Calibration of the Preshower Calorimeter

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Abstract

The CLAS12 Pre-Shower Calorimeter (PCAL) is described geometrically. This information is used to correct for the light attenuation occuring in the scintilating fiber readout. During cosmic ray runs, PMTs attached to the readout fibers collect light as a function of the hit distance along the scintillators, which measures the form of the light attenuation. This form is fitted and the fit parameters are stored in the CCDB calibration database. The procedure used to obtain these parameters is described in this note.

Contents

1 Introduction

The CLAS12 Forward Calorimeters are designed to stop high energy electrons and photons and sample a portion of their electromagnetic showers. The showers are created using interleaved layers of lead and plastic scintillator strips, where a fraction of the total shower energy sampled by the scintillators is converted to light and transported to photomultiplier tubes (PMT) for conversion to digital signals. As a part of the calibration procedure, it is necessary to measure the attenuation of the light as it propagates down the length of each stack of scintillator strips. This procedure also includes measurement of the gains of the PMTs. This document describes the initial calibration measurements for the new CLAS12 designed calorimeter module, referred to as the Preshower Calorimeter (PCAL).

2 Design

The CLAS12 PCAL is triangular in shape and installed in front of the CLAS6 EC module.. The triangular form is isosceles (not equilateral), which was chosen to better match the EC design and space limitations. A diagram of the front and side views of the PCAL with respect to the EC can be seen in Fig. 2.1.

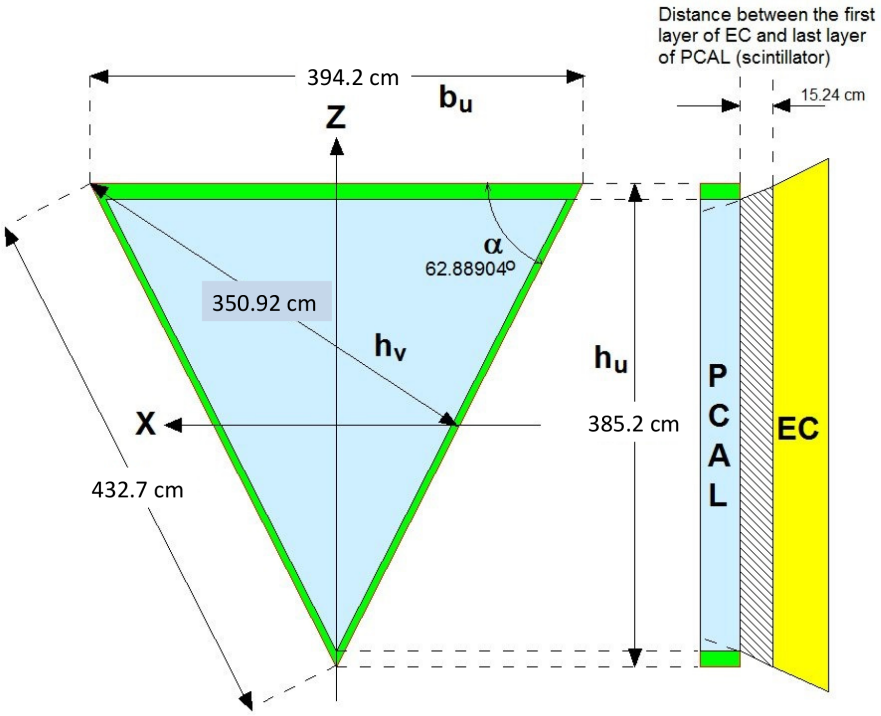


Figure 2.1: Front and side dimensions of the PCAL (from the PCAL geometry note [1]).

The PCAL box contains alternating layers of 1 cm thick scintillator strips and 0.22 cm thick lead sheets. Each scintillator layer has a readout orientation rotated with respect to the previous layer. These orientations are described as the U, V, and W layers. Each layer is parallel with one side of the PCAL box. The sequence (U,lead,V,lead,W,lead) is repeated five times within a single PCAL module. This results in a 15 layer lead/scintilator 'sandwich' as shown in Fig. 2.2.

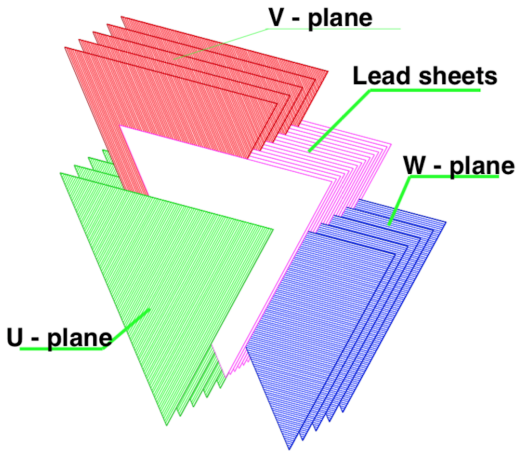


Figure 2.2: Schematic showing interleaving of U,V,W scintillator layers with lead.

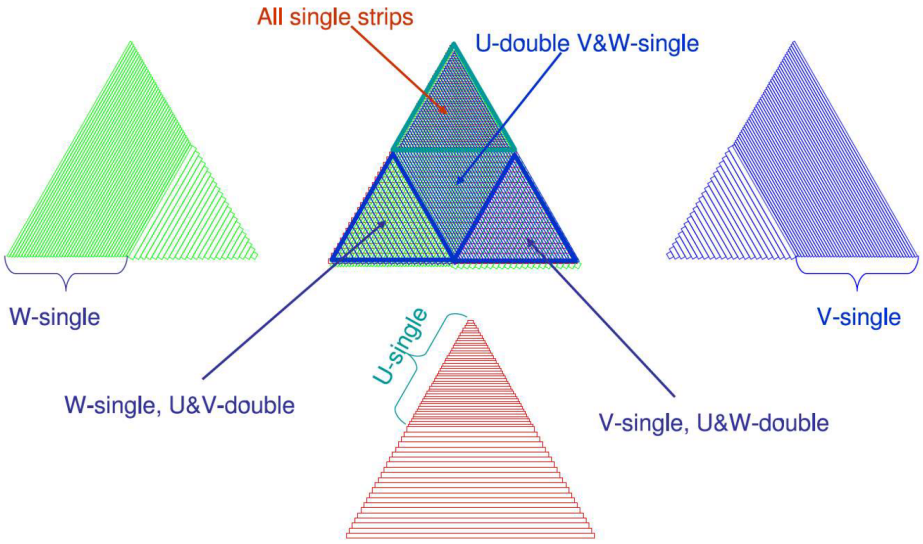


Figure 2.3: Orientation and readout size of scintillator strips [1].

There are 84 U strips, 77 V strips, and 77 W strips in each corresponding layer. The readout from the last 32 U strips are grouped in pairs into a single PMT per pair. The first 30 V and W strips are also grouped in pairs within their respective layer. As a consequence there is better spatial resolution for low strip numbers in the U layer and for high strip numbers in the V and W layers. Each of the five repeating layer strip readouts is coupled to the same PMT, which sums the five different signals. This readout pattern of scintillators is illustrated in Fig. 2.3.

Due to this grouping of scintillator strips, our numbering scheme uses the PMT receiving the readout fibers. Thus U PMTs 1-52 readout individual 'single' strips, while U PMTs 53-68 readout 'double' strips. Lower numbered PMTs readout shorter strips while higher numbered PMTs readout the longer strips. For example, V1 is the shortest and V62 is the longest strip in the V view. This strip convention is used throughout this document and is taken from the PCAL geometry note [1]. Using this convention, the layout of the PMT readout can easily be understood from Fig. 2.4 which shows PMT readout of a strip in each view.

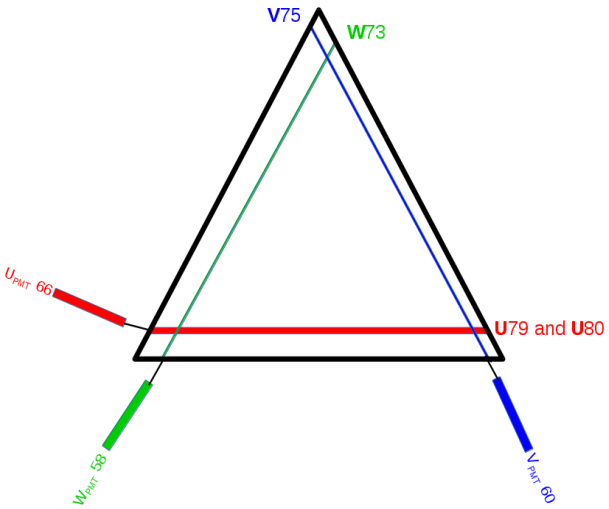


Figure 2.4: Cartoon showing the layout of the PMT readout for different views.

3 Cosmic Ray Tests

Assembly of six PCAL modules occurred in 2012-2013 in Room 26 of the EEL building. After assembly each module was moved to the cosmic-ray test (CRT) area where PMTs were installed and connected to a DAQ system for initial testing. A loose trigger was setup using the OR of all W strip PMTs, with the trigger threshold adjusted to reject low energy pulses. This choice of W increased the probability that the cosmic muons penetrated the U,V layers and the threshold setting helped reject non-perpendicular tracks.

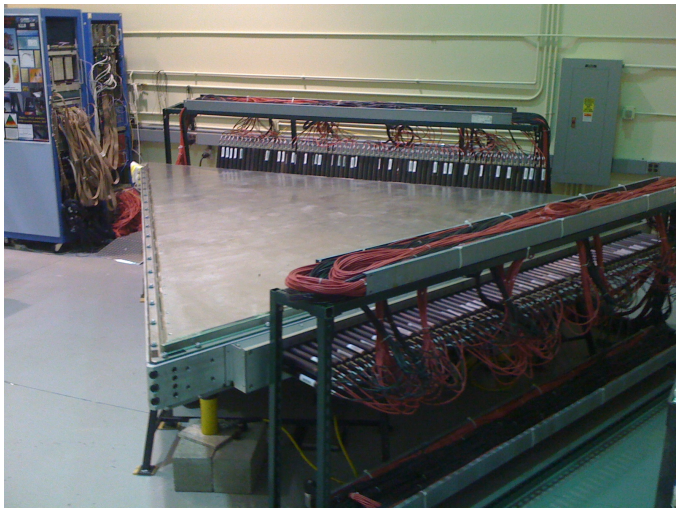
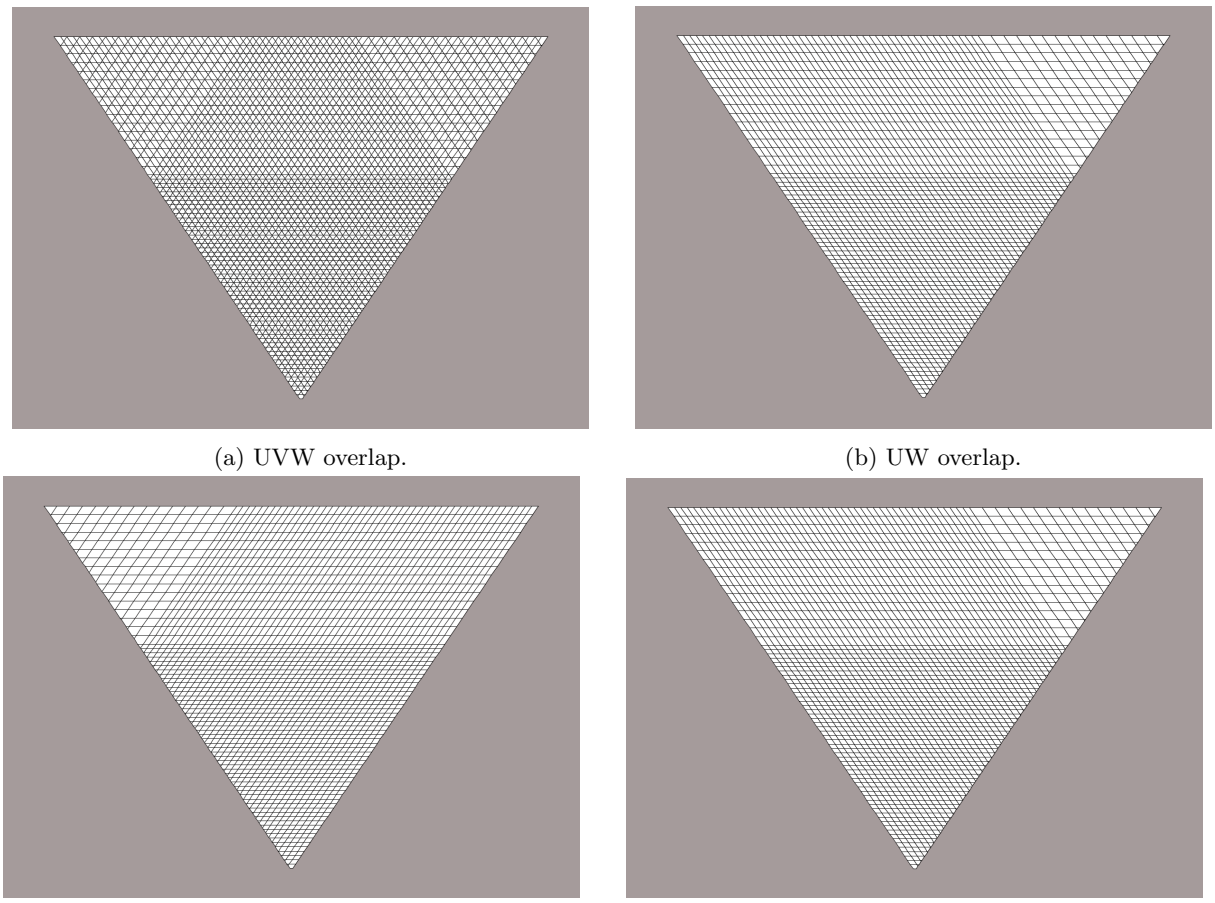


Figure 3.1: PCAL MODULE 3 - Tested July 2012. Installed as Sector 2 in HallB.

During these tests procedures were developed to gain match the PMTs by using the hodoscope function of the calorimeter to isolate perpendicular cosmic muon hits at a fixed distance from the end of the scintillator strips. This resulted in a constant minimum ionizing energy of 10 MeV deposited in the five scintillators making up each U,V,W stack. The PMT HV was adjusted until each PMT produced a MIP peak in channel 200 of the ADC distributions within an error of $\pm 5\%$. Attention was then turned to performing long runs to accumulate enough data to perform measurements of light attenuation constants.

4 Overlapping Shapes

As previously mentioned the PCAL functions as a hodoscope, allowing determination of the x,y position of a hit within a resolution determined by the overlap of the strips from each of the U,V,W layers. One can think of dividing each PCAL module into bins based on the overlapping shapes. The overlap shapes/pixels are of two types: a 3-strip pixel, which is a shape formed when all three views are superimposed together, and a 2-strip pixel formed from the overlap of two strips where the strips are part of different views. Maps of different overlap conditions are shown in Fig. 4.1. The current analysis extracts the attenuation calibration based on 2-strip pixels only.



(a) UVW overlap.

(b) UW overlap.

(c) UV overlap.

(d) WU overlap.

Figure 4.1: Shown are the different ways overlaps can be considered in a single PCAL module.

5 Event Selection

Triggers selected for calibration are restricted to events where only a single pixel is hit by the cosmic muon. This ensures the muon trajectory is nearly perpendicular and does not undergo multiple scattering. As a result a uniform distribution of desposited MIP energy is seen by all the PMTs, which provides a more accurate calibration. An intitial skim was used to select events that are most likely to involve a single pixel hit, using a multiplicity cut and a geometrical constraint.

5.1 Multiplicity Cut

The multiplicity cut removed any event that contained more than three PMT readouts (one from each layer). This reduces the number of cosmic ray events that are not perpendicular to the face of the PCAL unit. If a cosmic ray trajectory is not perpendicular to the PCAL face, it can intercept multiple strips in one orientation (e.g. - strip U30 and U31 both receive a signal). Although the accepted range of non-perpendicular angles depends on the size

of the strips and their overlapping shape, this effect is expect to average out. This multiplicity cut also helps to remove events where multiple cosmic rays hit the detector within the same time interval. Overall this cut removes 95% of the triggered events.

5.2 Dalitz Cut

The Dalitz cut relies on the geometry axiom that for any point inside an equilateral triangle, the sum of the distances to each edge of the triangle is constant. The same result also applies to distances along the edge of the triangle, in which case the constant is equal to two. Thus only PMT numbers are needed to test the Dalitz cut, rather than calculating the interior x and y coordinate for every hit. Once the N=3 multiplicity cut is passed, only the Dalitz condition need be tested for the U,V,W combination of hit strips to ensure the combination arises from a single pixel. If this condition is not satisfied, then the hit recorded is most likely electronic noise, an indirect hit, or multiple cosmic ray hits recorded at once.

The relatively simple calculation is given by equations 1-4. The calculation uses normalized coordinates calculated from the number of the triggered PMTs, which compensates for the PCAL not being an equilateral triangle. Examination of Figure 5.1 (left) shows that the N=3 multiplicity skim overwhelmingly favors events that produce a pixel, as indicated by the sharp peak at uvw=2 which contains most of the events. An example of the kind of hit pattern that would cause events outside of the uvw=2 peak is shown in Figure 5.1 (right).

$$dist(u) = \begin{cases} u/84.0 & \text{if } u < 52 \\ (52.0 + (u - 52.0) \times 2.0)/84.0 & \text{if } u \geq 52 \end{cases} \tag{1}$$

$$dist(v) = \begin{cases} 2.0 \times v/77.0; & \text{if } v < 15 \\ (30.0 + (v - 15.0))/77.0 & \text{if } v \geq 15 \end{cases} \tag{2}$$

$$dist(w) = \begin{cases} 2.0 \times w/77.0; & \text{if } w < 15 \\ (30.0 + (w - 15.0))/77.0 & \text{if } w \geq 15 \end{cases} \tag{3}$$

$$uvw = dist(u) + dist(v) + dist(w) \tag{4}$$

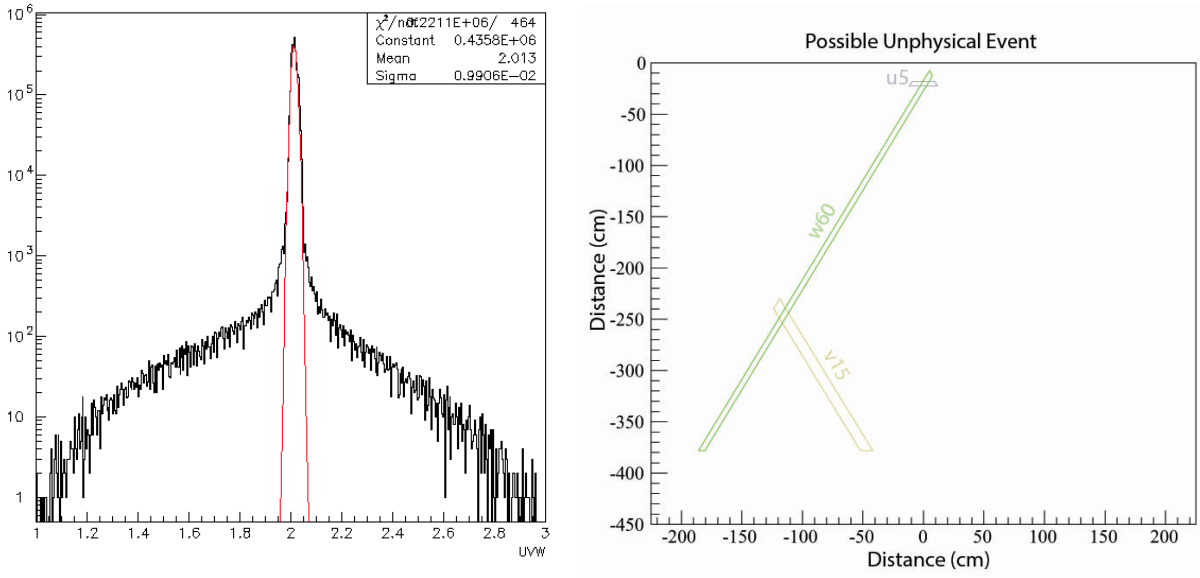


Figure 5.1: LEFT: Histogram of Dalitz condition (4) after multiplicity (N=3) skim of cosmic triggered data. RIGHT: Example of an event that passed the N=3 cut, but fell outside of the Dalitz peak at uvw=2.

