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Searching for Straws with Abnormal Spectra

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Introduction

During one of the QC meetings, it was pointed out that a straw with a potential problem passed the cuts designed to select out straws with potential HV problem. It was from M1.34 and the straw number was 209. The problem was that at two scanning positions (position 22 and 23), the peak value of the ADC spectrum is similar to normal positions but the width is very broad and that there are a large number of high hits (Figure 1). The width is about three times normal width. The high hits could indicate potential danger because this could indicate abnormally high electric field and result in HV instability. *I should note that I assume that there is nothing wrong with the data itself in this report.*

This location is peculiar because the gain and width are not correlated in the usual fashion (gain is slightly higher but width is very broad). Broad width is normally due to very high (bent straw or hung wire) or low gain (dirt). Thus, this location could not be classified into one of our usual categories and escaped our detection.

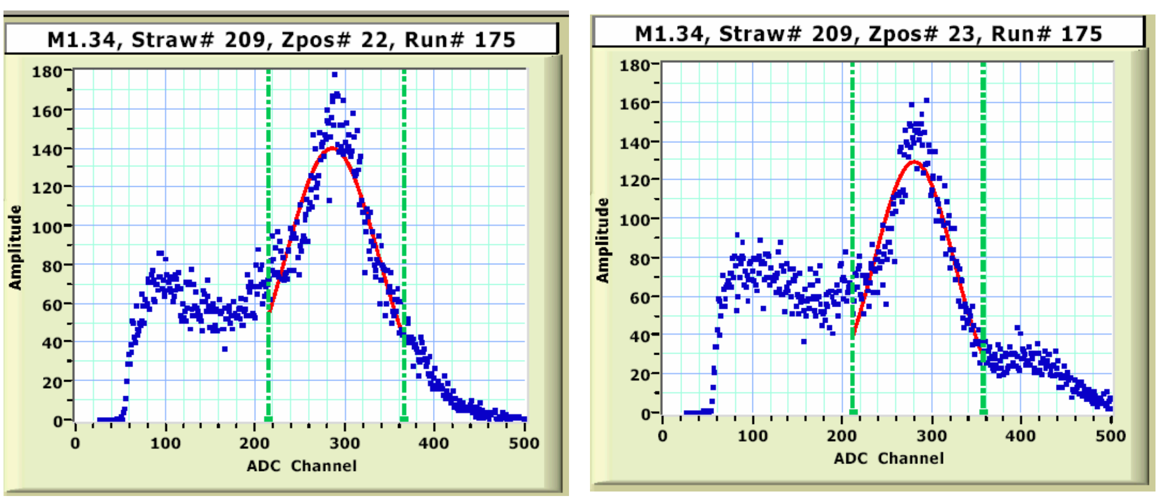


Figure 1. The ADC spectra from position 22 and 23. The data was taken with MGM.

It is conceivable that there are more of this type of straw that failed to be tagged, and it is important to estimate the number and make a correction (on our QC procedure) if necessary. Thus a systematic search was done and the results are reported here. Because of the special features of this type, the search was not difficult. Although this specific type of straws was searched, the search was broadened to look for straws with a large number of high hits but could escape our usual cuts.

Analysis I

In order to find straws with possible problems that pass our cuts, the ratio of the high hits to the total number of entries in an ADC plot was calculated. Typical ADC plots from MGM and the Duke scanner are shown in Figure 2. The ADC spectrum from the Duke scanner is somewhat different due to a higher threshold. Because the data used in this analysis is from the Duke scanner only, the high hits are defined above the ADC value of 600, which is about 2 sigmas away from the mean value of 500. This ratio is called H.

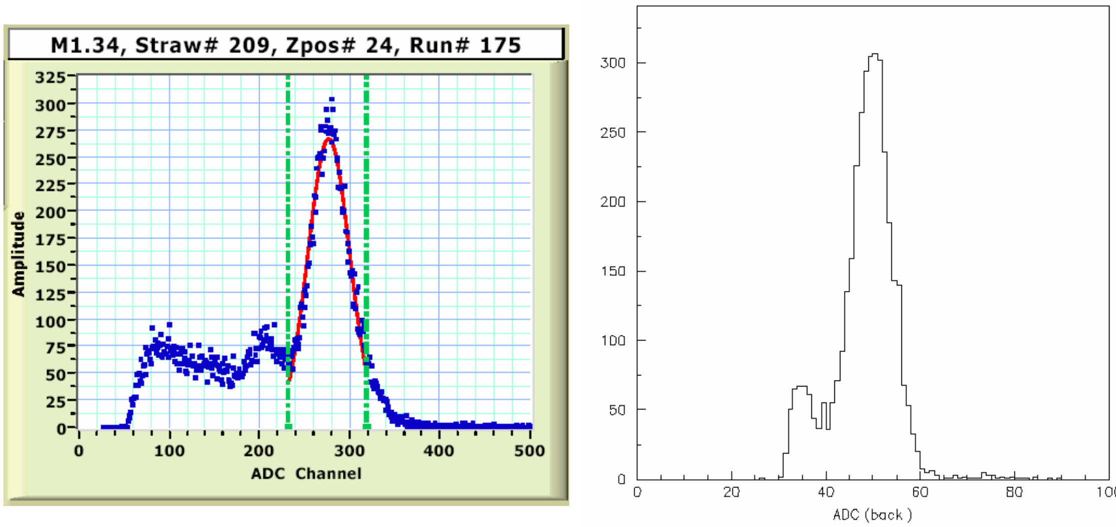


Figure 2. Typical ADC spectrum from MGM (left) and the Duke scanner (right). The x-axis of the right plot should be multiplied by 10 for a proper ADC value.

For normal straws H is quite small and order of a few percent. The high hits above 600 are dominated by background hits. For positions with higher gain, H gets higher. Let me define ΔG_i = (gain at ith position – normal gain)/(normal gain). This measures the gain increase at the ith position with respect to the normal gain. For higher ΔG values, (due to straw bending or hung wire, for example), H is about ~15% for ΔG~10%, and H is about ~50% for ΔG~20%.

The top figure in Figure 3 shows a plot of H from the front side of M2.25. The x-axis represents all 25 scanning positions of all the straws in the module. It is encoded as 30*straw number + scan position (from 1 to 25). In other words, the 10th scan position of straw number 100 would be plotted at 30*100+10 = 3010 in the x-axis.

The second plot in Figure 3 shows the dG value for all straws. dG is the usual one of our cut variables. Since there is only one dG value for the 25 positions, the same dG is plotted 25 times. In general, there should be a good correlation between the top and middle plot. In other words, if dG is large, then there should be large number of high hits.

The figures indeed exhibit the correlation. However there are a few cases when dG is large but the H is small. This could be when there is dirt on the wire.

