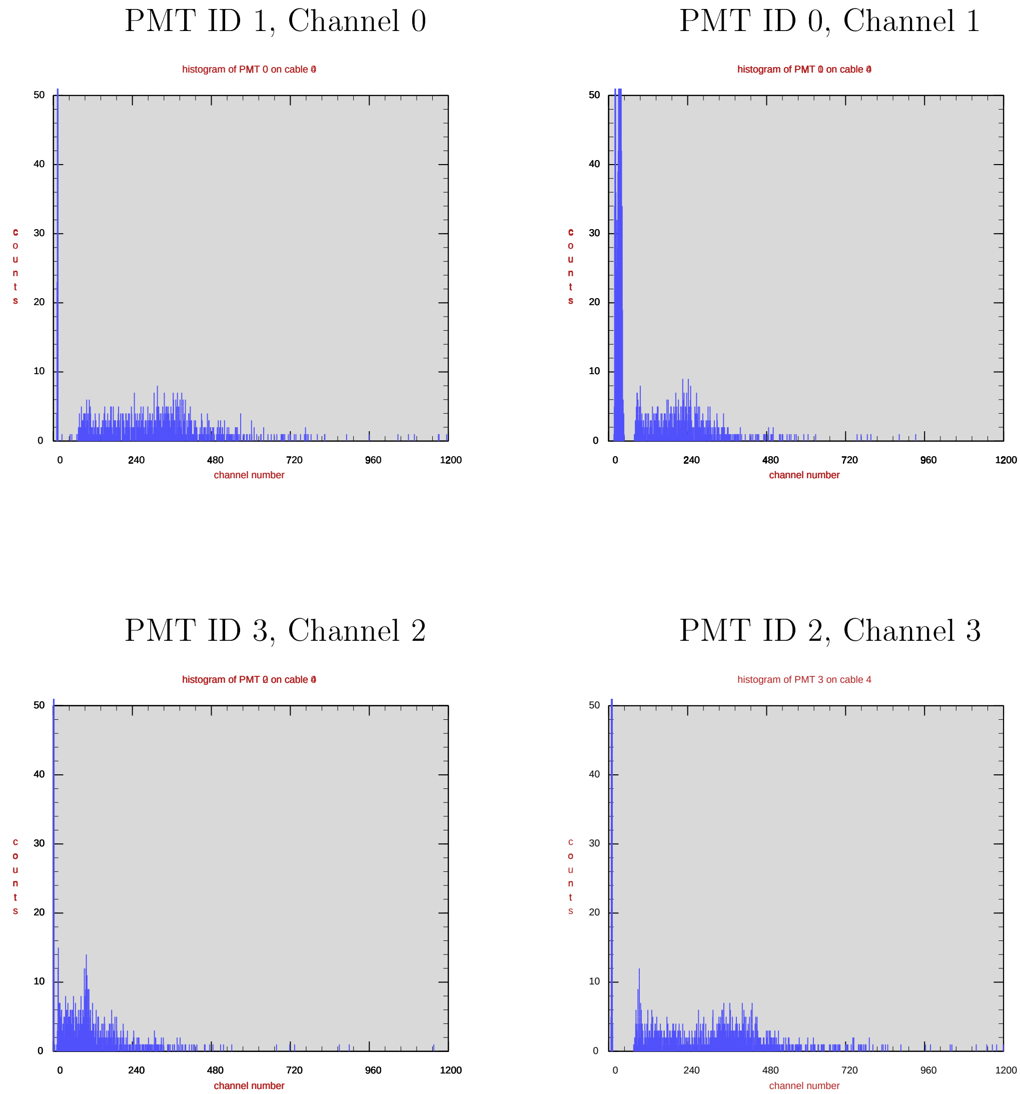

Figure 8: The same as Figure 7, but input to Channel 0 and 1, and Channel 2 and 3 were exchanged.