6 Light Attenuation

Light attenuation was determined by measuring the MIP energy as a function of distance from the readout edge of each U,V,W view. Fig. 6.1 shows a schematic of how crossing strips are used to define the hit distance. The overlap of the measured strip and the crossing strip creates a trapezoidal bin formed by the overlap of two different strip orientations. The width of this physical bin is given by

$$s = \frac{w}{\sin\alpha} = \frac{w}{\cos\beta} \tag{5}$$

where w is a single scintillator strip width (≈ 4.5cm). The strip number is converted into distance using equations 1-3,5, plus an offset such that the distance is referenced to the center of the physical bin.

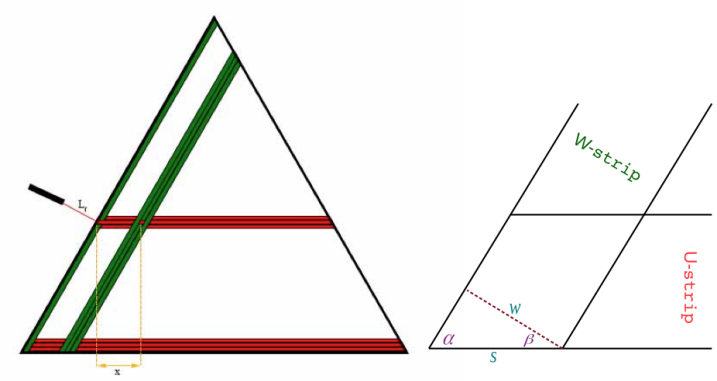


Figure 6.1: LEFT: Schematic demonstrates the use of crossing strips to measure distance from edge of PCAL triangle. RIGHT: Outline of a generic intersection of a u and w strip. The distance between the trapezoidal area and the PCAL edge can be represented by a linear function of s.

Fig. 6.2 shows a 2-D histogram of the measured MIP energy versus the PMT number of the crossing strip. The data clearly show the decrease in the MIP peak with distance. The next sections describe how the MIP energy for each distance slice is determined, and the fitting function used to describe the attenuation.

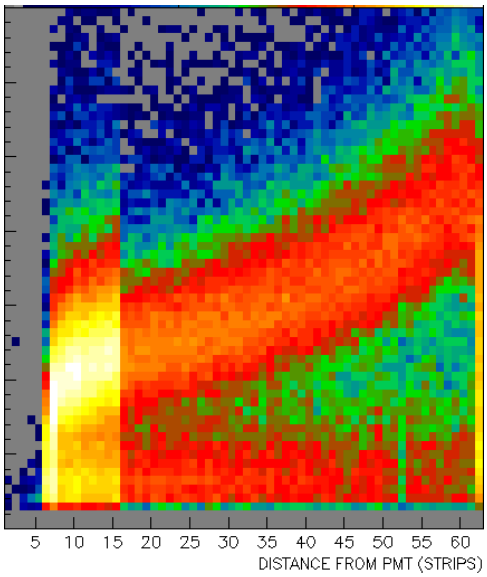


Figure 6.2: Cosmic data showing ADC plotted vs crossing strip number. In this case PMT 62 is closest to the readout end.

6.1 Fitting to MIP Peaks

Following event selection to isolate single pixel hits, the resulting energy loss distributions show two features:

1. MIP peak with a mean which is position dependent, corresponding to tracks which pass through all five scintillator layers in the measured pixel.

2. Background which diminishes with increasing pulse height and peaks near the ADC threshold.

Fig. 6.3 shows an ADC readout histogram for PMT U67, which reads out strips near the bottom edge of the PCAL. The low energy background likely arises from tracks which partially intercept adjacent pixels but fail to exceed the threshold in those pixels. As a result the Dalitz cut fails to exclude these tracks and incomplete collection of light occurs in the measured pixel. The background contamination is maximum for edge strips, since there is no adjacent strip to veto 'corner clipping' muon trajectories. The next section outlines the fitting strategy used to minimize background contributions.

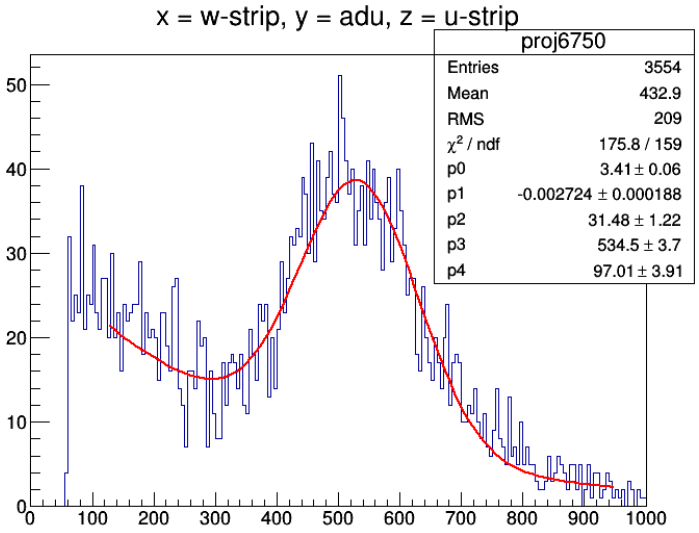


Figure 6.3: Example of ADC readout histogram from one U/W trapezoidal bin (U=67 W=50). The red line is an exponential+gaussian fit.

6.2 Fitting Strategy

The Dalitz pixel cut works best when ADC threshold cuts can be placed close to the onset of the MIP peak in all three PMTs which view a given readout pixel. This depends on all PMTs being well gain-matched and requires a knowledge of the light attenuation correction. Since this is only approximately the case at the start of calibration, an iterative approach was used to progressively improve the MIP fit accuracy.

For each iterative step, cuts to isolate the MIP peak energy are optimized using two cuts:

1. Cuts on U,V,W MIP energy: A 3σ cut is placed on each MIP peak for PMTs contributing to the readout pixel based on gaussian fits. The overall effect is to reduce the exponential background in the readout pixel. This improves the fits to some of the edges.

2. Cuts on U+V+W MIP energy sum: The desired muon trajectory should deposit the same amount of energy into each U,V,W layer. After the initial 3σ cuts and fitting attenuation curves, individual gains can be estimated. Using the emperically found gains, a cut on the U,V,W sum of ADC signals is used to eliminate events whose partial U,V,W energies could not contribute to the sum.

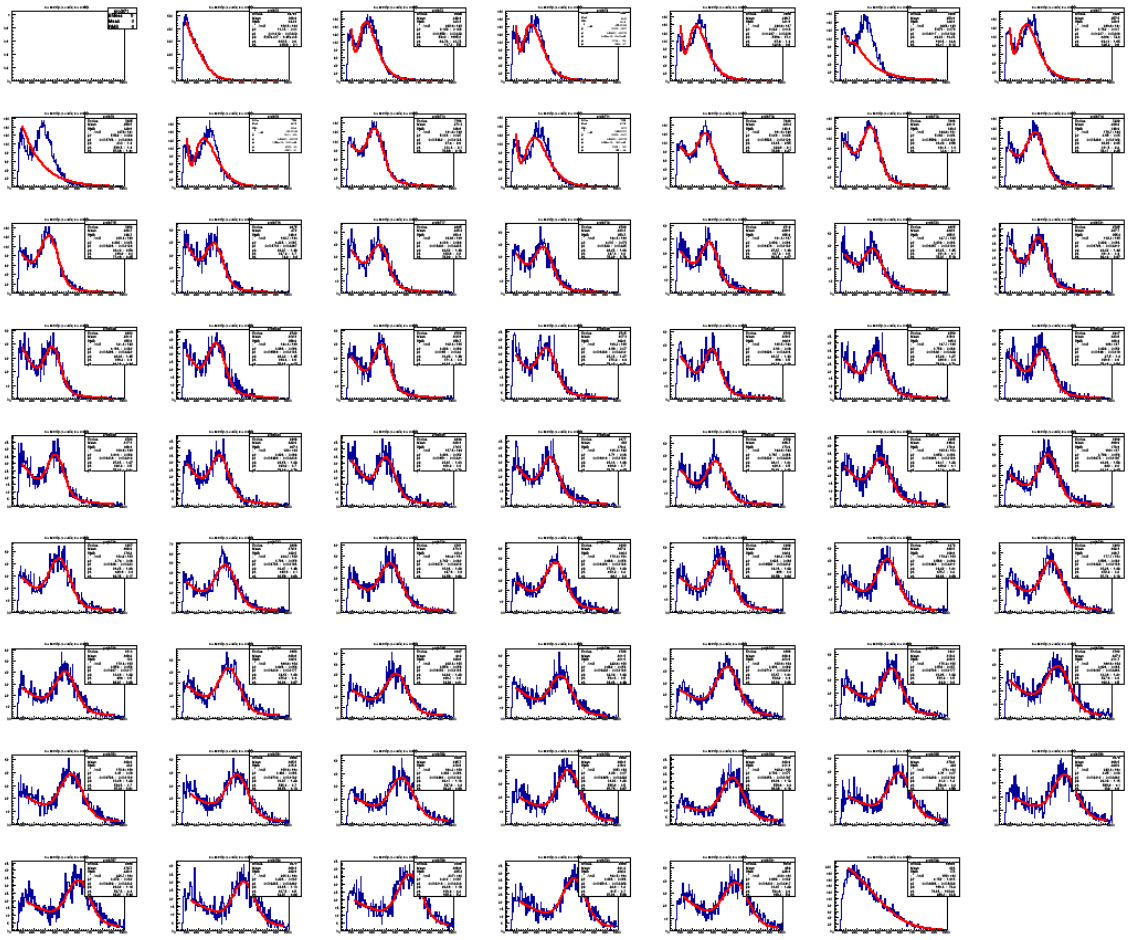


Figure 6.4: Example of all W crossing strip slices of the ADC readout from PMT U67.

6.3 Iteration Process

For each iteration pass a 3σ cut on ADC distributions are made around the MIP peaks, determined by either the MIP signal fits or by attenuation fits. This allows for a converging result because each cut on one U,V,W layer affects the other two. Therefore the MIP signal fits keeps improving as the attenuation fit and gains improve.

To illustrate how the process works, the following section shows each pass of a typical iteration. For each pass the cuts are described, followed by MIP fit plots for six representative U PMTs and a fixed crossing strip (W60). Finally attenuation fits for each PMT are shown, which show how the multiple cuts affect each attenuation fit as a function of strip number.

6.3.1 Pass 0

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit or near neighbor hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not. Extra uncertainty was allowed by also marking nearest neighboring pixels.

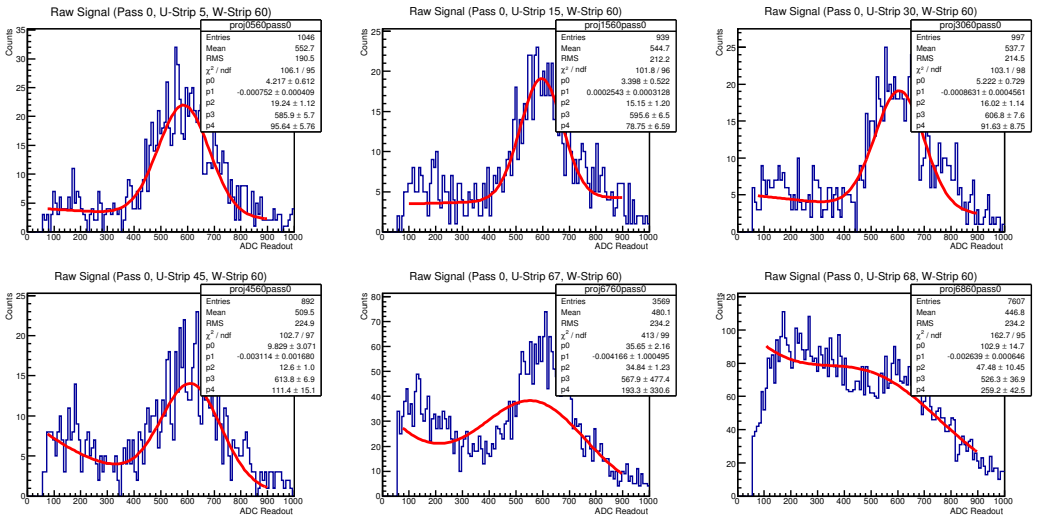


Figure 6.5: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

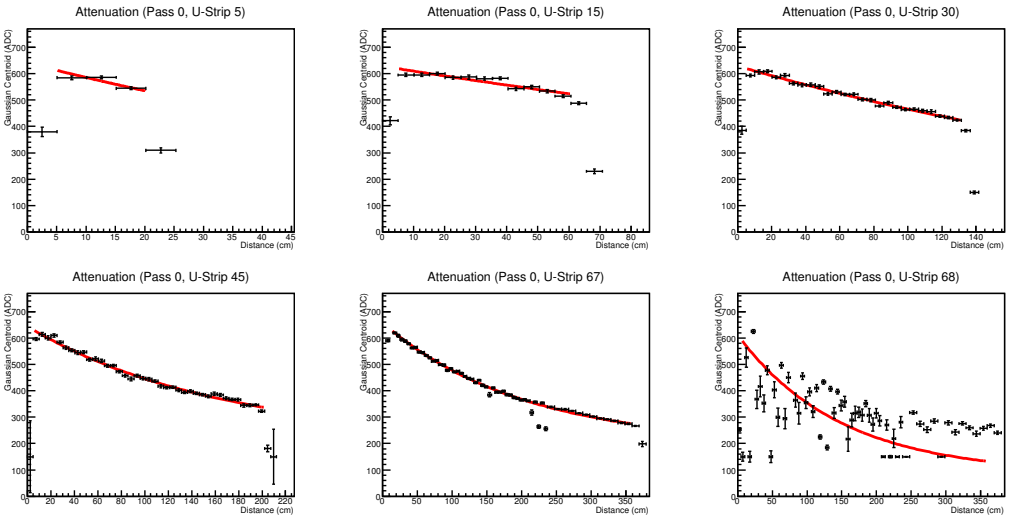


Figure 6.6: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).

6.3.2 Pass 1

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit or near neighbor hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not. Extra uncertainty was allowed by also marking nearest neighboring pixels.
- 3σ Cut on Signal: Each signal was fit to a Gaussian and exponential in pass 0. The parameter σ from the Gaussian fit was used to cut out the events that did not lie within this function.

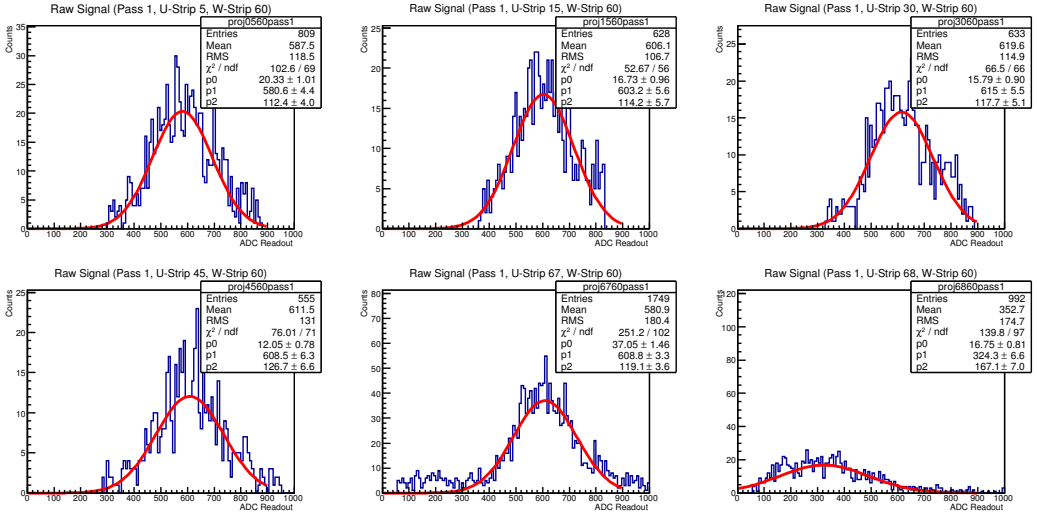


Figure 6.7: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

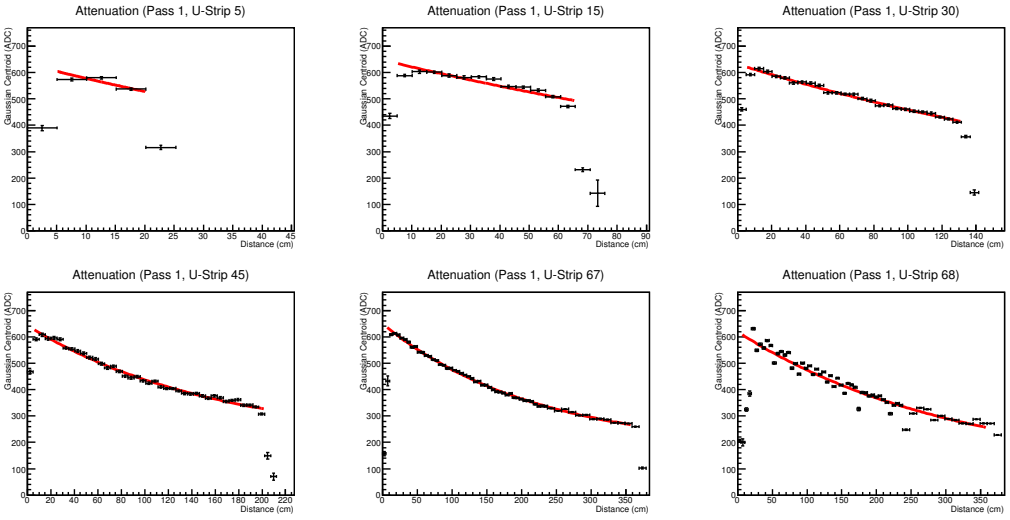


Figure 6.8: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).

6.3.3 Pass 2

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit or near neighbor hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not. Extra uncertainty was allowed by also marking nearest neighboring pixels.
- Cut on Attenuation Fits: When the signals where the Gaussian centroid from pass 1 were outside an ADC value of ± 50 from the attenuation fit, the obtained σ was ignored and a new cut about the attenuation fit was employed. If the centroid was close to ADC value from the attenuation fit a 2σ cut was used to remove extra background.