The last plot in Figure 3 is obtained by dividing the top plot by the middle plot. Let me call this ratio K. For normal straws, K should be small. For the straws with dG above 8%, K should be in the range of <~ 2. The straws with features in Figure 1 should show up with much higher K value. In other words, the straws with K value much larger than 2 should be investigated. But since there are not that many straws with K >~2, any straws with K >~2 are investigated.

Figure 4 shows the same three plots from M3.30 front side. This is one of the really bad modules with ~50 straws having dG>8%. However as can be seen in the bottom plot, there are no straws with features in Figure 1. Figure 5 and 6 (7 and 8) (9 and 10) show the same of the front and back side of M2.30 (M.28) (M2.26) respectably.

In total, I looked at six Type II modules (M2.25, M2.26, M2.27, M2.28, M2.29, and M2.30) and two Type III modules (M3.30, and M3.36), and investigated the straws with K >~2. The number of straws in these modules is about 10% of the entire barrel modules. No straws exhibiting features like in Figure 1 were found. All straws with high hits can be associated with large dG and were tagged properly as potentially trouble straws. Based on this study, I can conclude that there should be no more than a few straws with features in Figure 1 in the entire barrel TRT. One recommendation is that we go back to the practice of looking at the ADC plots for straws that cannot be easily categorized (as we have done at the beginning).

Analysis II

This is a special case of Analysis I. In this section only straws pass our cuts are studied, Since these are good straws, none of them should have a large K value (or out of ordinary H value).

Rather than showing the three plots as in Analysis I, the K distribution is plotted. This plot is a projection of the bottom plot in the previous figures. The figures are shown from Figure 11 to Figure 14. The figures are in log scale, and there are very few straws with K larger than 2. A similar number of wires as in Analysis I were investigated and no straws that could be classified as trouble makers were found. I can conclude that the cuts for choosing good straws are quite effective.

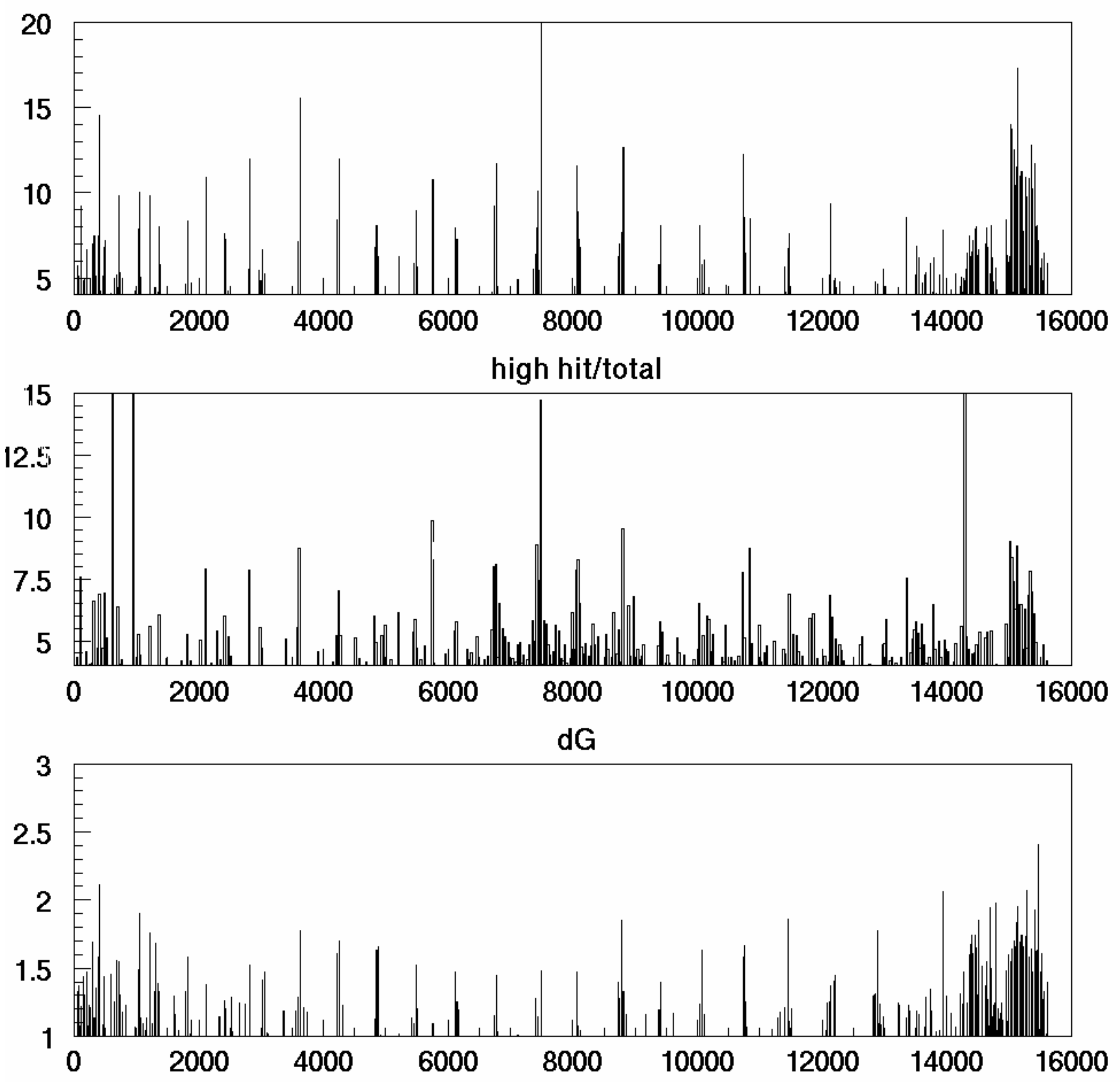


Figure 3. From M2.25 back side. Ratio H (in %) is plotted at the top, dG (in %) is plotted in the middle and ratio K is plotted at the bottom. Note the suppressed zeros for clarity. The straws to look for are with high H (>~10%) but low dG (or high K).