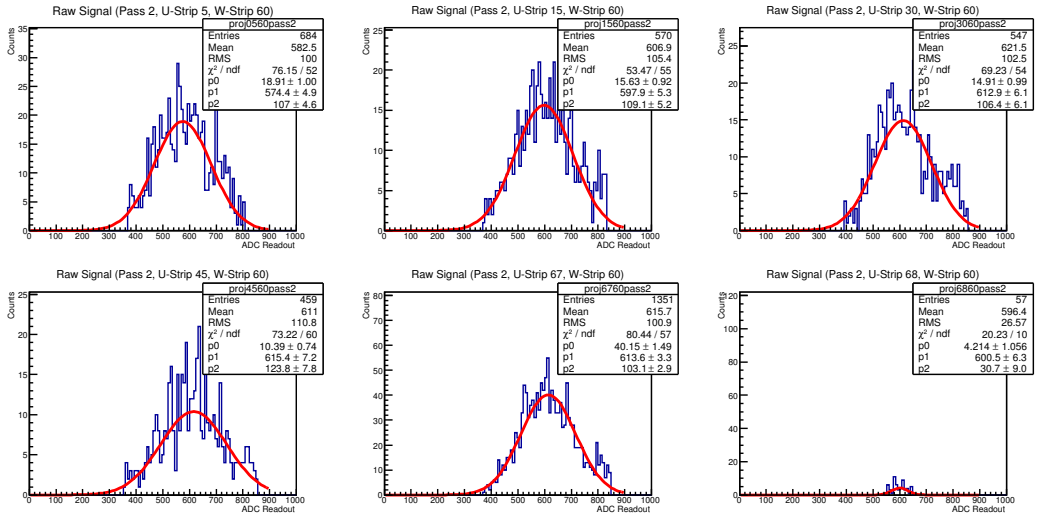


Figure 6.9: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

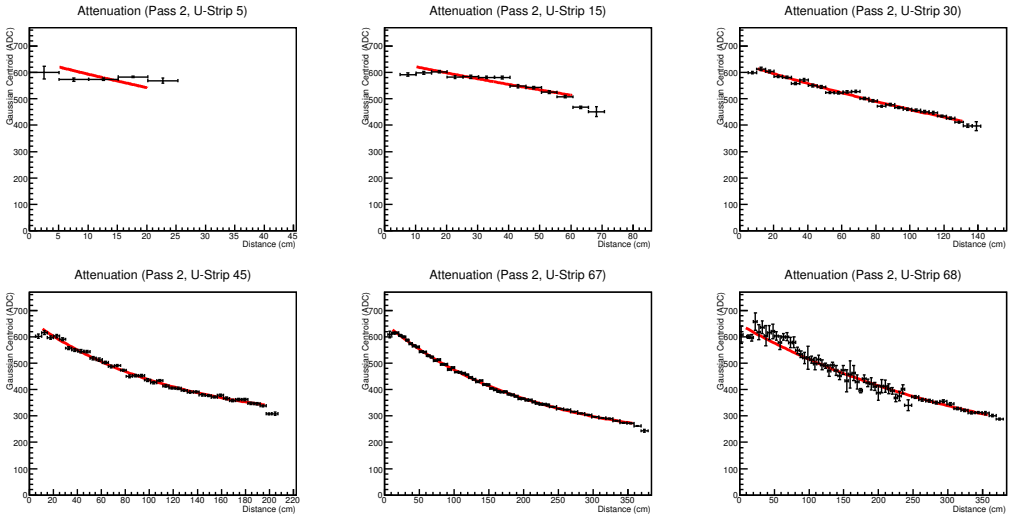


Figure 6.10: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).

6.3.4 Pass 3

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not.
- 3σ Cut on Signal: Each signal was fit to a Gaussian in pass 2. The parameter σ from the Gaussian fit was used to cut out the events that did not lie within this function.
- Attenuation Corrected Intensity Cut: The ADC value measured was corrected with the attenuation curves obtained from pass 2. The corrected value was summed over each layer. A cut on this intensity was placed generously from 1300 to 2700

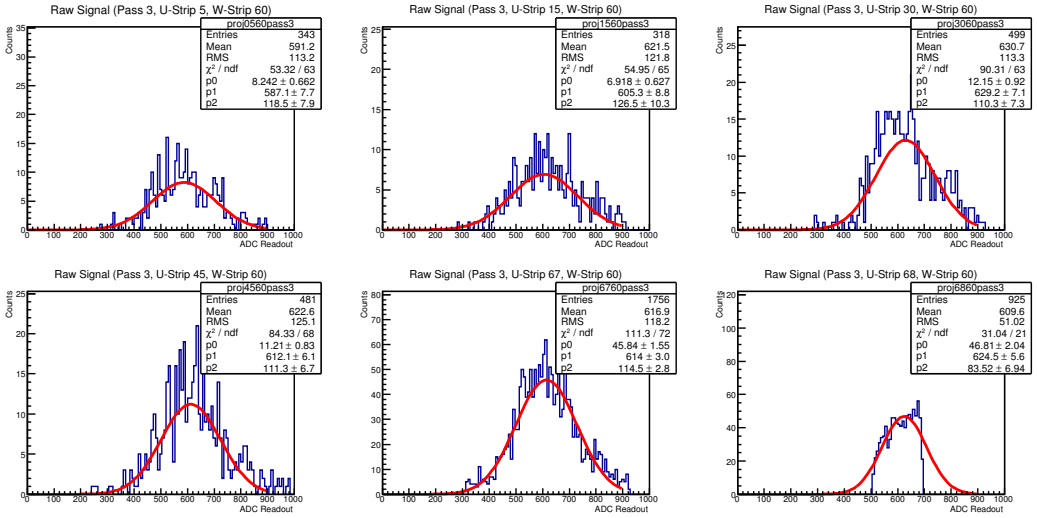


Figure 6.11: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

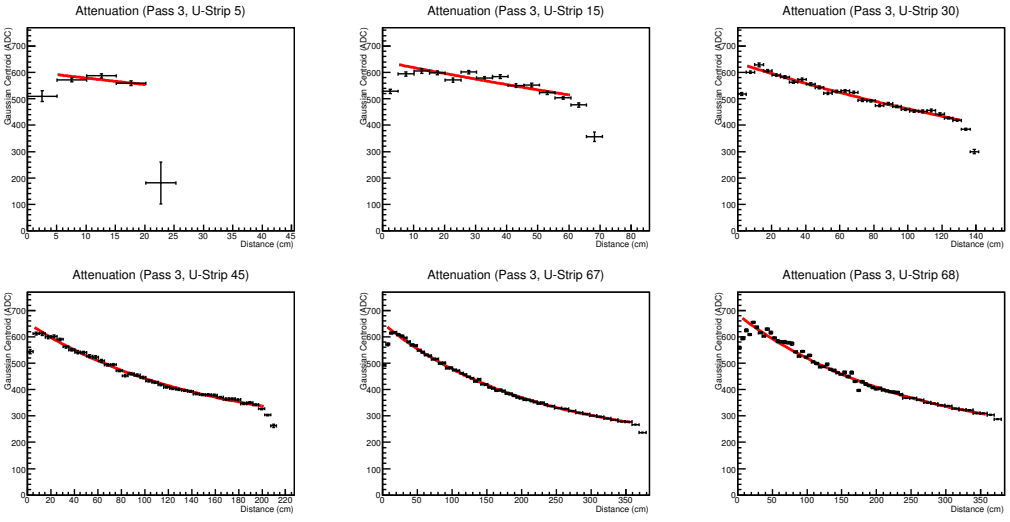


Figure 6.12: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).

6.3.5 Pass 4

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not.
- 3σ Cut on Signal: Each signal was fit to a Gaussian in pass 2. The parameter σ from the Gaussian fit was used to cut out the events that did not lie within this function.
- Attenuation Corrected Intensity Cut: The ADC value measured was corrected with the attenuation curves obtained from pass 2. The corrected value was summed over each layer. A cut on this intensity was placed generously from 1300 to 2700

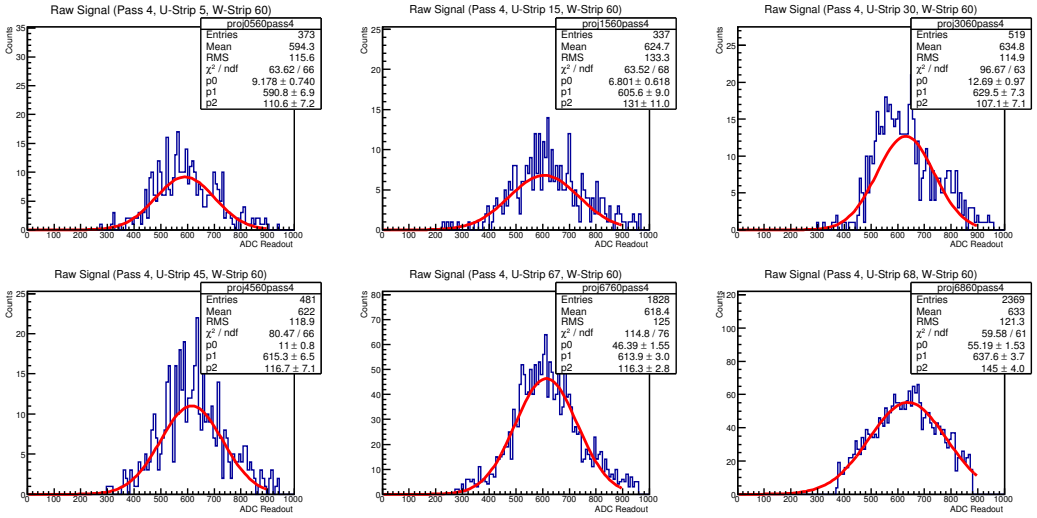


Figure 6.13: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

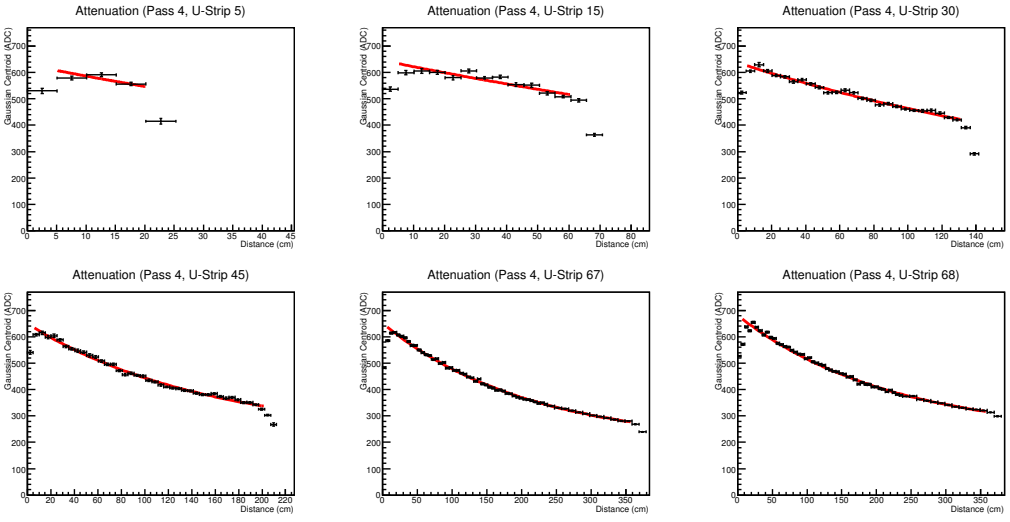


Figure 6.14: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).

6.3.6 Pass 5

- Multiplicity Cut: Only events where one PMT fired for each strip were allowed.
- Dalitz Cut: An empircal distance sum was used to remove events that don't fall into this range determined by Equation 4.
- Valid hit: Using generated events on a calculated skeleton of the pcal, each pixel was determined to be valid or not.
- 3σ Cut on Signal: Each signal was fit to a Gaussian in pass 2. The parameter σ from the Gaussian fit was used to cut out the events that did not lie within this function.
- Attenuation Corrected Intensity Cut: The ADC value measured was corrected with the attenuation curves obtained from pass 2. The corrected value was summed over each layer. A cut on this intensity was placed generously from 1300 to 2700

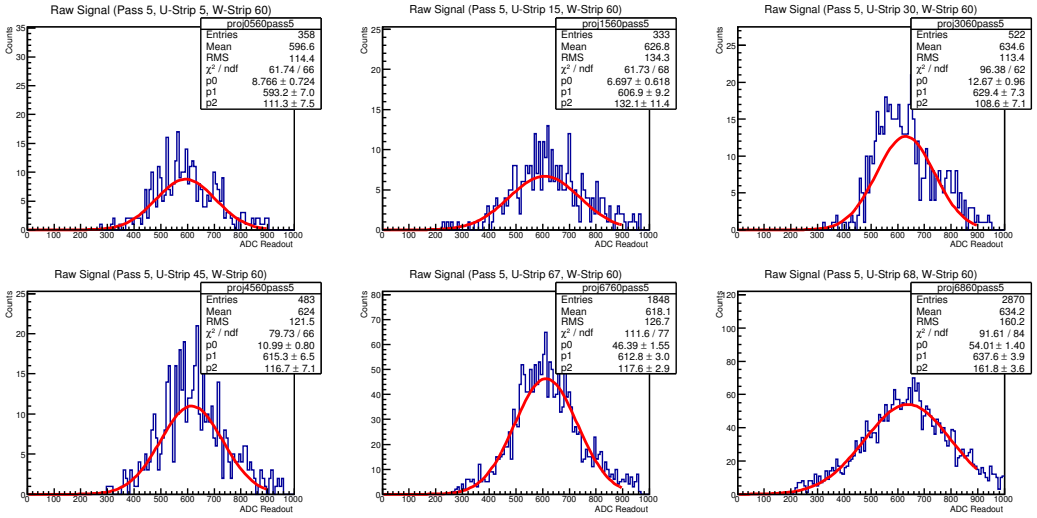


Figure 6.15: Shown is the ADC signal corresponding to signals from multiple u-strips (5, 15, 30, 45, 67, and 68) and a projection of the w60 strip.

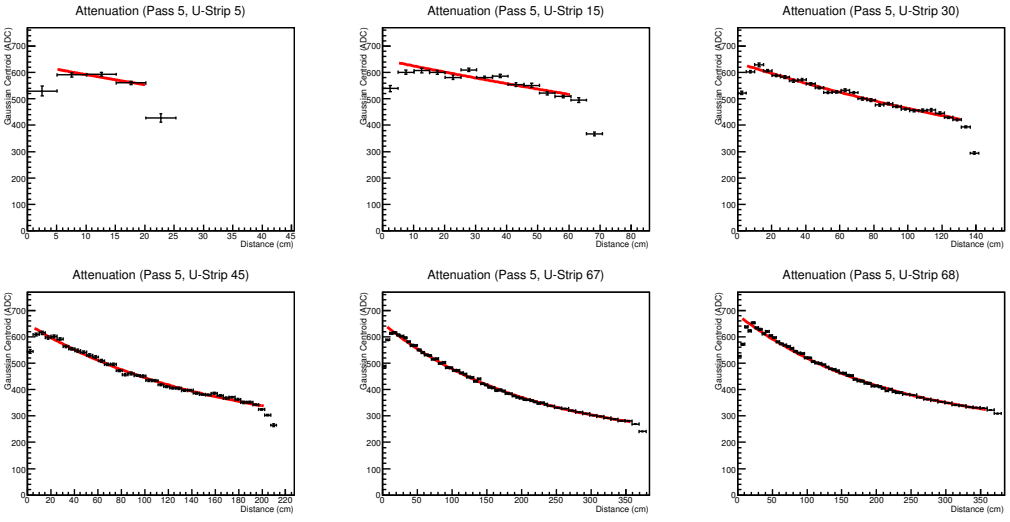
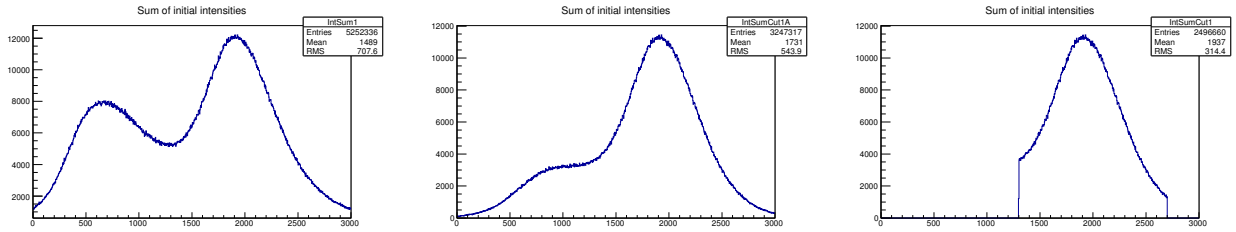


Figure 6.16: Shown is the overall attenuation fits to the selected u-strips (5, 15, 30, 45, 67, and 68).



(a) Sum of all initial intensities. No cuts.

(b) Sum of all initial intensities. Three sigma Cut.

(c) Sum of all initial intensities. Three sigma and sum Cut.

Figure 6.17: Sum of initial intensities should be near $650 \times 3 = 1950$ (after gain corrections).

6.4 Comparison of Fits

Possibly the best evidence for needed cuts about each signal in an iterative process is seen by looking at the raw signal fits for a w strip with the possible u projections. These comparisons can be seen from pass 0 to pass 5 in Figures 6.18 and 6.19. The difference between these signal tends to be cleaned up to a more Gaussian signal. By itself it is difficult to remove the backgound, but due to the correlating cuts on the u and v layers a reasonable output is produced.

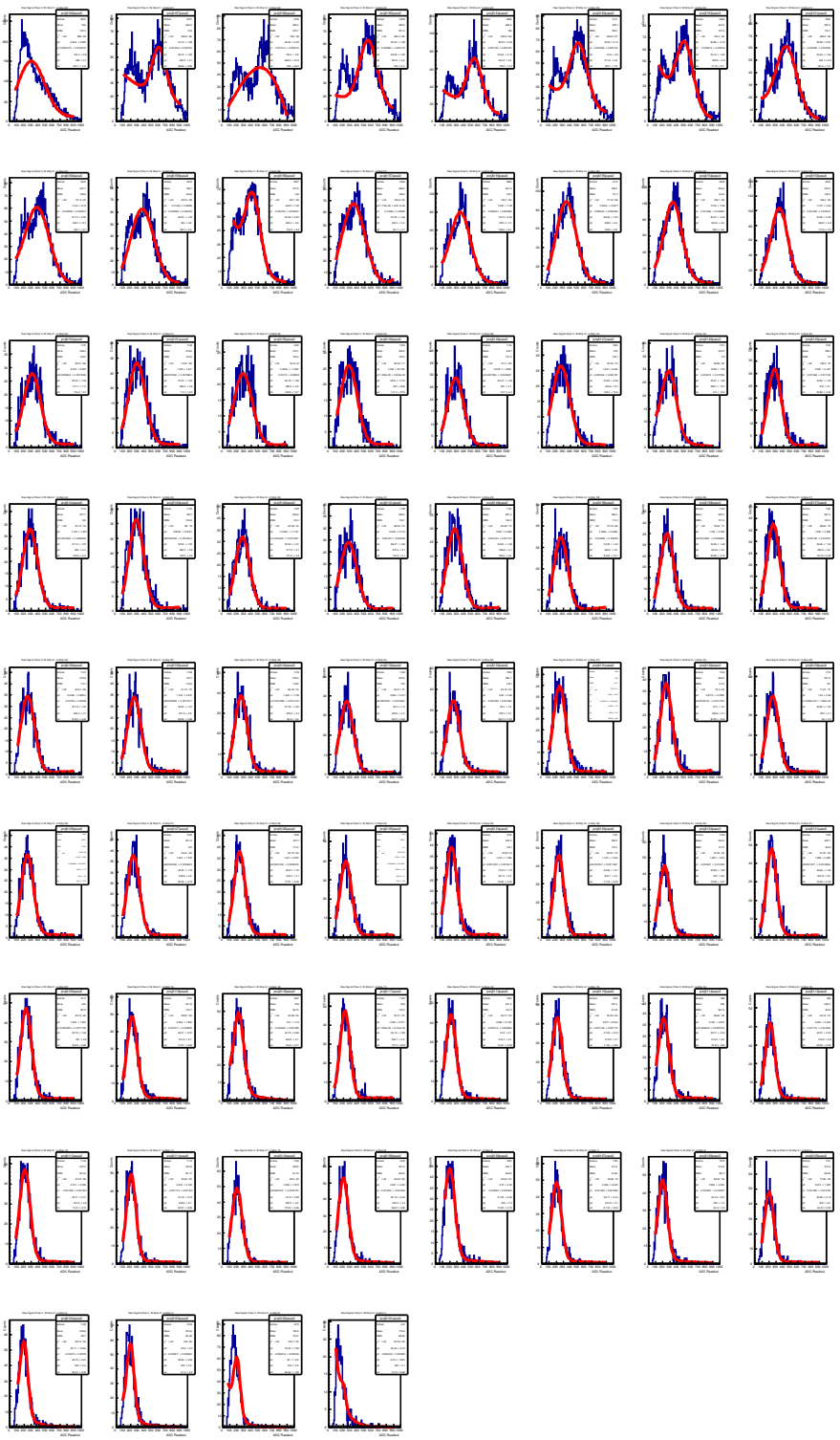


Figure 6.18: Shown is the ADC signal corresponding to signals from multiple u-strip projections of the w61 strip (pass0).

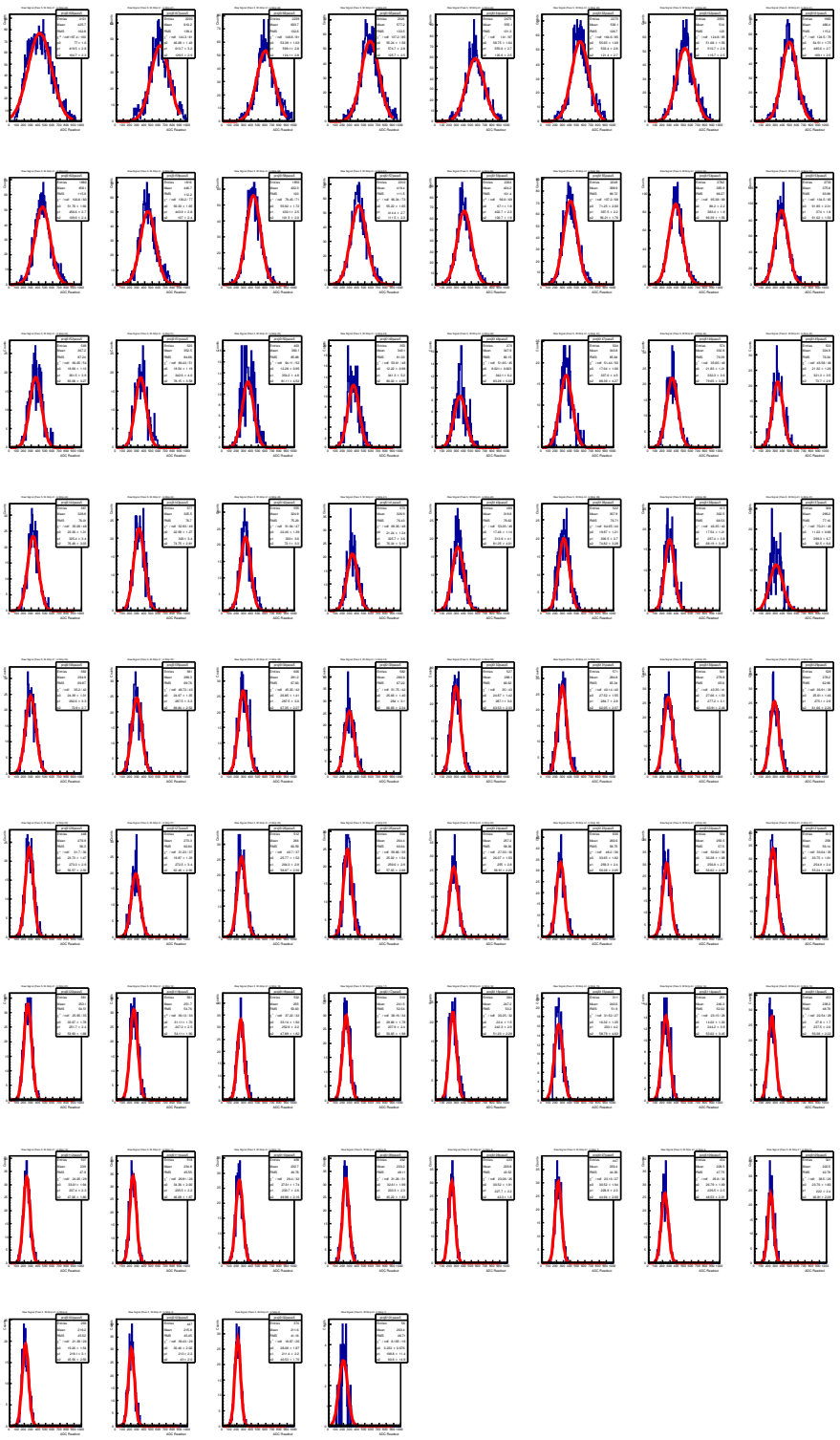


Figure 6.19: Shown is the ADC signal corresponding to signals from multiple u-strip projections of the w61 strip (pass5).

6.5 Fit Function

The fit function suggested in the geometry note is an exponential (equation 6). It is also suggested that here the distance, L, should include the distance from the end of the strip to the cosmic ray track, L_s, as well as the extra fiber length, L_f. In other words $L = L_s + L_f$. However to analyze the quality of fit L_f can be treated as a constant and absorbed into the parameter a in equation 6.

$$I = e^{a+bL} \tag{6}$$

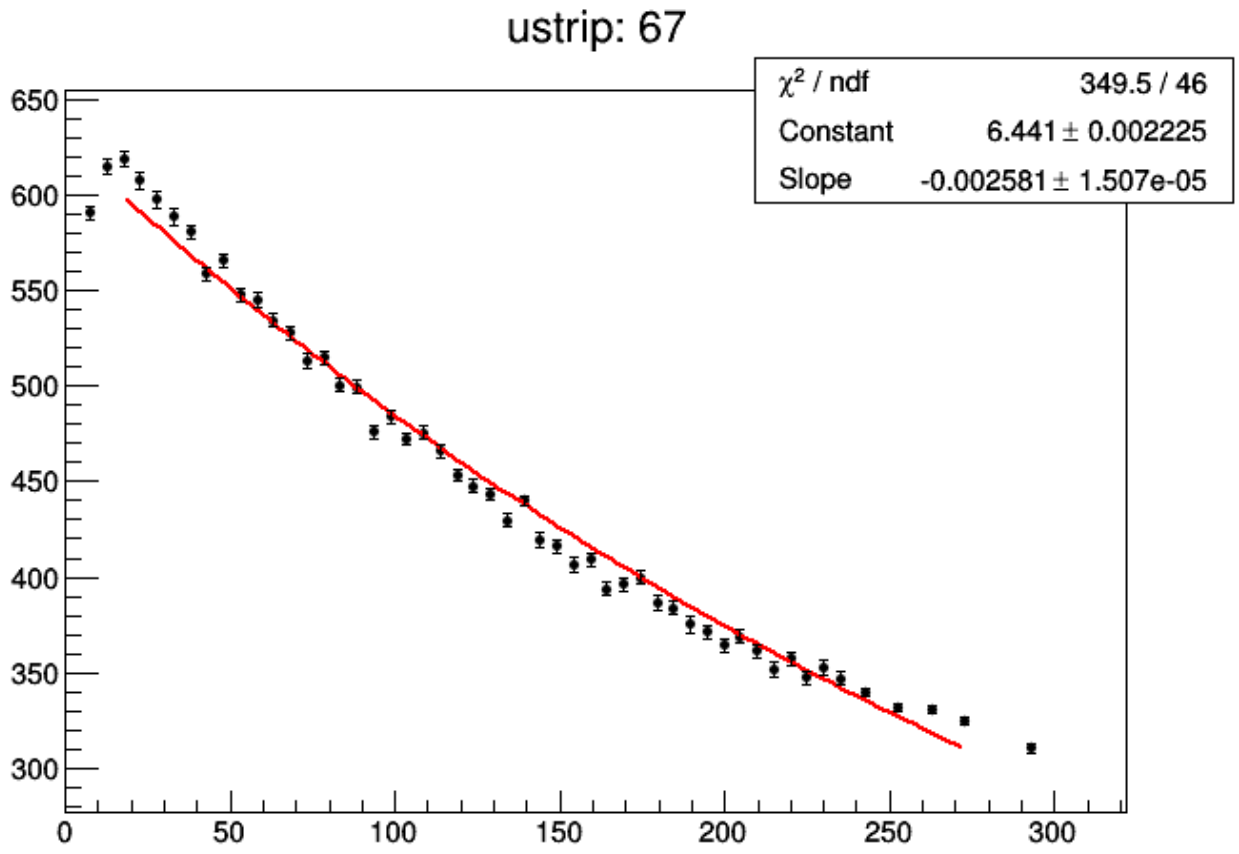


Figure 6.20: Shown is a fit with equation 6, where the y axis is the ADC value and the x axis is L_s.

As seen by figure **??**, a single exponential may not be the best fit for the data. One might suggest a fitting function similar to equation **??**, in order to separate the fiber attenuation from the scintillator attenuation. However this function again can reduce to equation 6 because L_f is a constant for each scintillator strip and is seen not to be a good fit.

Other functional forms that could represent the data should be similar to that of an exponential. A couple of these forms include an exponential plus a constant or a sum of exponentials. In both cases, some considerations have to be made on the domain of the function. The sum of two exponentials was considered to have some portion of the attenuation in the fibers to be different than inside the scintillator. This does not get a better fit, and does not allow any more information to be extracted. Therefore the function used in fitting the attenuation was chosen to be an exponential with an added constant as seen by Equation 7.

$$I(L_s) = ae^{bL_s} + c \tag{7}$$

6.6 Calibration Constants

A table of constants can be uploaded to the clas12 database once the fitting procedure is complete. For strips where fewer than five points were available for fitting, either a single exponential or a constant term was used for the fitting function. This was done to avoid overconstraining the fit. All the fits shown are for Sector One of the PCAL.

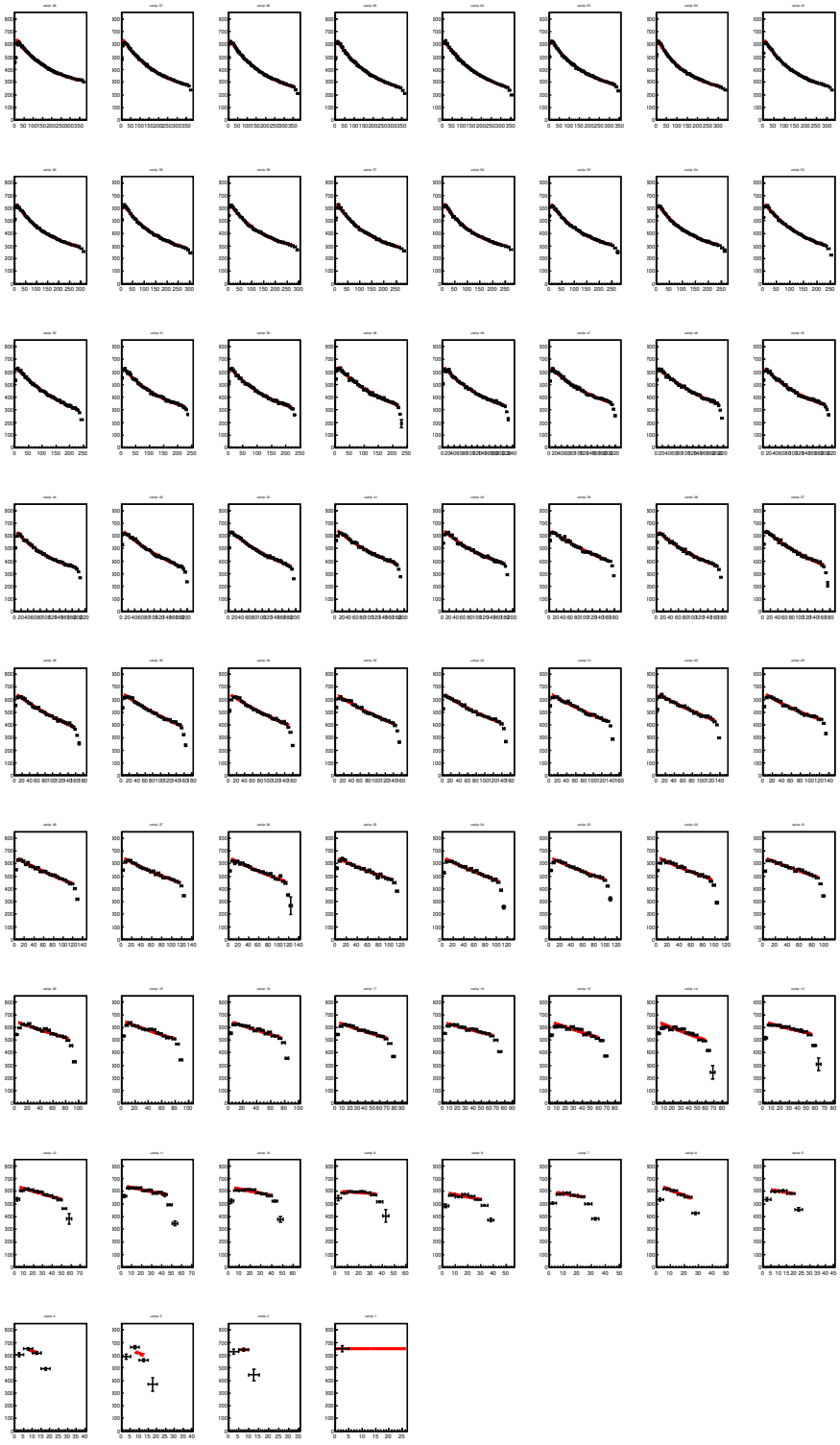


Figure 6.21: Attenuation fits for U strips with U68 in the upper left hand corner. Y-axis is linear ranging from 0 to 850. X-axis varies depending on the number of points in the plot.

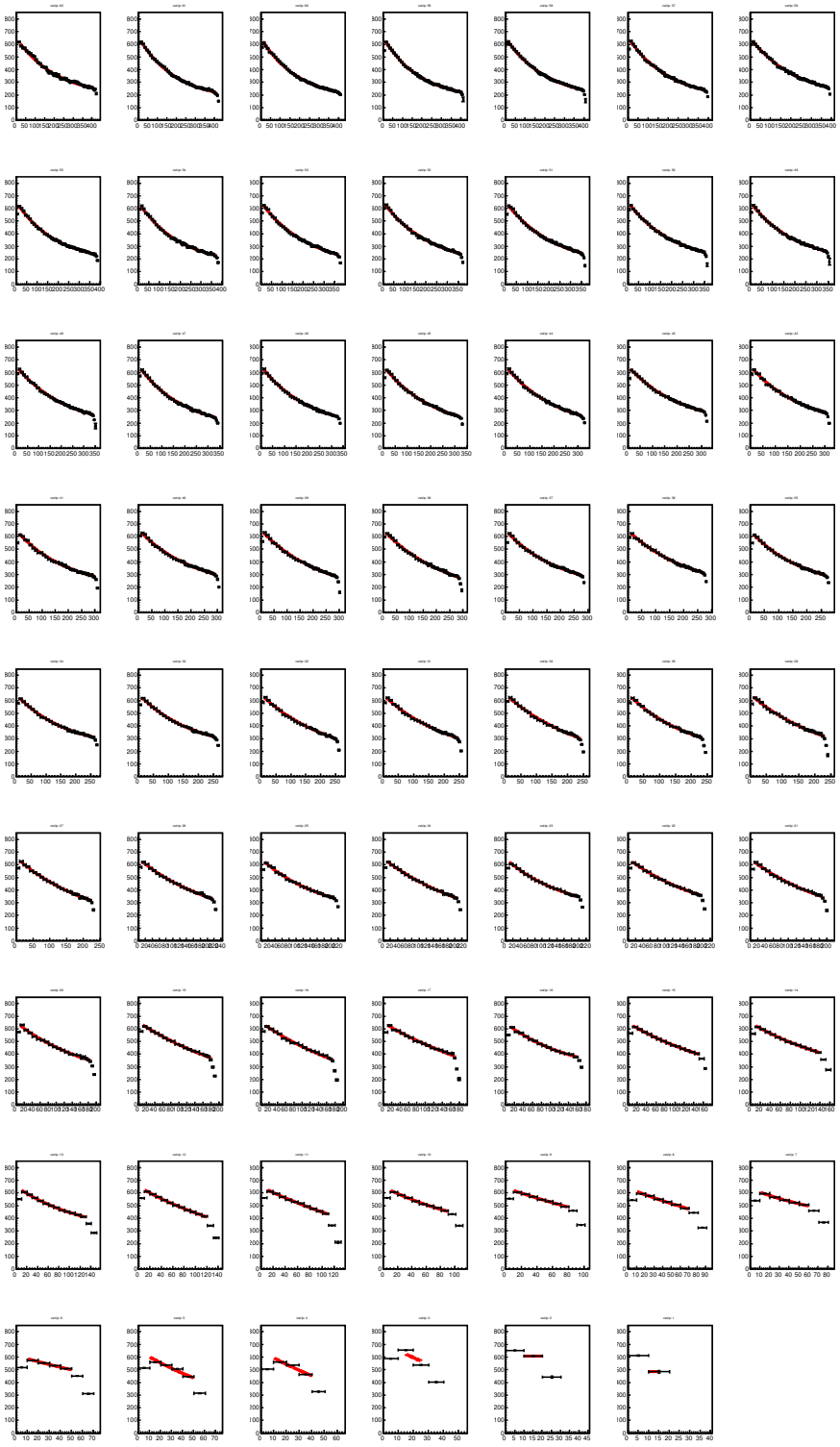


Figure 6.22: Attenuation fits for V strips V62 in the upper left hand corner. Y-axis is linear ranging from 0 to 850. X-axis varies depending on the number of points in the plot.