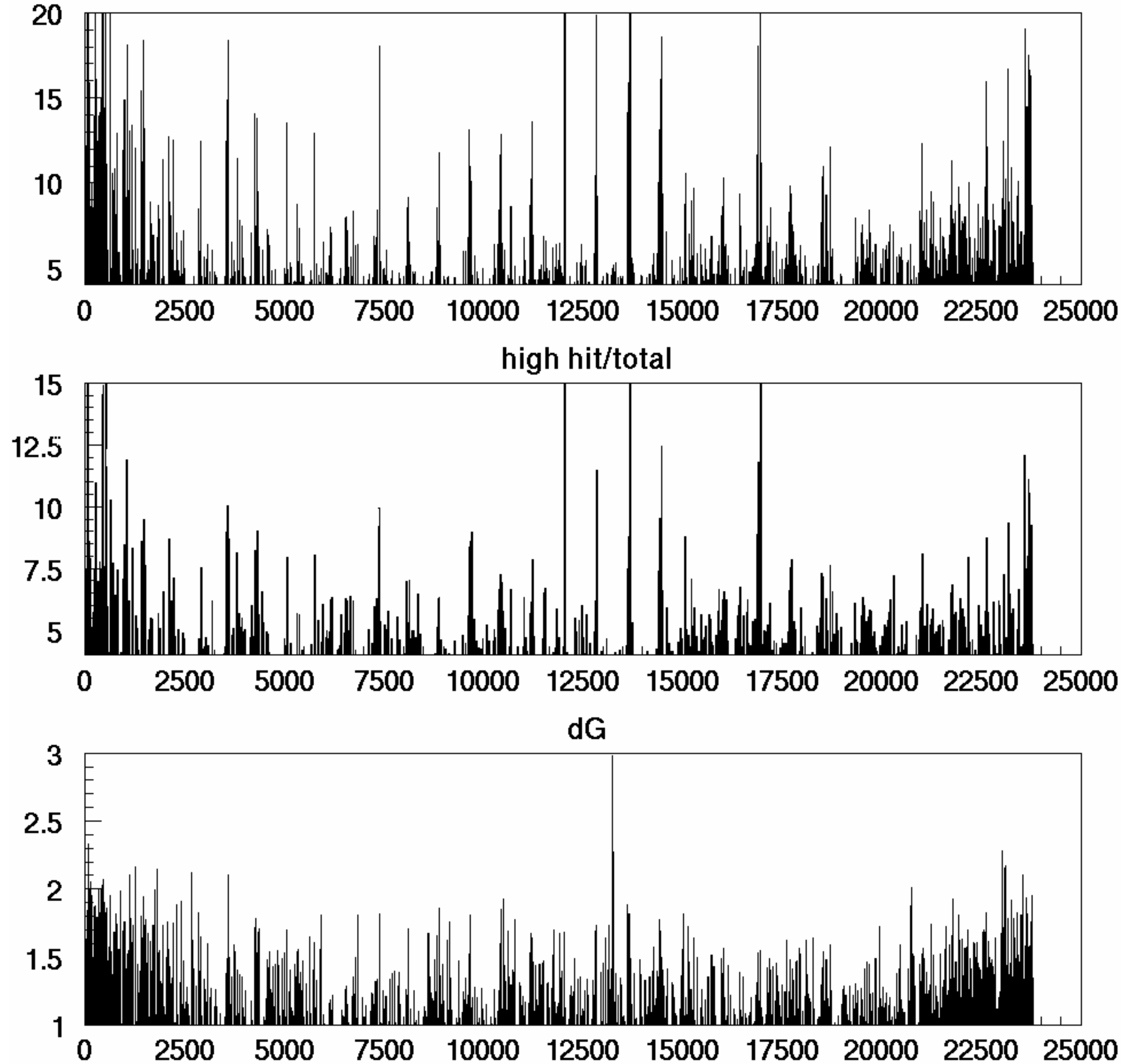


Figure 4. From M3.30 front side. The one high peak in the middle (straw #441) is due to unusually low dG.

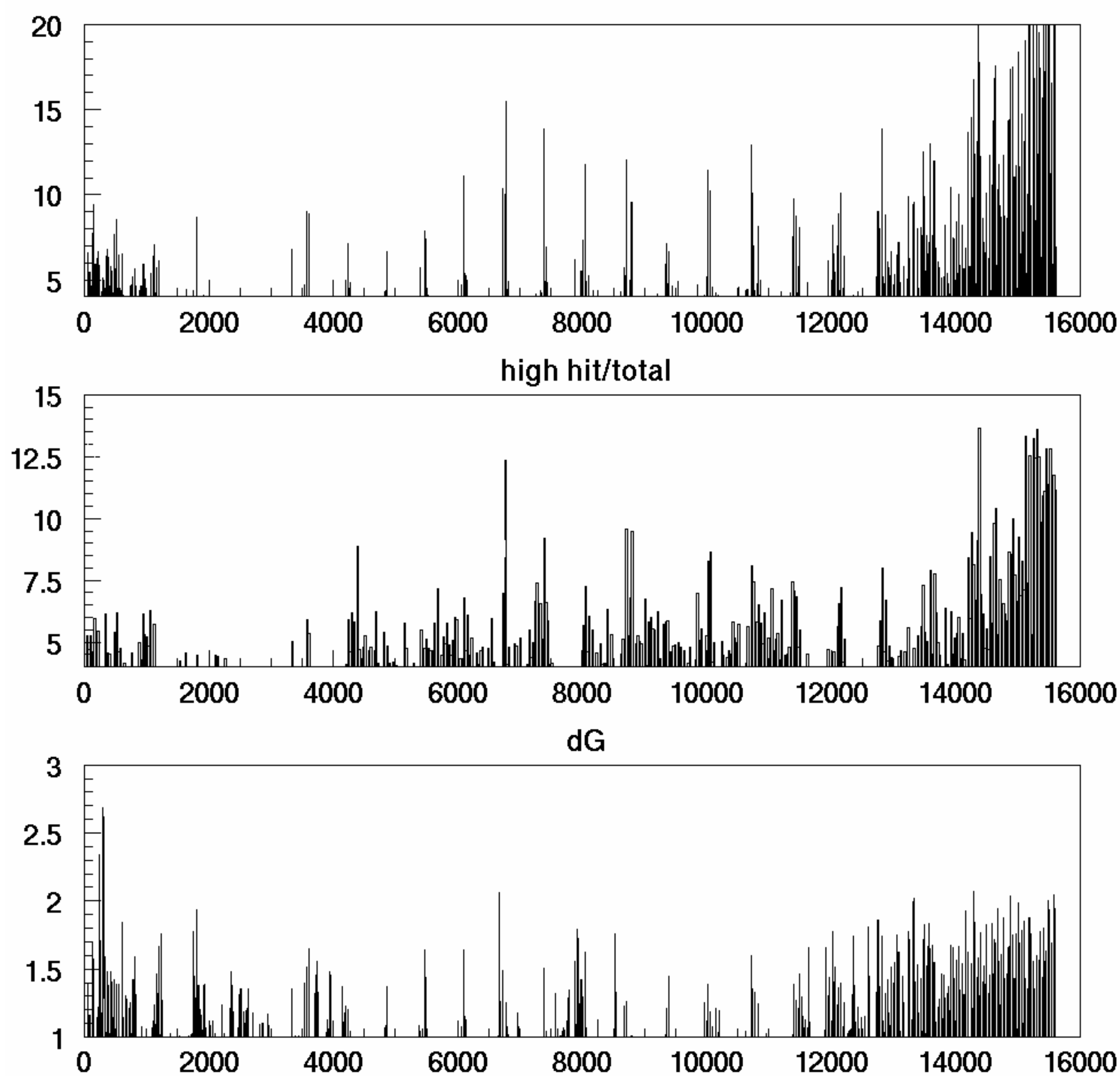


Figure 5. M2.30 front side.