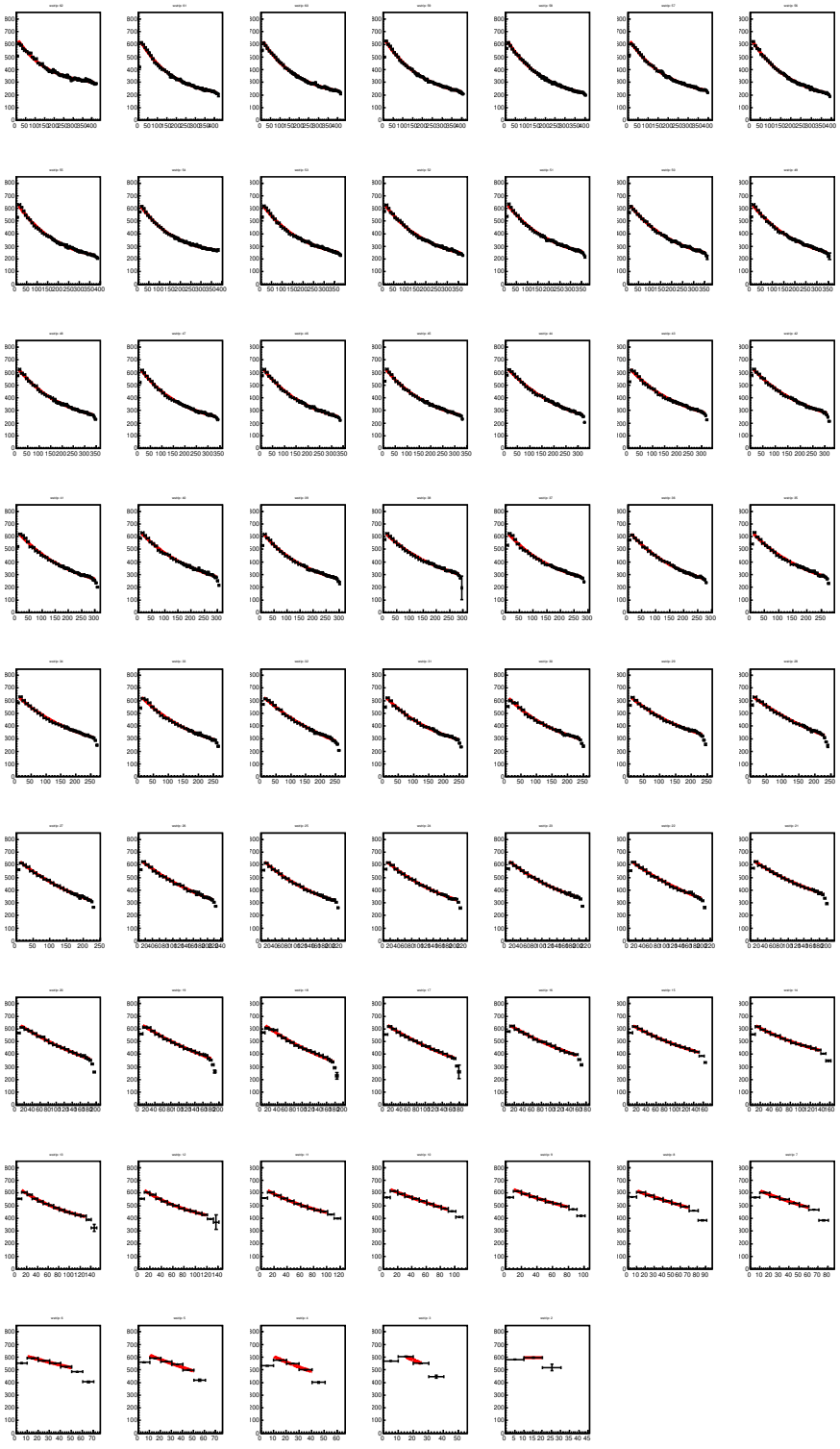


Figure 6.23: Attenuation fits for V strips V62 in the upper left hand corner. Y-axis is linear ranging from 0 to 850. X-axis varies depending on the number of points in the plot.

U-Strip	Parameter a	Parameter b	Parameter c
1	650	0	0
2	650	0	0
3	650	-0.009	0
4	650	-0.009	0
5	616.113	-0.00639717	33.8858
6	649.996	-0.00717551	0.0046356
7	649.968	-0.00318808	0.0319326
8	649.972	-0.00232476	0.0273016
9	649.146	-0.00112904	0.854413
10	649.999	-0.00281005	0.000286188
11	649.993	-0.00286292	0.00718601
12	650	-0.0041656	0.000445736
13	650	-0.003283	0.000103724
14	649.997	-0.00376077	5.37227e-06
15	650.001	-0.00339912	6.96689e-06
16	649.997	-0.00305411	8.14649e-06
17	649.999	-0.00345134	9.95183e-09
18	649.998	-0.00310718	4.19396e-07
19	650	-0.00311517	5.01049e-06
20	650	-0.00281725	6.09084e-06
21	650	-0.00315783	3.38135e-05
22	650	-0.00328681	2.55834e-08
23	650	-0.00316776	2.15877e-05
24	649.999	-0.00317021	4.66803e-05
25	650	-0.00327065	5.9556e-06
26	650.001	-0.00309179	1.40689e-08
27	551.087	-0.00385902	98.9141
28	649.997	-0.00307714	7.49416e-05
29	419.522	-0.00552754	230.477
30	650	-0.00316014	0.000130702
31	650.001	-0.00312815	2.25921e-06
32	585.658	-0.00373922	64.3455
33	581.001	-0.00374214	68.997
34	650.002	-0.00328878	0.000131253
35	650	-0.00332314	1.43305e-05
36	649.998	-0.00340294	1.07435e-07
37	556.399	-0.00428136	93.5991
38	483.854	-0.00534903	166.146
39	482.458	-0.00431684	167.541
40	392.765	-0.00669036	257.235
41	499.22	-0.00443664	150.78
42	513.839	-0.00445738	136.164
43	581.507	-0.00388427	68.4914
44	391.463	-0.00757633	258.536
45	434.393	-0.00632194	215.608
46	463.813	-0.00513914	186.187
47	413.809	-0.00605594	236.189
48	442.234	-0.00592955	207.766
49	509.976	-0.00449146	140.024
50	443.895	-0.00614484	206.105
51	425.765	-0.00641114	224.233
52	504.812	-0.00511618	145.188
53	454.838	-0.0061679	195.162
54	406.411	-0.00766326	243.589
55	415.976	-0.00690821	234.026
56	421.326	-0.00710769	228.675
57	435.635	-0.00660386	214.362
58	411.518	-0.00663318	238.483
59	438.882	-0.00625669	211.118
60	423.763	-0.00618908	226.238
61	444.671	-0.0063621	205.328
62	438.481	-0.00674885	211.519
63	437.138	-0.00564978	212.862
64	482.525	-0.00495599	167.473
65	473.388	-0.00516614	176.613
66	465.633	-0.00500512	184.367
67	455.941	-0.00479029	194.059
68	410.201	-0.00506009	239.798

Table 1: Calibration Constants for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	650.002	0	0
2	649.999	0	0
3	650.001	-0.009	0
4	650.001	-0.009	8.41036e-07
5	650	-0.00794645	5.04738e-06
6	649.225	-0.00402729	0.773706
7	341.165	-0.009	308.835
8	649.999	-0.0043402	0.000921065
9	650	-0.00346629	0.00030414
10	409.661	-0.0073313	240.338
11	650	-0.0036951	0.000157707
12	543.255	-0.00487653	106.745
13	385.429	-0.00755387	264.571
14	462.536	-0.00523798	187.463
15	490.318	-0.00478212	159.682
16	409.407	-0.00682511	240.592
17	644.496	-0.00311038	5.50402
18	649.997	-0.00345834	1.60129e-06
19	650	-0.00314254	4.40293e-06
20	476.84	-0.00525174	173.161
21	504.696	-0.00482932	145.304
22	501.641	-0.00447931	148.359
23	427.011	-0.00618067	222.989
24	532.597	-0.00429752	117.404
25	452.731	-0.00555935	197.267
26	514.63	-0.00444436	135.371
27	562.158	-0.00411837	87.8438
28	552.525	-0.00397784	97.4754
29	505.009	-0.00490977	144.992
30	545.684	-0.00417772	104.316
31	520.37	-0.00441109	129.628
32	545.125	-0.00412529	104.875
33	454.001	-0.00531295	195.999
34	430.052	-0.00591867	219.949
35	472.603	-0.00523221	177.394
36	479.173	-0.0044464	170.826
37	472.073	-0.00500161	177.926
38	521.65	-0.00433543	128.35
39	523.67	-0.00413843	126.33
40	475.448	-0.00450584	174.551
41	463.401	-0.0051012	186.6
42	486.03	-0.0046867	163.97
43	474.905	-0.00454652	175.094
44	512.336	-0.00460079	137.664
45	518.211	-0.00460405	131.79
46	503.032	-0.00487218	146.968
47	501.666	-0.00500745	148.335
48	488.139	-0.00450074	161.861
49	479.791	-0.00489837	170.209
50	487.47	-0.00479649	162.531
51	516.592	-0.0043148	133.409
52	504.835	-0.0045441	145.166
53	516.386	-0.00442848	133.615
54	493.162	-0.0051403	156.838
55	475.544	-0.00530062	174.455
56	483.85	-0.00428974	166.15
57	493.428	-0.00469419	156.572
58	485.197	-0.00470872	164.802
59	484.814	-0.00529538	165.185
60	492.715	-0.00499336	157.285
61	496.221	-0.00497787	153.779
62	472.264	-0.00469273	177.736

Table 2: Calibration Constants for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	650	0	0
0	650	0	0
0	650	-0.009	0
0	649.996	-0.00691378	0.00571745
0	650	-0.00558302	0.000738429
0	649.98	-0.00407219	0.0177906
0	422.924	-0.0082021	227.077
0	505.741	-0.00555023	144.259
0	372.286	-0.00737429	277.714
0	649.979	-0.00366028	0.0192191
0	650.001	-0.00372954	0.00118075
0	342.164	-0.009	307.836
0	355.773	-0.00855197	294.227
0	363.361	-0.00666561	286.64
0	434.311	-0.00525056	215.689
0	556.671	-0.00394053	93.3294
0	649.998	-0.00335208	7.53184e-06
0	650.001	-0.00360869	0.000280125
0	650	-0.00315057	1.4947e-05
0	650	-0.00319373	1.11969e-05
0	527.95	-0.00400632	122.05
0	618.622	-0.00362112	31.3758
0	500.057	-0.00478853	149.941
0	548.15	-0.00446747	101.85
0	479.19	-0.00563269	170.81
0	577.911	-0.00381978	72.0904
0	571.915	-0.00386651	78.0872
0	650	-0.00301759	6.97793e-06
0	476.296	-0.00466684	173.704
0	469.596	-0.0056956	180.406
0	483.094	-0.00545448	166.906
0	648.632	-0.0033354	1.3664
0	496.17	-0.00515118	153.83
0	487.383	-0.00461829	162.617
0	506.497	-0.00489625	143.503
0	517.17	-0.00494086	132.832
0	464.957	-0.00562927	185.046
0	481.521	-0.00435674	168.479
0	461.989	-0.00582562	188.011
0	499.489	-0.00442904	150.51
0	506.749	-0.00475107	143.248
0	502.841	-0.00434983	147.157
0	469.808	-0.00484038	180.192
0	527.099	-0.00412014	122.901
0	486.457	-0.00490661	163.543
0	489.691	-0.00510504	160.309
0	471.254	-0.00553953	178.746
0	472.808	-0.0050091	177.192
0	509.753	-0.00440386	140.247
0	487.851	-0.00484449	162.148
0	484.151	-0.0047396	165.851
0	479.294	-0.00498712	170.706
0	468.169	-0.00519666	181.83
0	427.693	-0.00598915	222.306
0	491.659	-0.00526729	158.341
0	514.732	-0.0050567	135.269
0	475.716	-0.00527028	174.285
0	500.373	-0.00518313	149.628
0	496.167	-0.00495883	153.833
0	475.153	-0.00531751	174.847
0	476.541	-0.00557183	173.458
0	371.958	-0.00688108	278.043

Table 3: Calibration Constants for the W layer.

U-Strip	Gain
68	0.919826
67	0.994387
66	0.996668
65	1.13365
64	1.0289
63	0.988108
62	1.05729
61	1.00024
60	0.918702
59	0.937388
58	0.971579
57	0.968278
56	0.9886
55	1.01584
54	0.972431
53	0.985789
52	1.06724
51	1.06537
50	1.15373
49	1.05132
48	1.05095
47	0.990354
46	1.05387
45	1.00345
44	0.90308
43	1.05416
42	1.03789
41	1.08503
40	0.964149
39	0.984689
38	1.07509
37	1.02063
36	0.973037
35	0.960093
34	0.999216
33	1.01442
32	0.966014
31	1.01264
30	1.01884
29	0.99361
28	1.12513
27	1.11908
26	1.14991
25	0.99626
24	1.01688
23	1.04101
22	0.993246
21	1.00052
20	0.927249
19	0.943803
18	0.975746
17	1.0319
16	1.05238
15	1.03268
14	0.999323
13	1.07013
12	0.974823
11	1.02237
10	1.0473
9	1.00103
8	1.13001
7	0.979758
6	0.945828
5	1.06426
4	1.08689
3	1.00753
2	1.03341
1	2.38937

(a) Gains for the U layer.

V-Strip	Gain
62	0.856903
61	0.975891
60	0.957263
59	0.984709
58	0.945978
57	0.94414
56	0.929243
55	0.981845
54	1.00783
53	0.970635
52	0.99664
51	0.984337
50	0.9841
49	1.02766
48	0.972439
47	1.05155
46	1.03861
45	0.98368
44	1.00809
43	0.991325
42	0.989896
41	0.965113
40	0.939102
39	1.05284
38	1.04087
37	0.972662
36	0.980653
35	0.993551
34	0.961802
33	1.01387
32	1.03706
31	1.04414
30	1.00396
29	0.994342
28	0.993199
27	1.00151
26	1.04742
25	1.05564
24	1.08135
23	0.971184
22	0.916638
21	1.026
20	0.978999
19	1.0785
18	1.03334
17	1.00605
16	1.02326
15	0.947529
14	0.943325
13	0.978369
12	0.965212
11	0.94848
10	1.05385
9	0.960673
8	1.04593
7	0.965207
6	0.930664
5	0.924364
4	0.906707
3	0.994952
2	1.11947
1	1.16553

(b) Gains for the V layer.

W-Strip	Gain
62	0.984625
61	1.04515
60	0.984452
59	1.05211
58	1.01464
57	1.01152
56	1.12032
55	1.08628
54	1.04743
53	1.03443
52	0.973068
51	0.986971
50	1.0584
49	1.02468
48	1.00968
47	1.03928
46	1.1033
45	1.00978
44	1.01194
43	0.991657
42	1.04533
41	1.07685
40	1.0462
39	1.01952
38	1.04494
37	0.940542
36	1.07141
35	1.02338
34	1.01296
33	0.977284
32	1.11503
31	0.955289
30	1.00997
29	0.980596
28	0.999784
27	1.0662
26	1.01917
25	0.998049
24	1.07542
23	1.01097
22	1.00608
21	0.995989
20	1.00445
19	1.04812
18	1.05886
17	1.00316
16	1.00583
15	0.920611
14	0.95728
13	0.928774
12	0.932801
11	0.975309
10	1.02923
9	0.969189
8	0.978204
7	0.927413
6	1.01355
5	1.00309
4	0.965665
3	0.959464
2	1.1257
1	1

(c) Gains for the W layer.

Table 4: Preliminary Gains

7 Calibration Studies

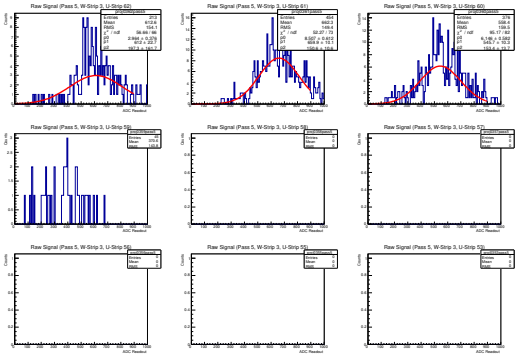
7.1 Optimal ADC Bin Size

A study was performed to view an optimal binning of the ADC readout. The ADC readout was plotted from zero to one thousand. This study looked at the effect from variation of the number of bins. The final Gaussian fit was used on each signal pixel when finding differences. It is clear that the optimal binsize is limited by the small pixel readouts, or the portion of the detector nearest the beam line. Therefore a reasonable limit on the smallest bin size (for these statistics) was estimated to be around $\frac{1000}{200} = 5$ on the ADC readout. To get more trustworthy fits a choice was made of bin size to be $\frac{1000}{125} = 8$ on the ADC readout.

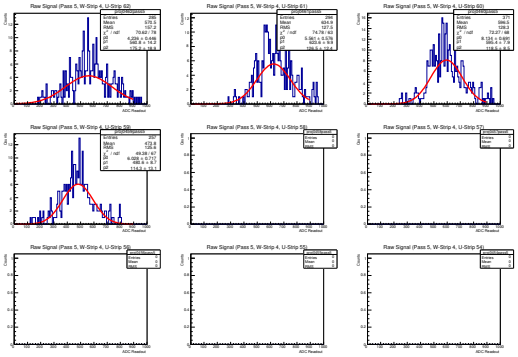
7.2 Minimum Statistics

A minor study was conducted to determine the minimum statistics needed for calibration of the PCAL unit. However, this is tangled into multiple different components. Adjusting the bin size might affect the total statistics needed. This study only focuses on the optimal bin size determined by section 7.1. Another factor for the amount of statistics needed is the physical bin size. This limits the overall statisics to the lowest number needed to calibrate the shortest strips (i.e. low u strip number, high w/v strip number). Figure 7.1 shows the first few u-strips (strips 3 through 8), that are physically binned by the w-strips.

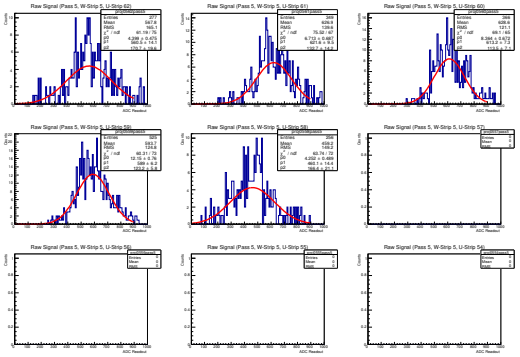
If these strips are to be calibrated and the ADC bin size is to stay the same, then based on these plots the minimum statistics needed is roughly equal to the data obtained currently. This analysis contains 5.2 billion post-skimmed events. This equilavates to a days worth of data with the PCAL unit laid out horizontally. Due to the decrease of the cosmic ray flux when the unit is vertically aligned, a larger time scale will be needed.



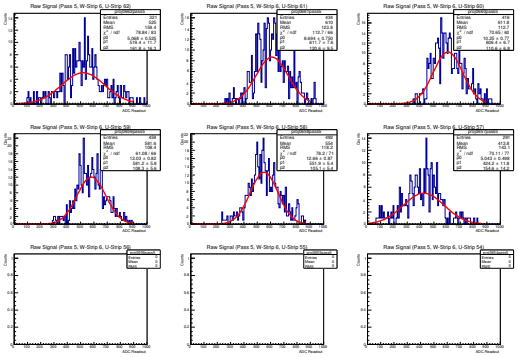
(a) Shown are all of the w projections onto u-strip 3. The distribution shown peaks around 15 counts.



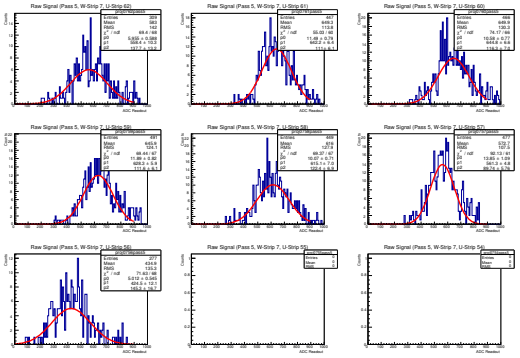
(b) Shown are all of the w projections onto u-strip 4. The distribution shown peaks around 15 counts.



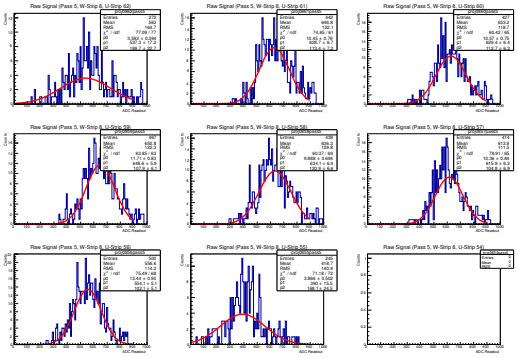
(c) Shown are all of the w projections onto u-strip 5. The distribution shown peaks around 15 counts.



(d) Shown are all of the w projections onto u-strip 6. The distribution shown peaks around 15 counts.



(e) Shown are all of the w projections onto u-strip 7. The distribution shown peaks around 15 counts.



(f) Shown are all of the w projections onto u-strip 8. The distribution shown peaks around 15 counts.

Figure 7.1: Plotted are a six of the short scintillator strips. Each subfigure shows projections of the last 9 w-strips. Therefore these plot axises are counts versus ADC value detected by the u layer PMT.

8 Simulation

This section deals with extraction of the attenuation coefficients in the JAVA framework. Generation of simulated events is discussed, followed by a brief description of the cuts that are applied. Then the ADC signals are fit for each overlap shape at a specific distance from the PMT ends to extract the coefficients.

8.1 GEMC: Event Generation

Events are generated using the GEMC software which uses a *gcard*:

```
gemc gcard/fc-ecpcsc-s2.gcard -RUNNO=12 -N=5000000 -USE_GUI=0
```

The attenuation constants extracted from the data are saved in the database as CCDB constants. These constants (with gains normalized) are picked up by the *gcard* with `RUNNO=12`. When executed with the above command, 5,000,000 events are produced. A snapshot of the code snippet is shown in Fig. 8.1. A total of 3 million events are generated in module 2 of the PCAL unit in order to do the simulation studies.

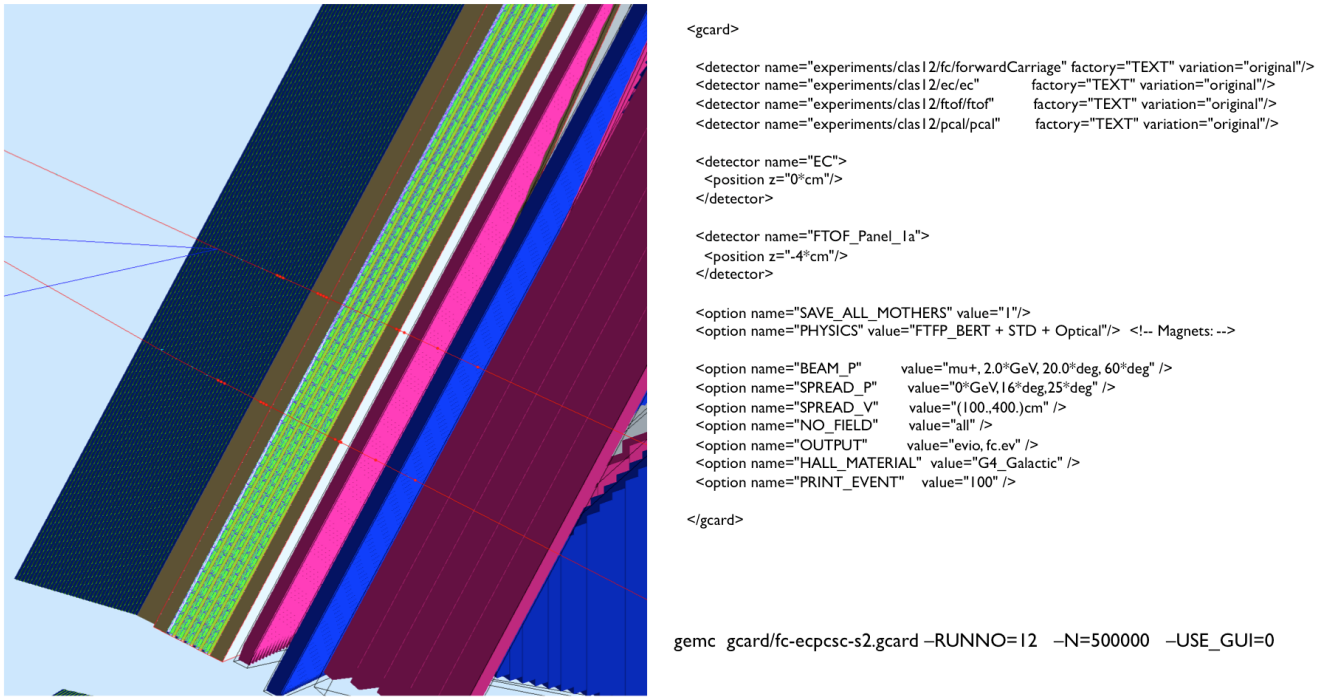


Figure 8.1: Snippet of the code to produce simulated events using GEMC. The graphic shows two muon tracks passing from right to left.

8.2 Input: Generation coefficient

The attenuation coefficients given in Tables 1, 2 and 3 are used as the generation coefficients. In the attenuation equation,

$$y = Ae^{Bx} + C \tag{8}$$

A, B and C are the attenuation coefficients and $A + C$ is defined as the gain. The gain was normalized to an *ad hoc* MeV muon. The normalized values are fed as the generation input, which, as previously mentioned, are picked up by the *gcard*. Here distance is the variable x.

8.3 Cuts Applied

Different cuts wherever relevant should be applied to ensure a more accurate calibration. The ADC distributions of the generated events are much cleaner as they contain no background. However, they do contain corner clippers.

Therefore, to be consistent with the method used for the calibration of the data, two cuts are made so far: the multiplicity cut and the valid pixel cut. These cuts are discussed below:

8.3.1 Multiplicity Cut

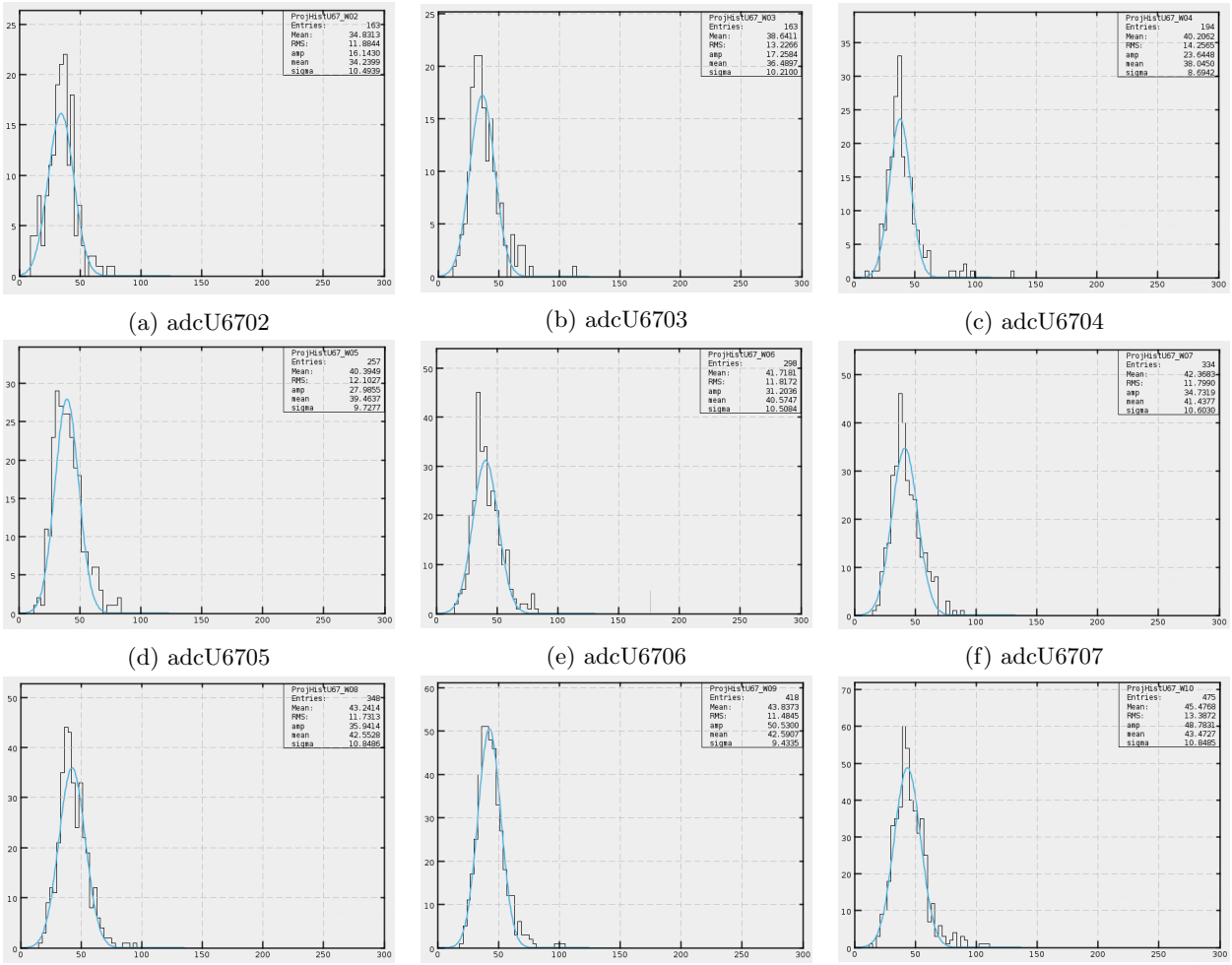
Only events with exactly one U-hit, one V-hit and one W-hit are selected. This will also help to reduce/remove events which are not relatively perpendicular to the surface of the PCAL module. Events which do not pass this cut are removed from the analysis.

8.3.2 Valid Pixel Cut

Another condition required for the events to be selected is that they are within the physical shape made by the overlap. The database geometry provides with the coordinates of the vertices of the PCAL module which can be used to construct pixel and overlap shapes. Events with only one hit in these shapes in each view is only taken into account. The shapes which pass this cut are termed as the valid pixel/overlap shapes. Events that do not fall within these shapes are removed from the analysis. In other words, this cut ensures the signal track was physically valid and relatively perpendicular with respect to the face of the PCAL module.

8.4 ADC signals and fits

The events that passed the cuts are binned according to which strip is being calibrated. For example, to calibrate U-strips, bins of W cross-strips are used. In most of these bins a Gaussian function describes the ADC distribution reasonably well. The centroids for such bins are approximated from the Gaussian fits. However, it is also found that some bins have very small number of counts and the Gaussian funtion can not define the distribution accurately. To account for that a fit condition is employed. If the number of events is less than 20, the statitical mean is used as the centroid. The process is repeated for every strip in each view. The ADC distributions and the Gaussian fits for U67 are shown in Figures 8.2-8.6.

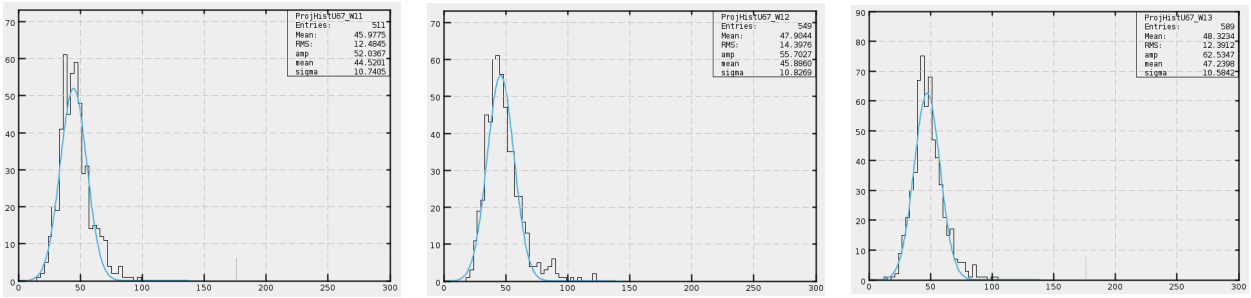


(a) adcU6702 (b) adcU6703 (c) adcU6704

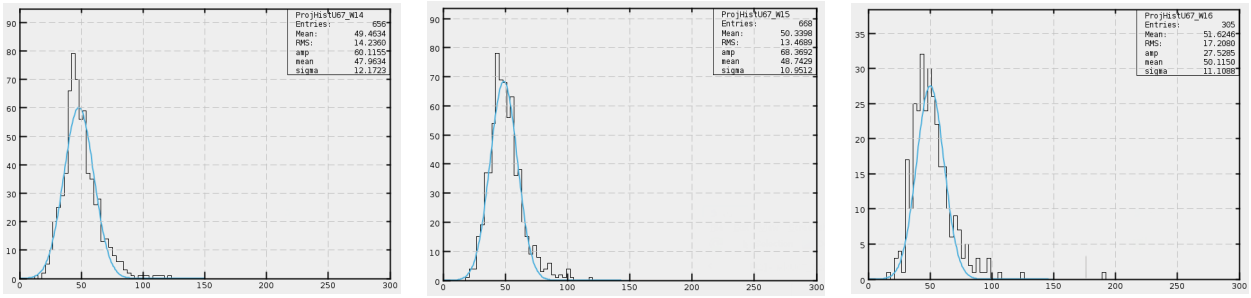
(d) adcU6705 (e) adcU6706 (f) adcU6707

(g) adcU6708 (h) adcU6709 (i) adcU6710

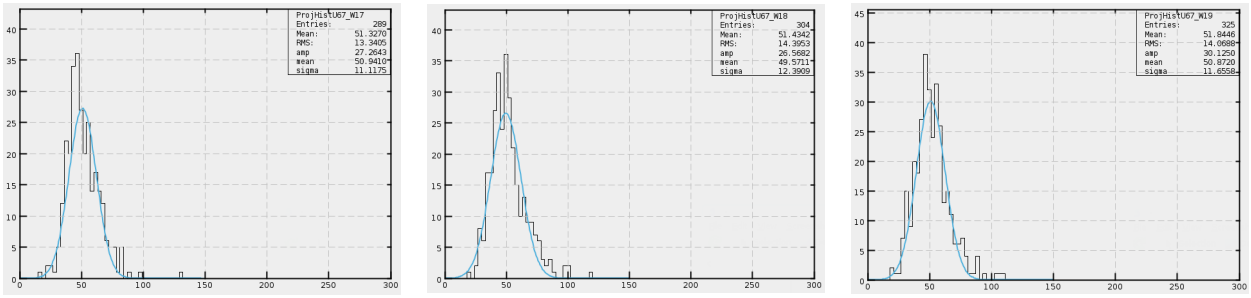
Figure 8.2: ADC distribution for U67. The last two digits in the caption of each figure represent the bin number based on the W strip. Blue curve is the Gaussian fit.



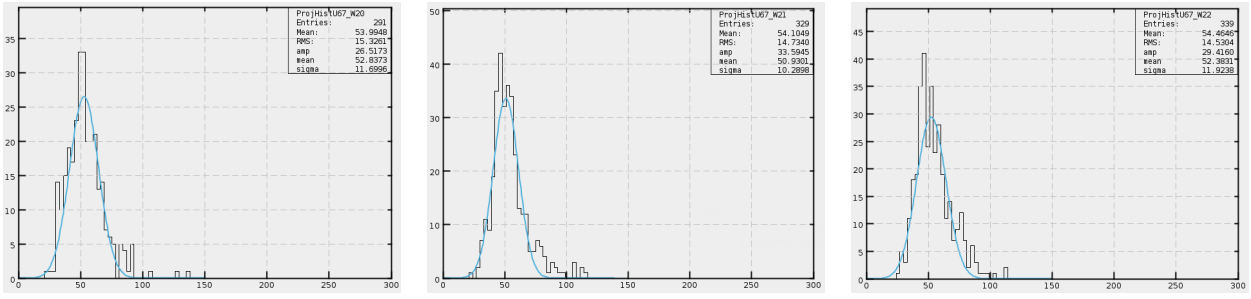
(a) adcU6711 (b) adcU6712 (c) adcU6713



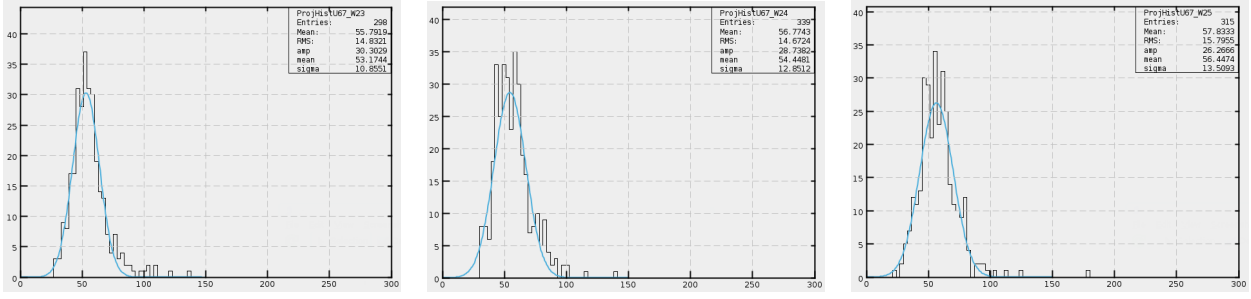
(d) adcU6714 (e) adcU6715 (f) adcU6716



(g) adcU6717 (h) adcU6718 (i) adcU6718

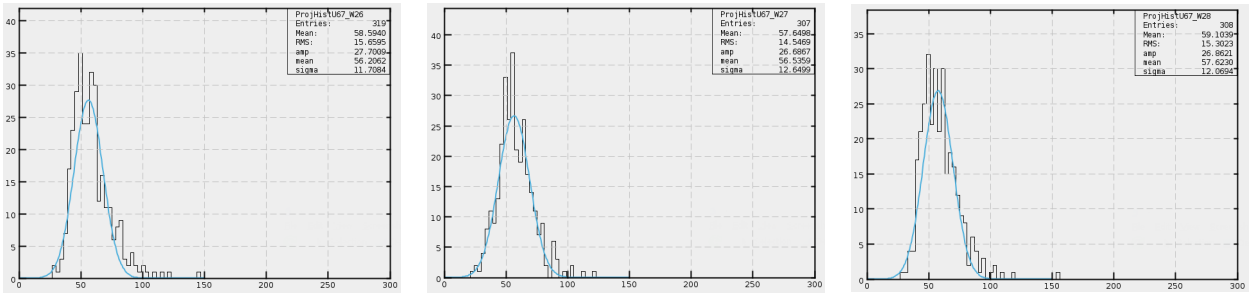


(j) adcU6720 (k) adcU6721 (l) adcU6722

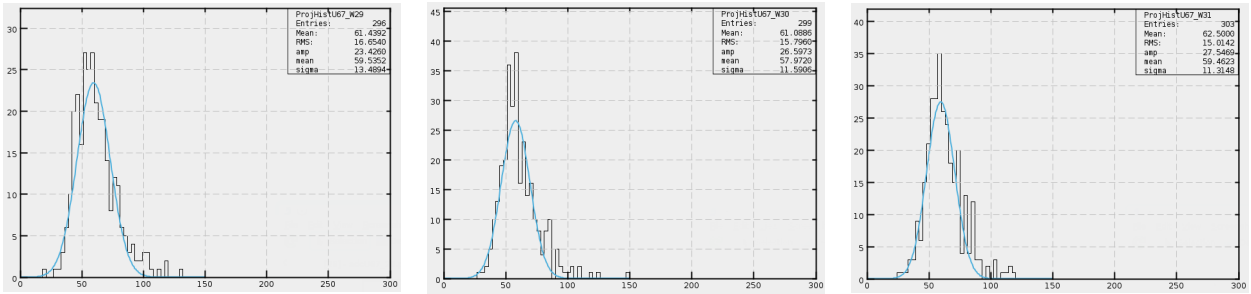


(m) adcU6723 (n) adcU6724 (o) adcU6725

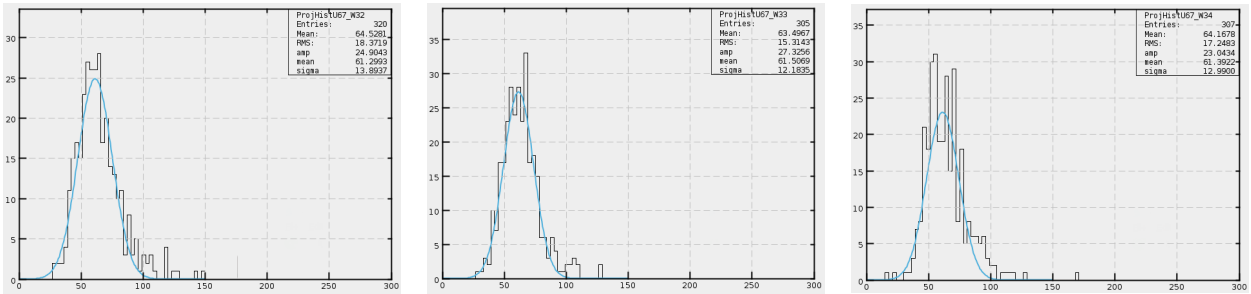
Figure 8.3: ADC distribution for U67. The last two digits in the caption of each figure represent the bin number based on the W strip. Blue curve is the Gaussian fit.