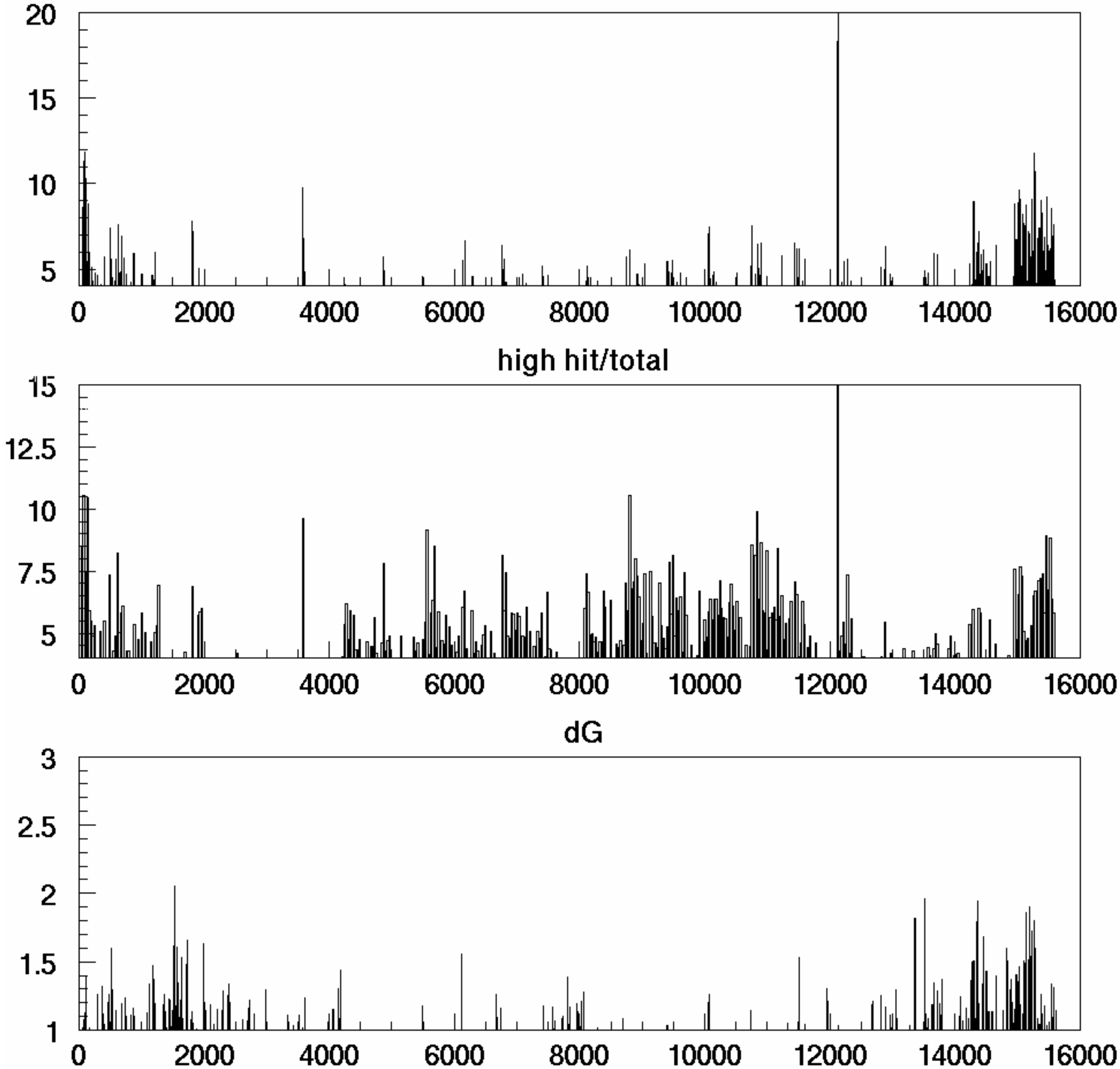


Figure 6. M2.30 back side.

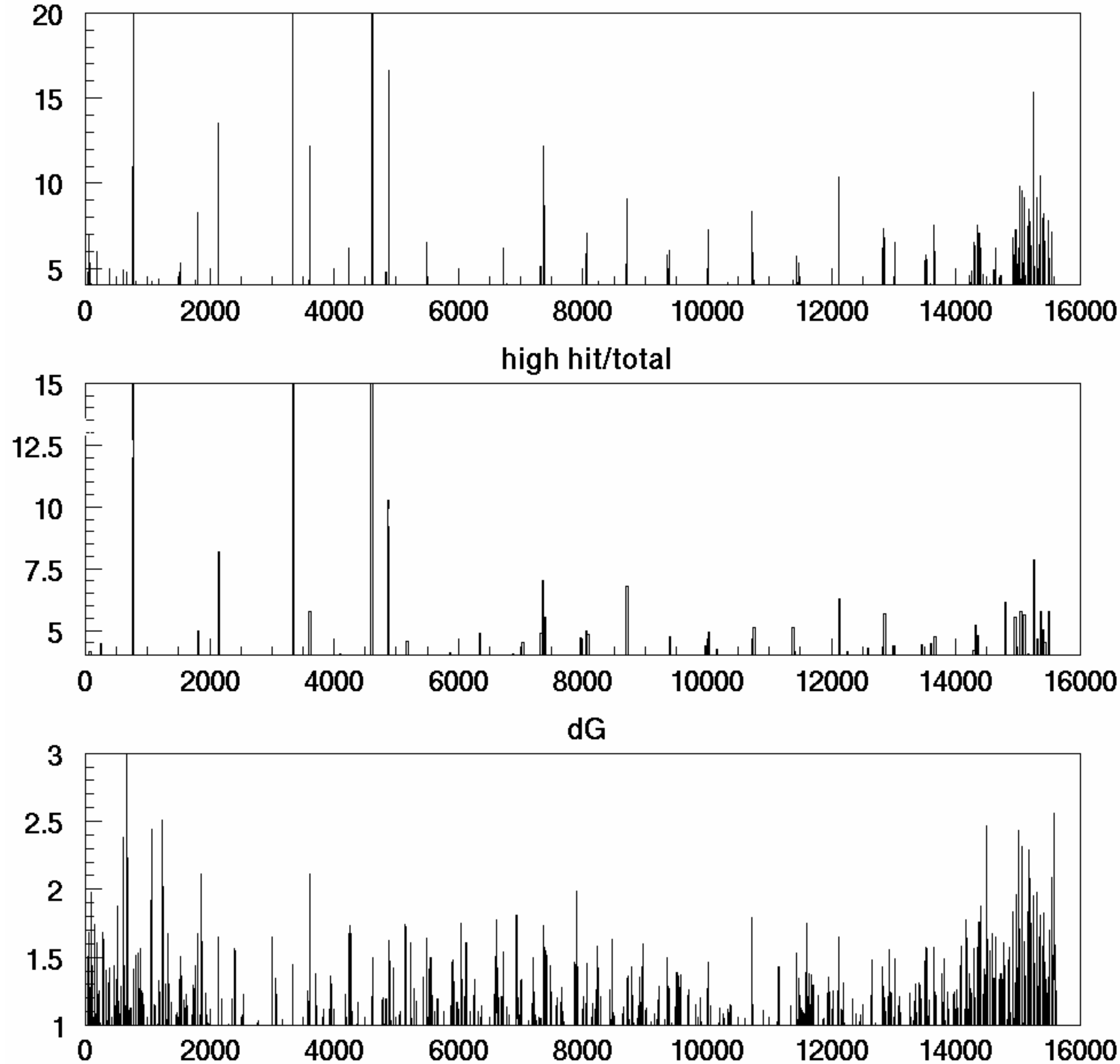


Figure 7. M2.28 front side.

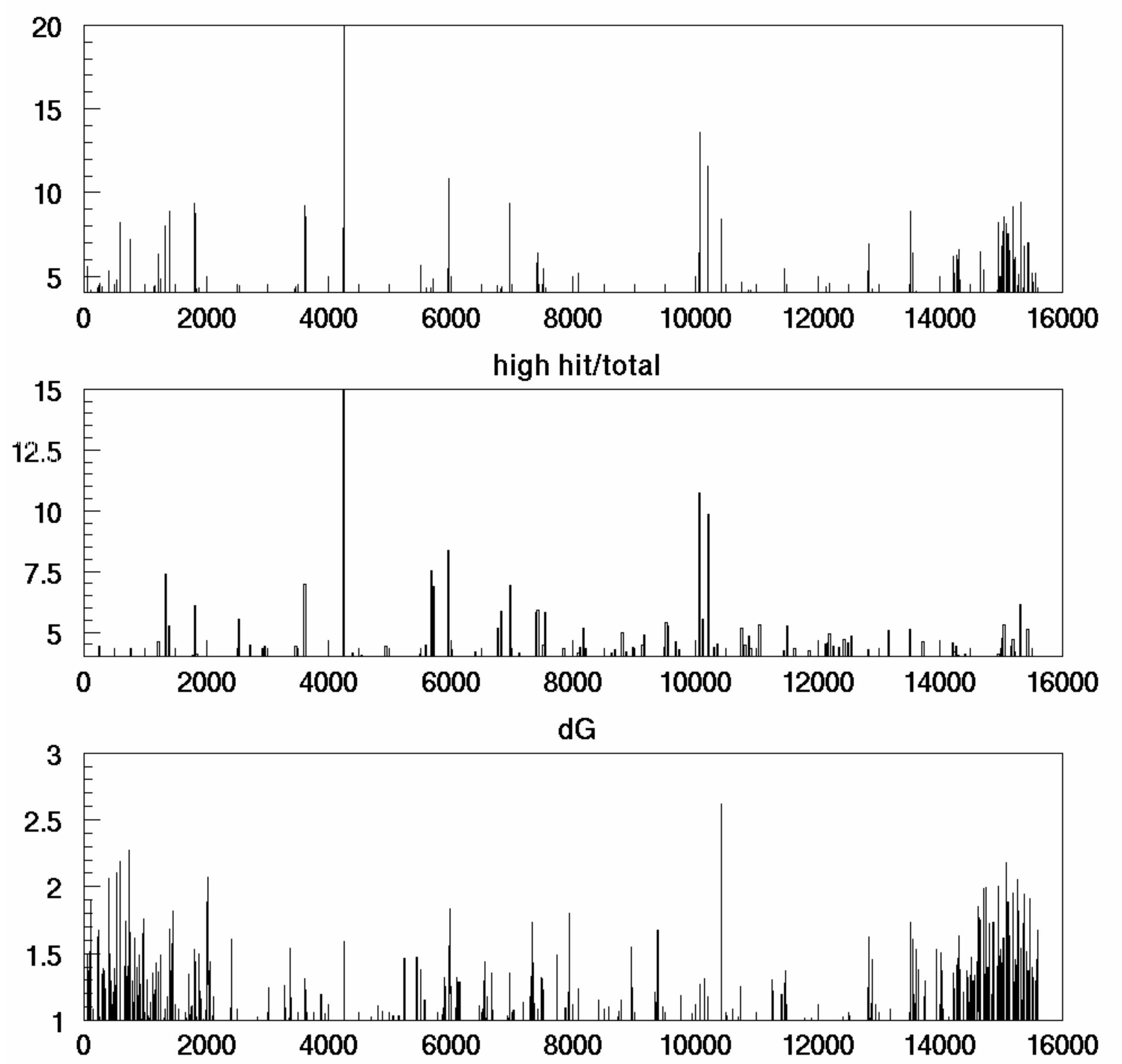
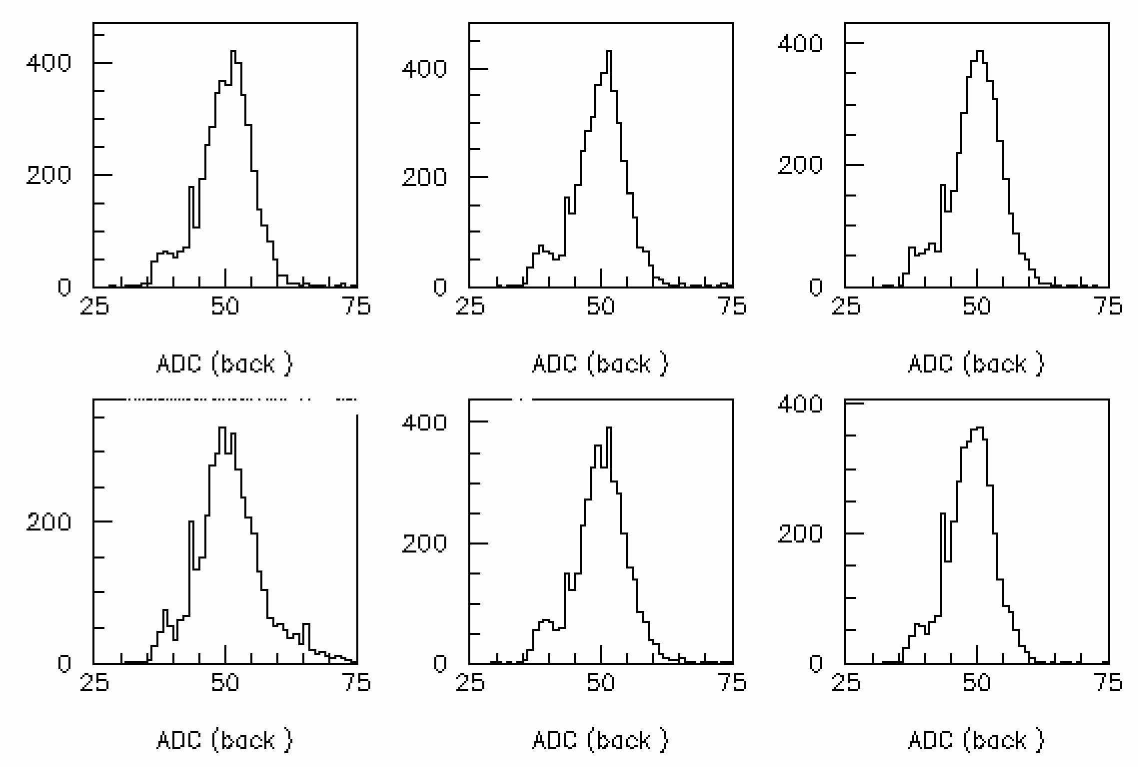