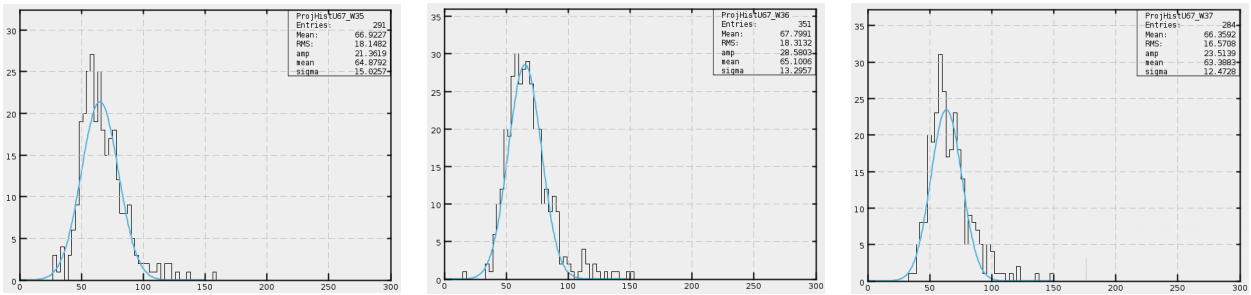
(a) adcU6726 (b) adcU6727 (c) adcU6728



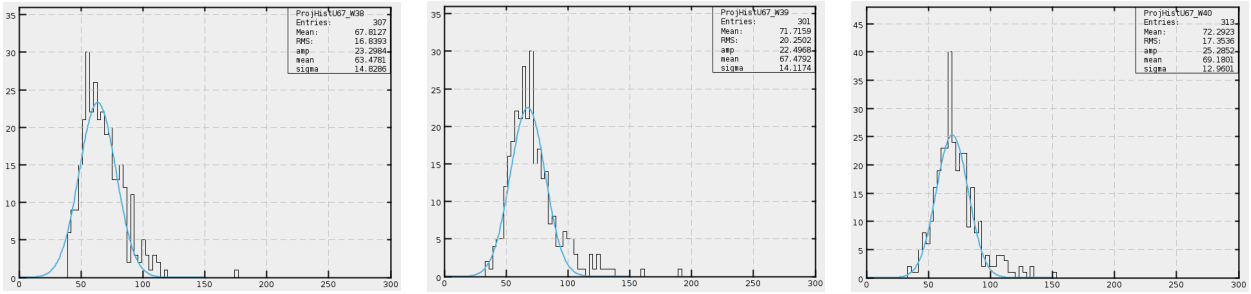
(d) adcU6729 (e) adcU6730 (f) adcU6731



(g) adcU6732 (h) adcU6733 (i) adcU6734

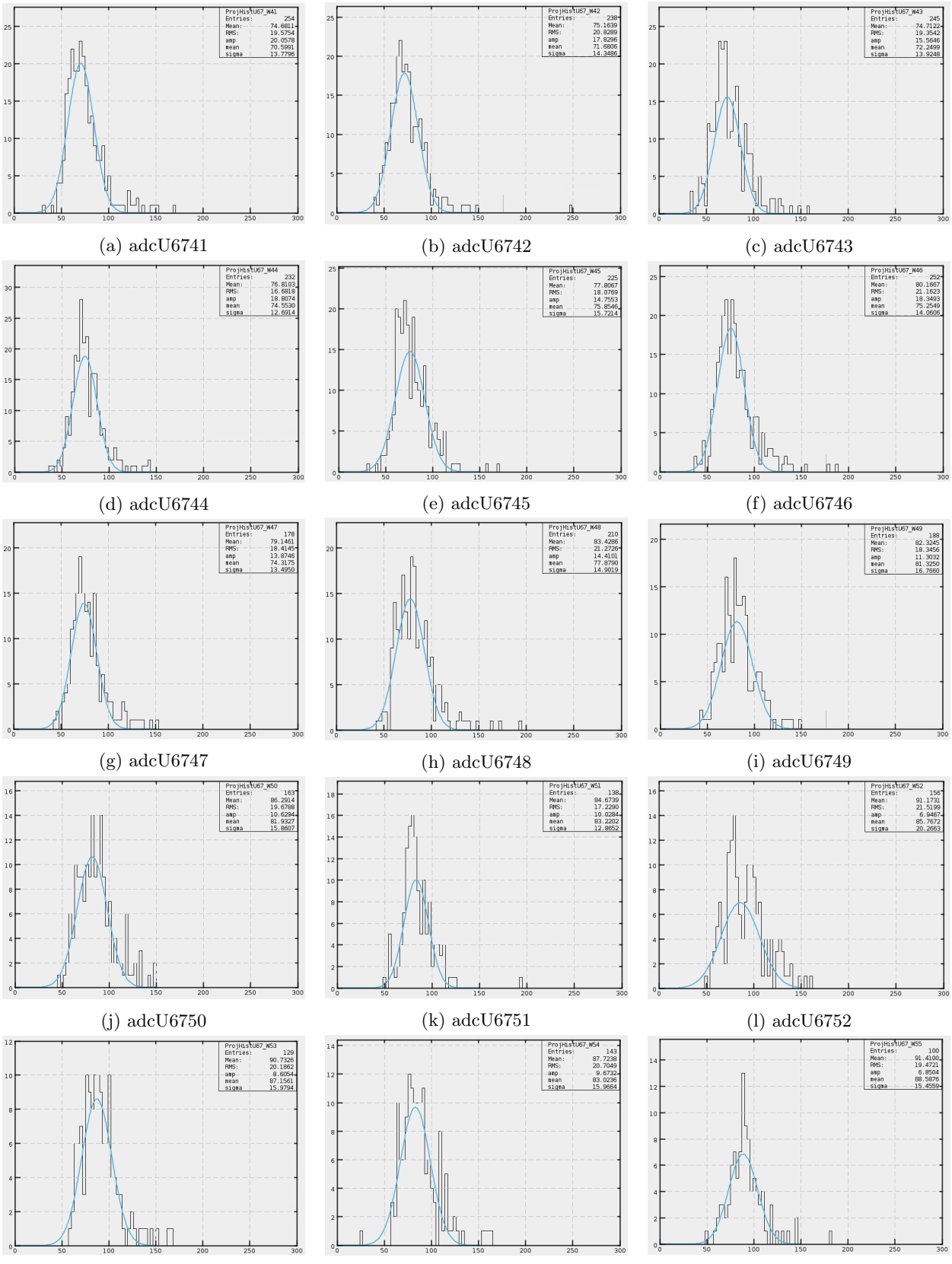


(j) adcU6735 (k) adcU6736 (l) adcU6737



(m) adcU6738 (n) adcU6739 (o) adcU6740

Figure 8.4: ADC distribution for U67. The last two digits in the caption of each figure represent the bin number based on the W strip. Blue curve is the Gaussian fit.



(a) adcU6741 (b) adcU6742 (c) adcU6743

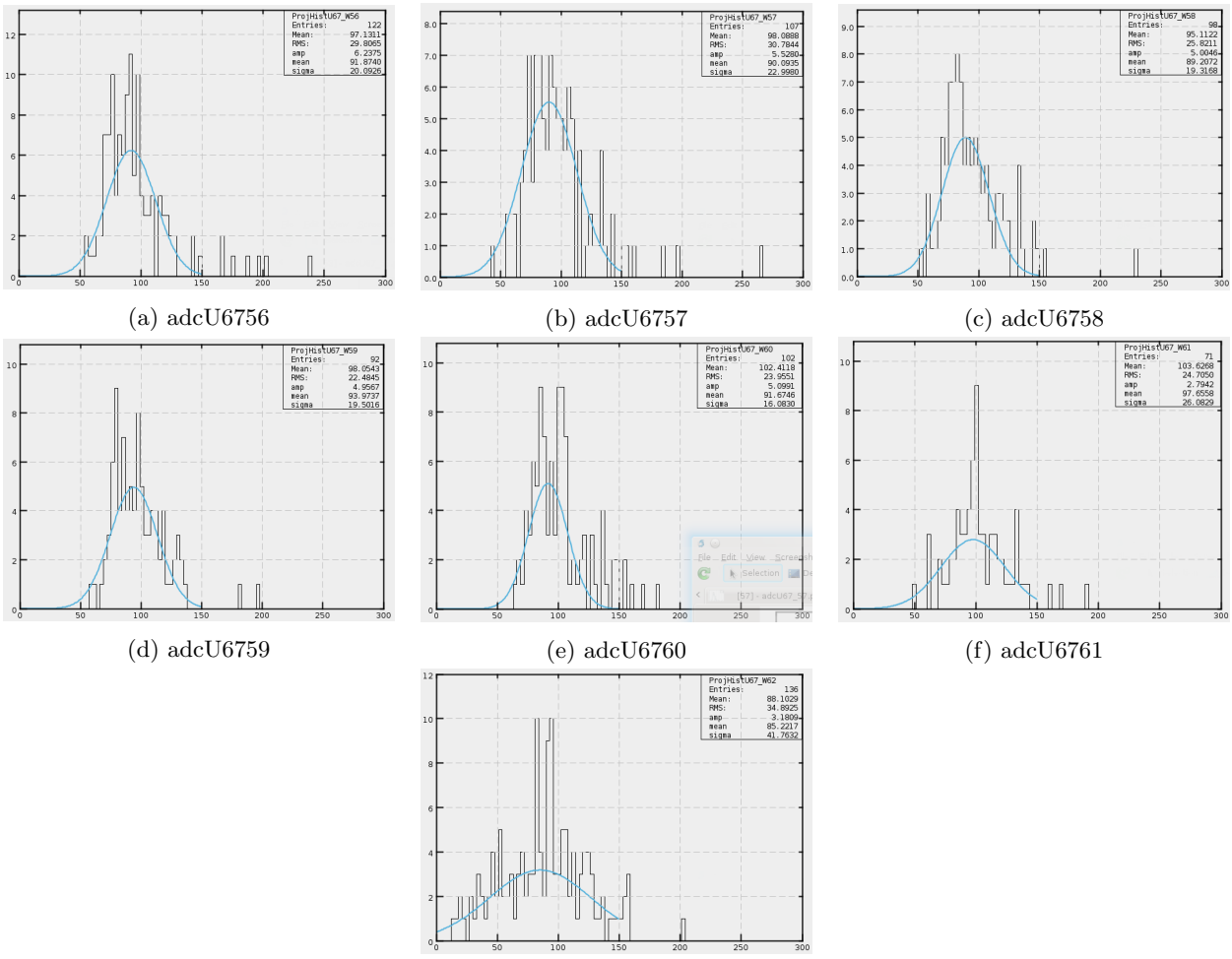
(d) adcU6744 (e) adcU6745 (f) adcU6746

(g) adcU6747 (h) adcU6748 (i) adcU6749

(j) adcU6750 (k) adcU6751 (l) adcU6752

(m) adcU6753 (n) adcU6754 (o) adcU6755

Figure 8.5: ADC distribution for U67. The last two digits in the caption of each figure represent the bin number based on the W strip. Blue curve is the Gaussian fit.



(a) adcU6756 (b) adcU6757 (c) adcU6758

(d) adcU6759 (e) adcU6760 (f) adcU6761

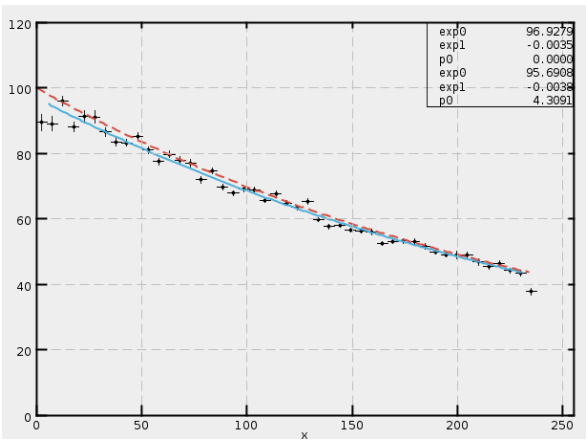
(g) adcU6762

Figure 8.6: ADC distribution for U67. The last two digits in the caption of each figure represent the bin number based on the W strip. Blue curve is the Gaussian fit.

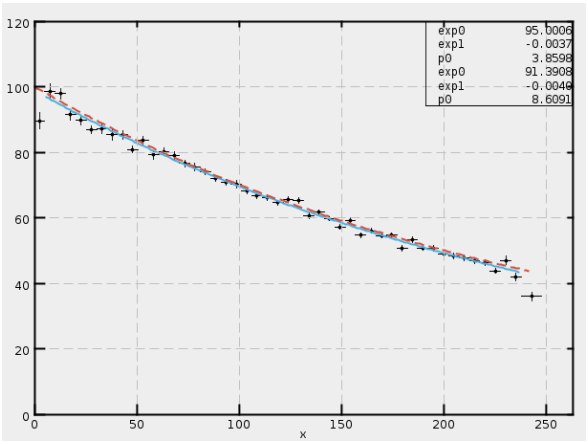
In the similar way centroids for other U-strips are extracted and stored. The correspoding distances from the center of these bins are also evaluated. The next section deals with the exponential fits using these values to extract the calibration constants.

8.5 Exponential fits

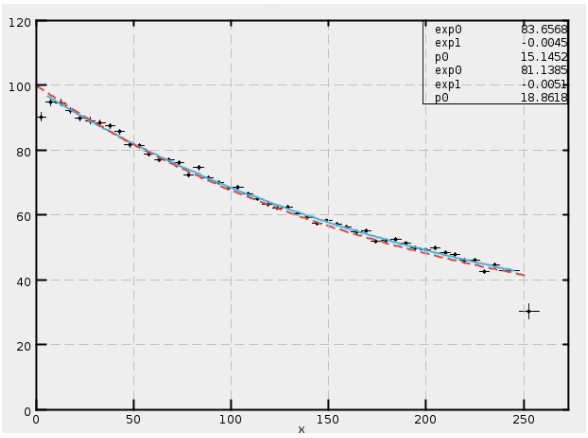
The centroid of each bin is plotted as a function of distance between the bin center to the PMT ends. An exponential funtion of the form given in Eq. 8 is used to fit these points. The fit parameters are then extracted which are the required attenuation coefficients (A, B and C). This process is repeated for each strip in each view so that a set of 68 U, 62 V and W coefficients are recorded. To illustrate the process, the fits for ten U-strips (U51- U59 and U67) are shown in Figures 8.7- 8.8. As a comparison, the CCDB constants are also drawn (red curves).



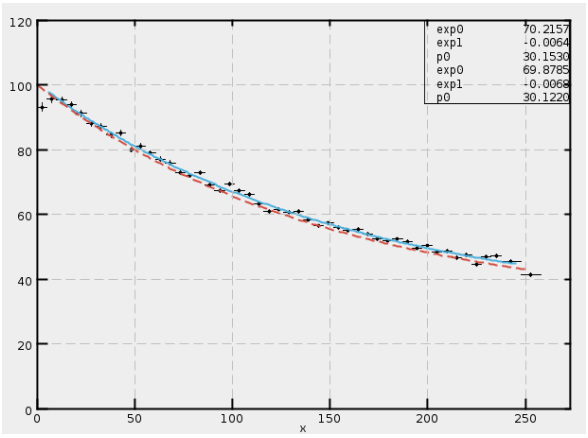
(a) expfitU51



(b) expfitU52

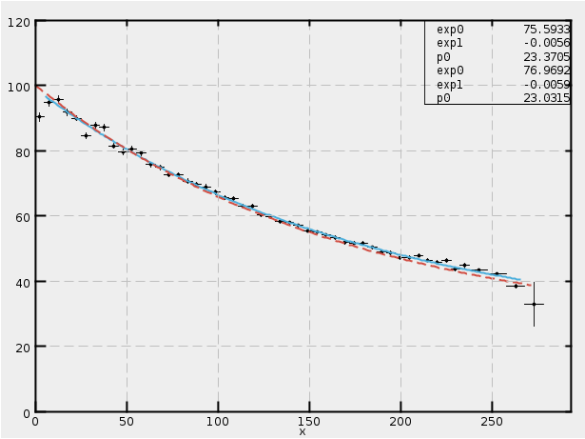


(c) expfitU53

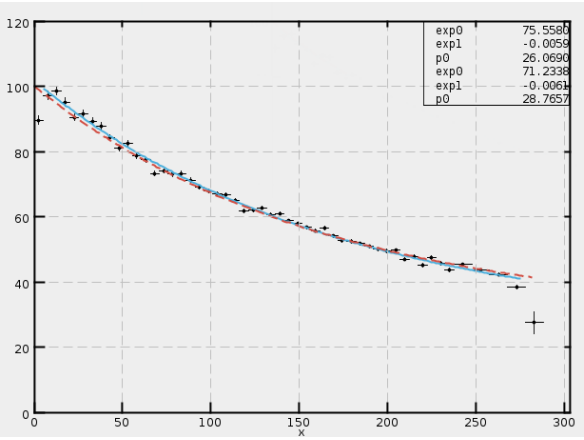


(d) expfitU54

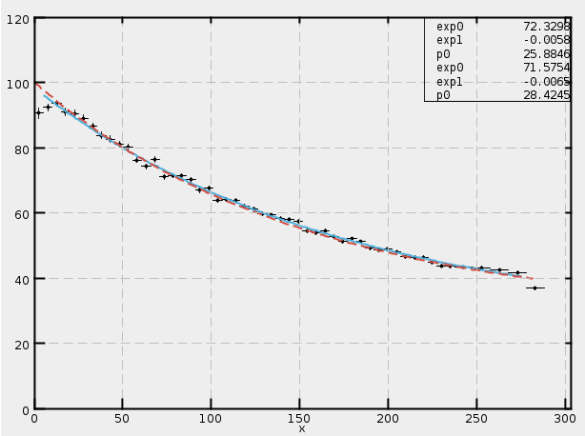
Figure 8.7: Exponential fits for strips U51-U54. The first set of three coeffcients are from the fit and the next set of three are the coefficients used in the event generation.