Figure 8. M2.28 back side. There is one peak above 2.5. This is from on location of one straw (#347) has many high hits but with normal G. The ADC spectra around this position are shown in the following plots. The one produced the high peak is the fourth plot. This is somewhat odd because the width is normal while there are many high hits.



The fourth plot is somewhat odd that the width is normal but it has many high hits.

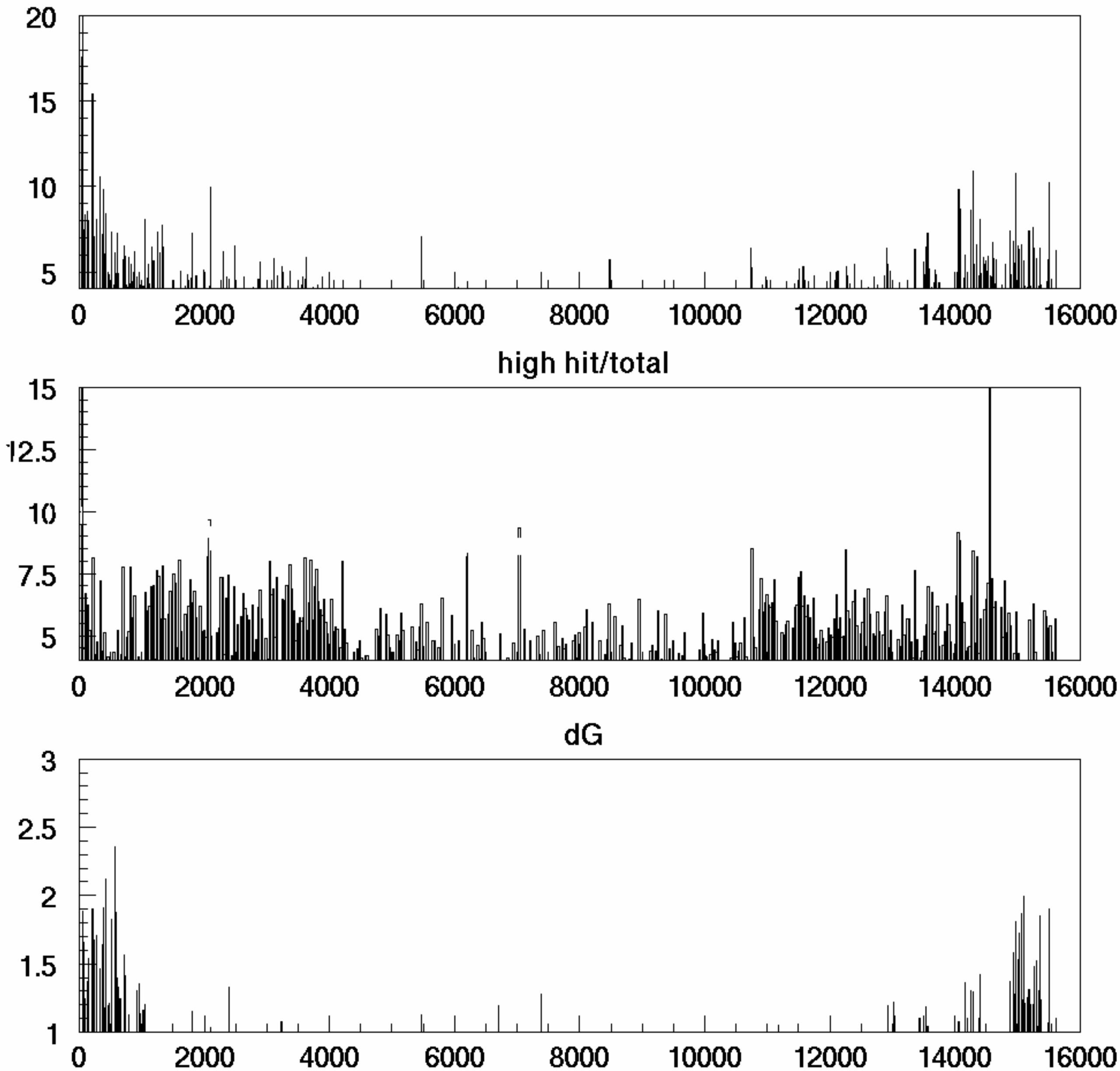


Figure 9. M2.26 front side. This module has sense wires with diameter problem.

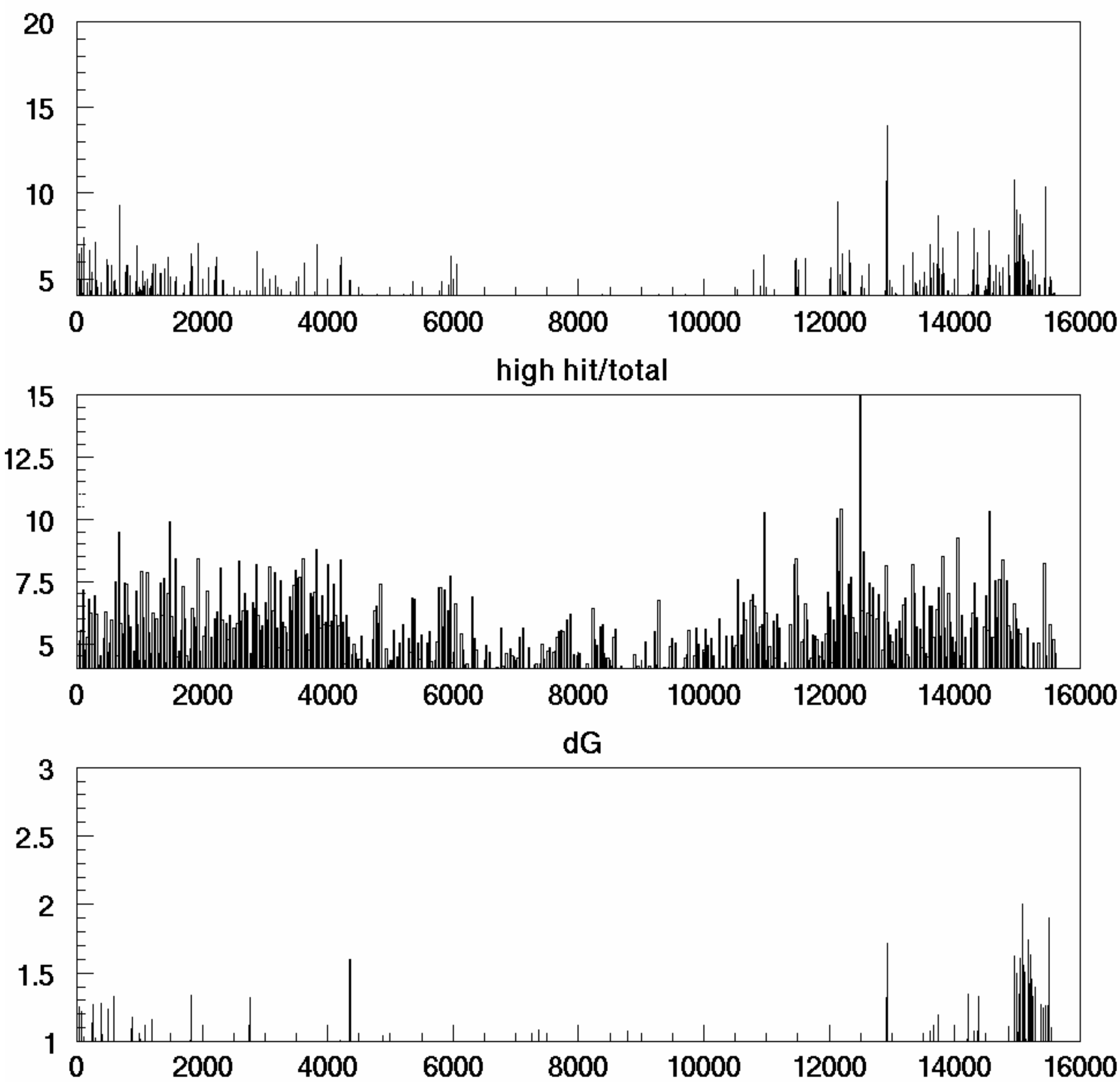


Figure 10. M2.26 back side. This module has sense wires with diameter problem.

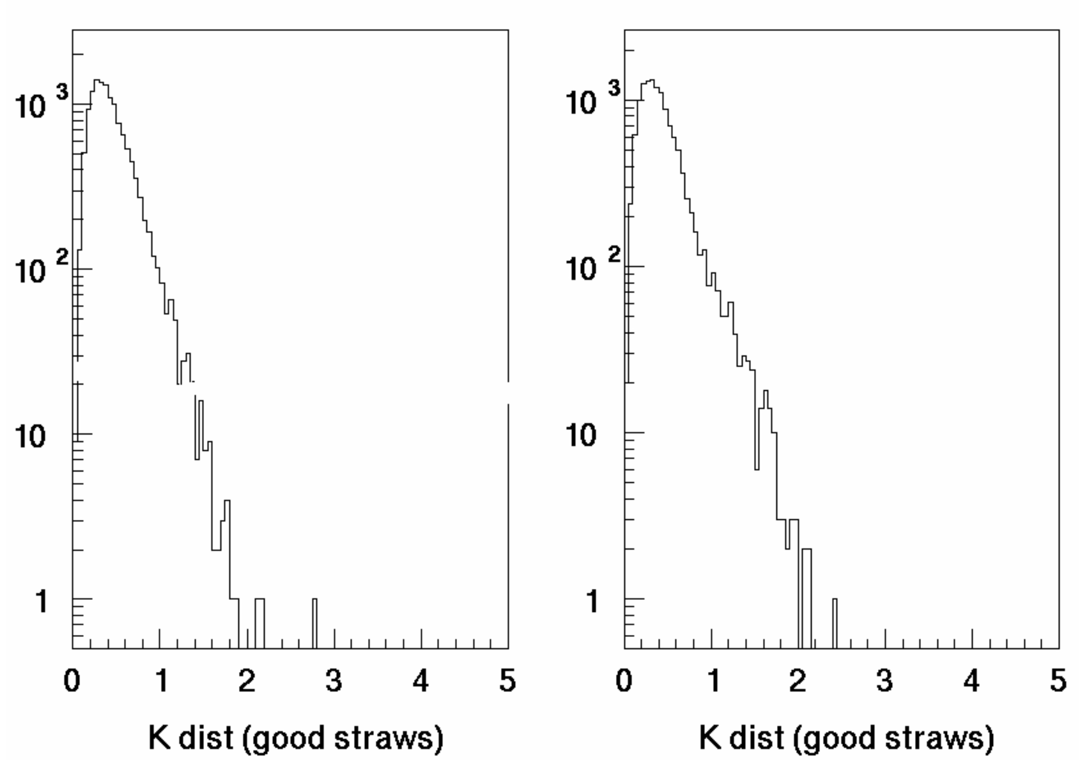


Figure 11. K distributions. The left side plot is from the front side of M2.25. The right side plot is from the back side of the module.

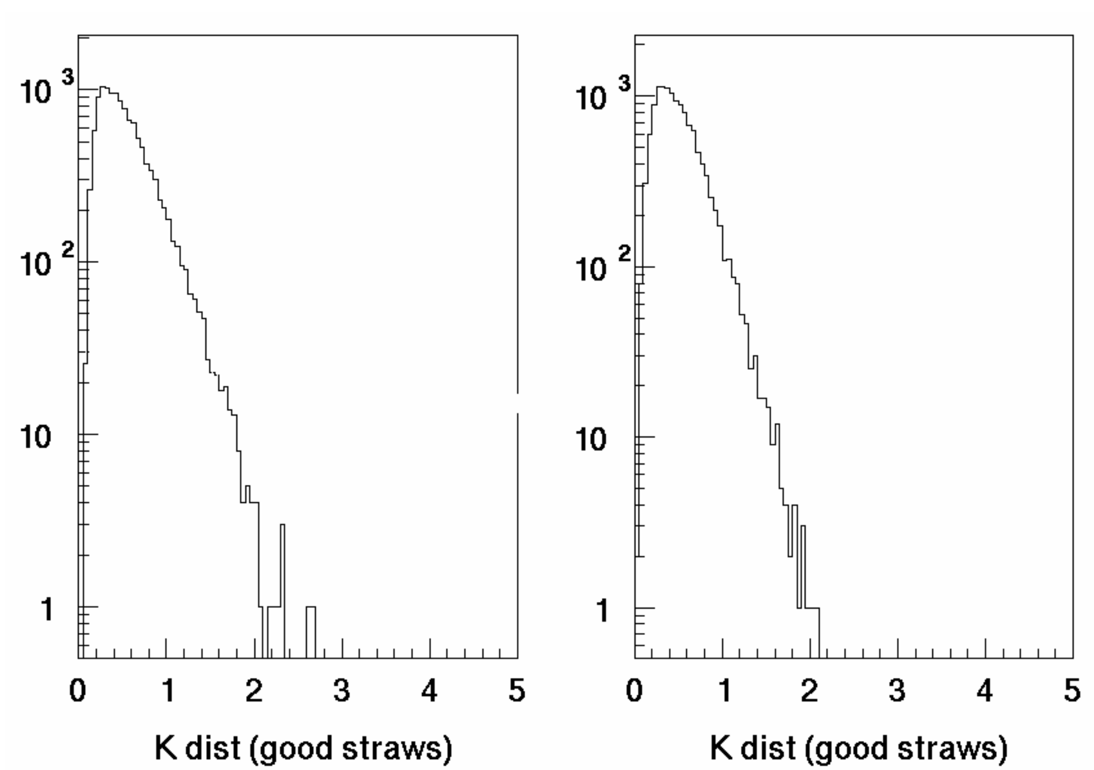


Figure 12. K distributions from M2.30.

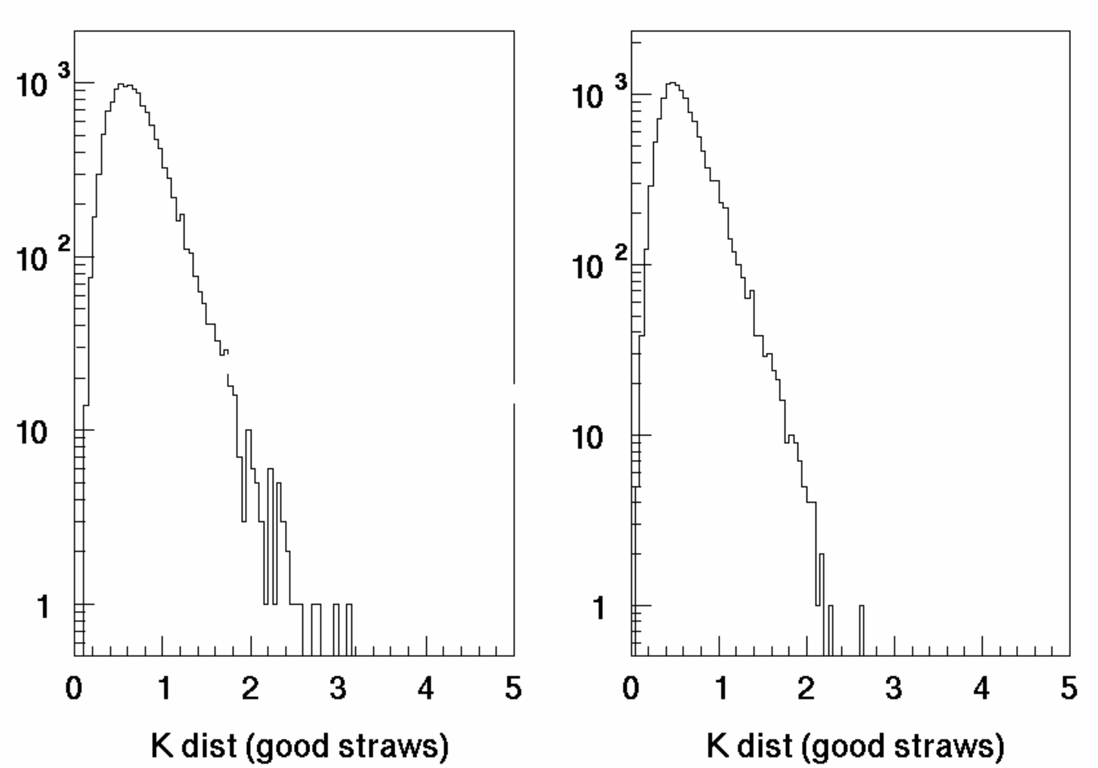


Figure 13. M2.28.

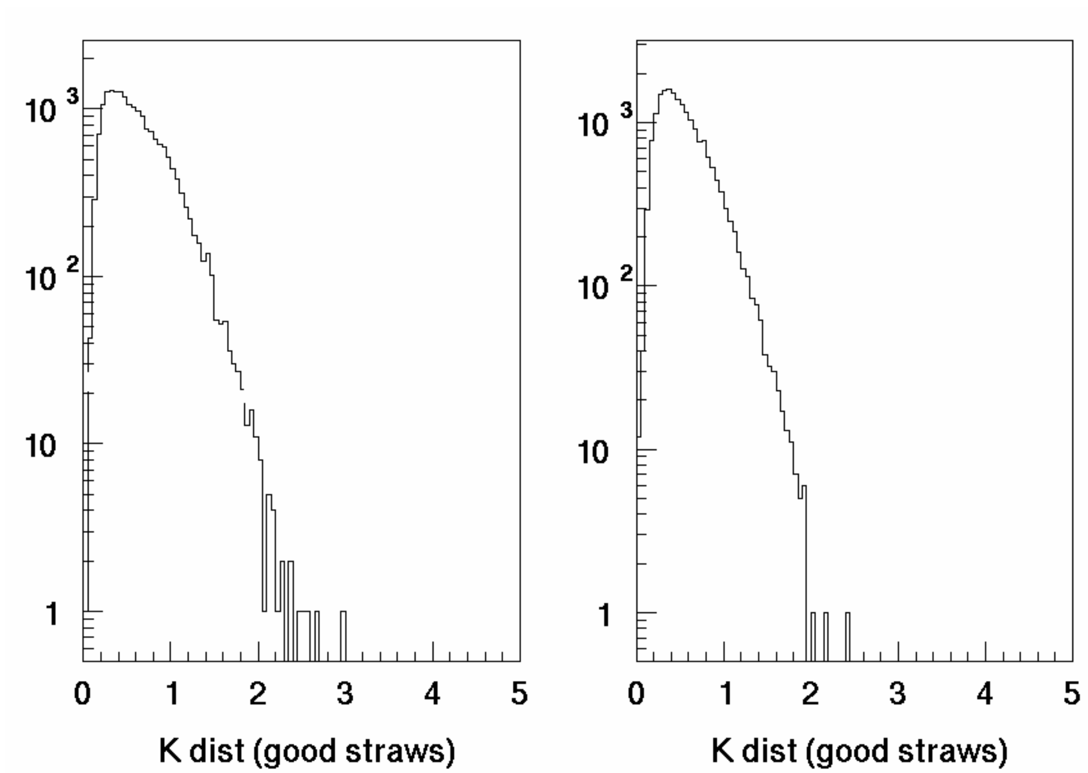


Figure 14. M3.30. This is one of worst modules with a lot of bent straws. The entries in the left side plot near K~2.5-3.0 are from one straw (# 441). Note that there are 25 entries from each straw. See also Figure 4 caption.