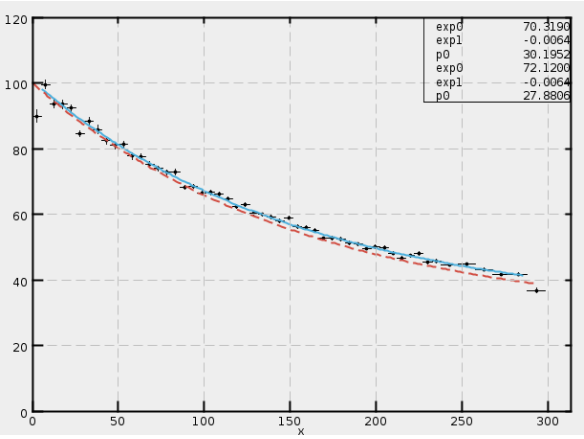
(a) expfitU55



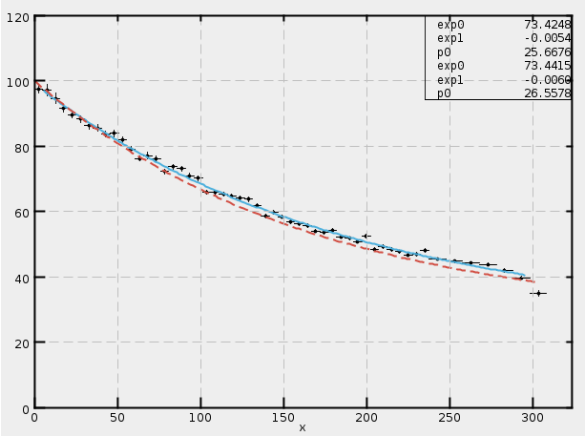
(b) expfitU56



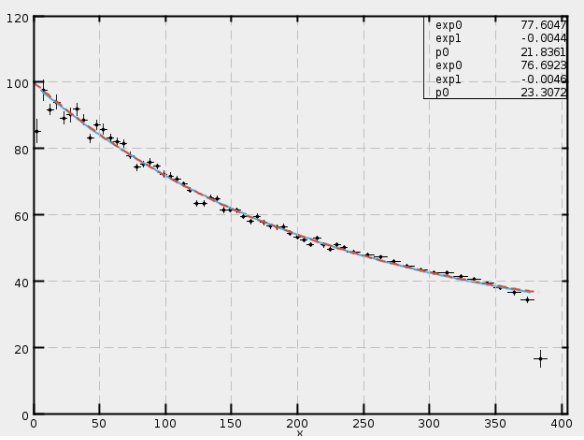
(c) expfitU57



(d) expfitU58



(e) expfitU59



(f) expfitU67

Figure 8.8: Exponential fits for strips U55-U59 and U67. The first set of three coeffcients are from the fit and the next set of three are the coefficients used in the event generation.

8.6 Attenuation Coeffiecients

The attenuation coefficients for all the strips extracted using overlap shapes are listed in Tables 5, 6 and 7 respectively for the U, V and W views.

U-Strip	Parameter A	Parameter B	Parameter C
1	51.6222	0	0
2	87.6722	0	0
3	75.2066	0	0
4	0	0	0
5	115.642	-0.0227617	1.31895e-05
6	25.9129	0.0573538	1.84741e-11
7	92.8515	-0.0111834	8.87529
8	99.9122	-0.0071888	0.000272534
9	98.7009	-0.00673623	5.30282e-05
10	95.7012	-0.00501738	3.87816e-06
11	99.5796	-0.00600944	5.70812e-05
12	101.893	-0.0068082	7.35174e-05
13	98.5639	-0.00536148	4.98004e-05
14	100.276	-0.00639663	5.58738e-05
15	99.7085	-0.00501107	5.66326e-05
16	100.059	-0.00515426	5.60184e-05
17	98.1727	-0.00350673	4.48953e-05
18	95.789	-0.00272249	7.85182e-06
19	99.1342	-0.00377288	5.03733e-05
20	100.051	-0.00427194	5.98579e-05
21	99.1343	-0.00399251	4.8361e-05
22	99.2099	-0.00426886	4.78836e-05
23	99.6019	-0.00407383	3.86109e-05
24	99.9645	-0.00461704	5.33197e-05
25	98.7092	-0.00440979	3.91902e-05
26	100.775	-0.00416001	6.2126e-05
27	99.3643	-0.00397178	4.43273e-05
28	99.8181	-0.00397622	5.15282e-05
29	97.8789	-0.00332809	2.01511e-05
30	99.9657	-0.00359143	5.95054e-05
31	99.7239	-0.00366359	4.3584e-05
32	98.0351	-0.00356509	4.60719e-07
33	99.4801	-0.00364831	4.0398e-05
34	99.3881	-0.00371637	2.09242e-05
35	101.015	-0.00372339	5.36132e-05
36	98.1016	-0.00366948	0.766677
37	100.265	-0.00380836	5.16826e-05
38	84.1899	-0.00488329	15.3043
39	98.6384	-0.00380455	4.01091e-07
40	97.8206	-0.00349042	0.0308864
41	96.808	-0.00352197	2.07162e-06
42	86.4983	-0.00420312	11.2017
43	99.1538	-0.00374538	1.95099e-06
44	98.6514	-0.00371103	1.79772e-07
45	96.0939	-0.00402188	2.2359
46	87.9136	-0.00497247	12.1946
47	86.9237	-0.00479709	12.3982
48	97.3443	-0.00364544	2.5916e-07
49	92.823	-0.00404197	6.66571
50	72.8505	-0.00625032	24.4329
51	96.9279	-0.00346737	7.73055e-08
52	95.0006	-0.00369719	3.85976
53	83.6568	-0.00451389	15.1452
54	70.2157	-0.0064378	30.153
55	75.5933	-0.00561765	23.3705
56	75.558	-0.00589872	26.069
57	72.3298	-0.00582056	25.8846
58	70.319	-0.00644272	30.1952
59	73.4248	-0.00540184	25.6676
60	75.9223	-0.00532469	22.5712
61	90.9427	-0.00271026	1.37682e-07
62	75.5486	-0.00468108	23.8171
63	77.8982	-0.00465535	22.7054
64	78.8414	-0.00434455	20.5445
65	82.9688	-0.0039061	18.0106
66	89.8554	-0.00247545	2.51534e-08
67	77.6047	-0.00440715	21.8361
68	75.2323	-0.00463455	25.3975

Table 5: Calibration Constants for the U layer.

V-Strip	Parameter A	Parameter B	Parameter C
1	81.3251	0	0
2	93.8447	0	0
3	89.258	0	0
4	0	0	0
5	112.714	-0.0116148	0.000140092
6	108.147	-0.00753567	8.66376e-09
7	104.461	-0.00518872	2.50789e-06
8	45.7132	-0.0283992	67.1725
9	99.9987	-0.00409683	0.654341
10	103.367	-0.00490372	2.64129e-07
11	101.999	-0.00448106	8.5592e-06
12	101.161	-0.00434226	5.51421e-06
13	89.4121	-0.00480225	12.9398
14	98.3878	-0.00325741	0.624151
15	72.3921	-0.00538143	27.9022
16	98.7883	-0.00352409	6.08974e-08
17	99.6729	-0.00356374	3.38963e-07
18	100.02	-0.0036647	1.82501e-07
19	101.396	-0.00337965	3.62534e-08
20	89.5551	-0.00406814	10.8602
21	100.24	-0.00320595	3.83976e-07
22	79.997	-0.00447596	21.0638
23	79.5925	-0.00469138	21.4686
24	84.2625	-0.00430666	16.033
25	87.2411	-0.00406931	12.8588
26	99.4143	-0.00322608	2.38418e-06
27	99.0414	-0.00328074	2.68513e-08
28	90.6274	-0.00369328	9.22529
29	90.2512	-0.00396402	9.83799
30	81.0107	-0.00490791	20.333
31	80.4556	-0.00436419	18.046
32	95.7675	-0.0036954	5.01714
33	86.3945	-0.00415465	14.1529
34	81.9767	-0.00475111	18.6153
35	86.444	-0.00400936	13.1011
36	98.1088	-0.00321114	1.63514
37	91.1958	-0.00427169	8.74885
38	87.556	-0.00374749	10.6152
39	84.6679	-0.00480555	16.3922
40	86.1274	-0.00410958	13.1448
41	79.803	-0.00479862	21.4568
42	82.7876	-0.00421391	17.9667
43	77.6727	-0.00477563	24.3102
44	82.7088	-0.00433188	17.2481
45	81.0337	-0.00505961	20.0948
46	83.7595	-0.00407532	14.8532
47	81.9191	-0.00453048	18.6102
48	86.6122	-0.00409001	14.6335
49	84.7559	-0.00461439	16.8
50	84.9907	-0.00415237	16.3736
51	82.6795	-0.00486204	18.6174
52	85.7642	-0.00455222	15.118
53	85.23	-0.00445134	15.377
54	84.2234	-0.00451731	17.081
55	83.6998	-0.00428485	16.7591
56	84.6766	-0.00440632	14.549
57	84.574	-0.00386128	15.0527
58	86.9262	-0.00392846	12.2401
59	82.764	-0.00404404	15.0655
60	85.8456	-0.00382857	12.7791
61	84.1674	-0.00396819	15.3756
62	77.0637	-0.00309805	8.36148

Table 6: Calibration Constants for the V layer.

W-Strip	Parameter A	Parameter B	Parameter C
1	76.5834	0	0
2	94.6674	0	0
3	0	0	0
4	109.142	-0.0130086	0.00015922
5	107.035	-0.00894442	8.24225e-07
6	105.492	-0.00708408	1.33493e-05
7	96.1992	-0.00724769	11.9308
8	98.279	-0.00491833	1.82152
9	49.0971	-0.0127096	55.5526
10	94.9267	-0.00399965	5.86104
11	102.166	-0.00463505	7.03285e-06
12	102.1	-0.00427262	1.17733e-06
13	88.889	-0.00478508	12.4618
14	95.8496	-0.00374209	5.45295
15	77.3844	-0.00529214	25.067
16	100.583	-0.00404282	2.15117e-07
17	96.9804	-0.0038156	1.44707e-05
18	99.9379	-0.00396405	2.17298e-05
19	75.9695	-0.00514872	21.2028
20	71.233	-0.00617771	28.0456
21	77.7536	-0.00547851	23.1228
22	99.7207	-0.00369463	1.71972e-05
23	98.6427	-0.00343161	1.23854e-06
24	100.039	-0.00387015	3.2979e-06
25	82.408	-0.00501709	16.3269
26	99.6441	-0.00372218	1.05835e-07
27	93.5772	-0.00365972	5.49534
28	91.8945	-0.00409323	8.37447
29	86.8697	-0.00452968	14.2807
30	84.8415	-0.00458064	15.0535
31	79.2046	-0.00520979	22.875
32	77.2896	-0.00508816	23.2359
33	82.1087	-0.00533502	19.7361
34	89.4605	-0.00406	10.7605
35	88.6131	-0.00375663	10.4811
36	97.2606	-0.0033744	2.02937
37	86.0419	-0.00461505	14.1821
38	83.2823	-0.00477393	18.1849
39	80.9365	-0.00487184	19.3808
40	86.8735	-0.00415256	13.2762
41	86.8237	-0.00428351	14.3152
42	87.9619	-0.00388999	11.4198
43	83.4599	-0.00446605	16.7767
44	84.7084	-0.00409597	14.6483
45	85.7983	-0.00418715	14.7523
46	78.5469	-0.0046913	22.0838
47	80.8861	-0.00455342	19.7712
48	85.9249	-0.00390414	14.0986
49	84.238	-0.00427813	14.5056
50	80.7529	-0.00426804	18.3437
51	81.6971	-0.00434176	16.7262
52	73.9153	-0.00529965	27.8944
53	83.048	-0.00254593	7.55929e-09
54	81.2306	-0.00447303	18.2888
55	85.9745	-0.00421353	12.3989
56	80.6208	-0.00523589	22.6337
57	87.486	-0.00368434	9.59789
58	81.3392	-0.00504944	21.1264
59	86.0705	-0.00417194	12.3202
60	84.3917	-0.00441815	14.8435
61	77.2549	-0.0049831	23.2266
62	78.4089	-0.00232346	8.83974e-07

Table 7: Calibration Constants for the W layer.

9 Reproducibility

The attenuation coefficients found in the previous section is from the simulated events with given CCDB constants as input. One way to test the result is to compare the input and the output coefficients. However, the coefficents cannot be directly compared to one another as different coefficients can define the same exponential form (Eq. 8) reasonably. Therefore, the better way of comparison is to compare the exponential forms they define as a function of distance.

9.1 Without Iteration

Figure 9.1 shows the difference of the y values calculated from the generated and calculated coefficients for a given distance for the U-view. Similar plot for the V- and W-views are shown in Figures 9.2 and 9.3 respectively. It can be seen that the coefficients are reproduced within 5% for longer strips in each views. The shorter strips are not reproduced that well. One reason is very low number of events in each bin for short strips.

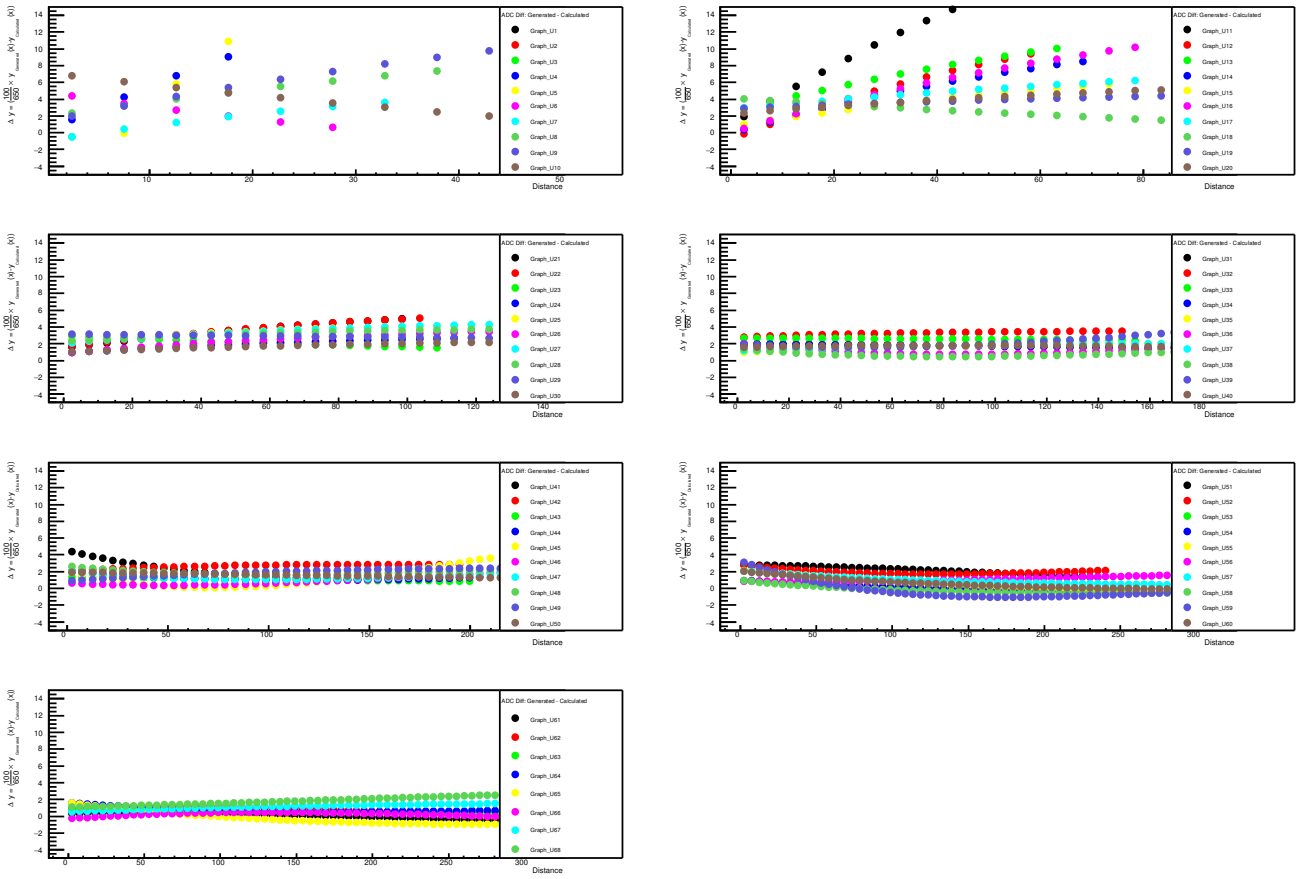


Figure 9.1: Shown is the difference of the generated and calculated attenuation curves as a function of distance for all U-strips

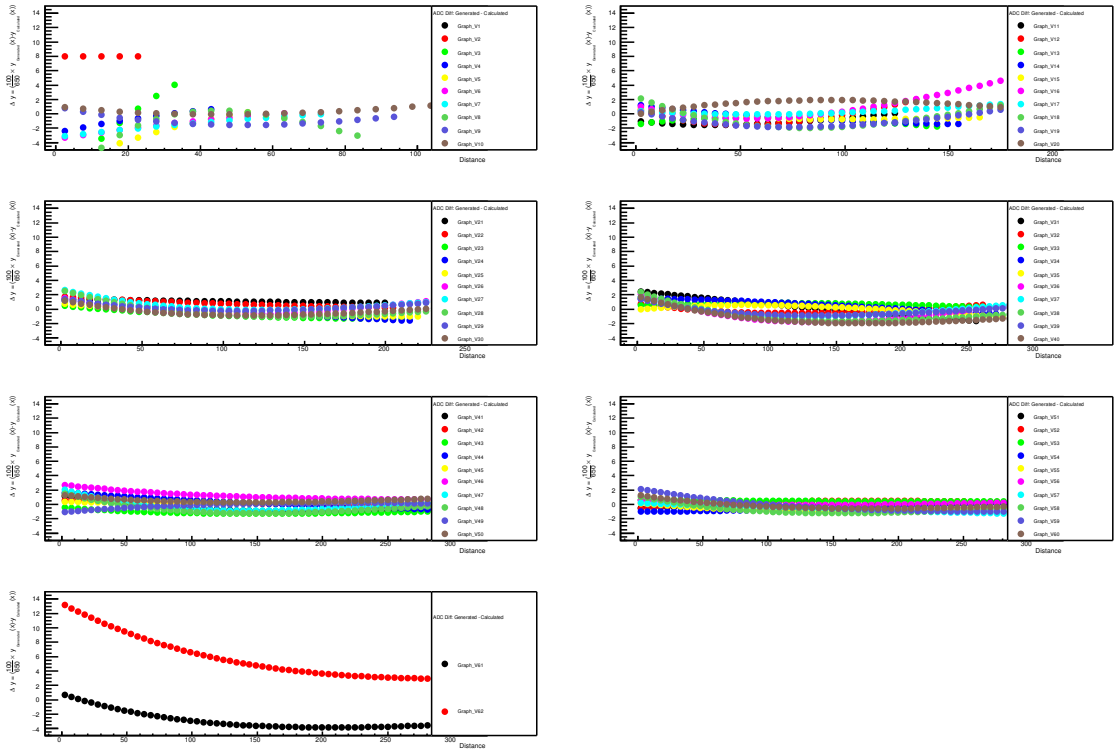


Figure 9.2: Shown is the difference of the generated and calculated attenuation curves as a function of distance for all V-strips

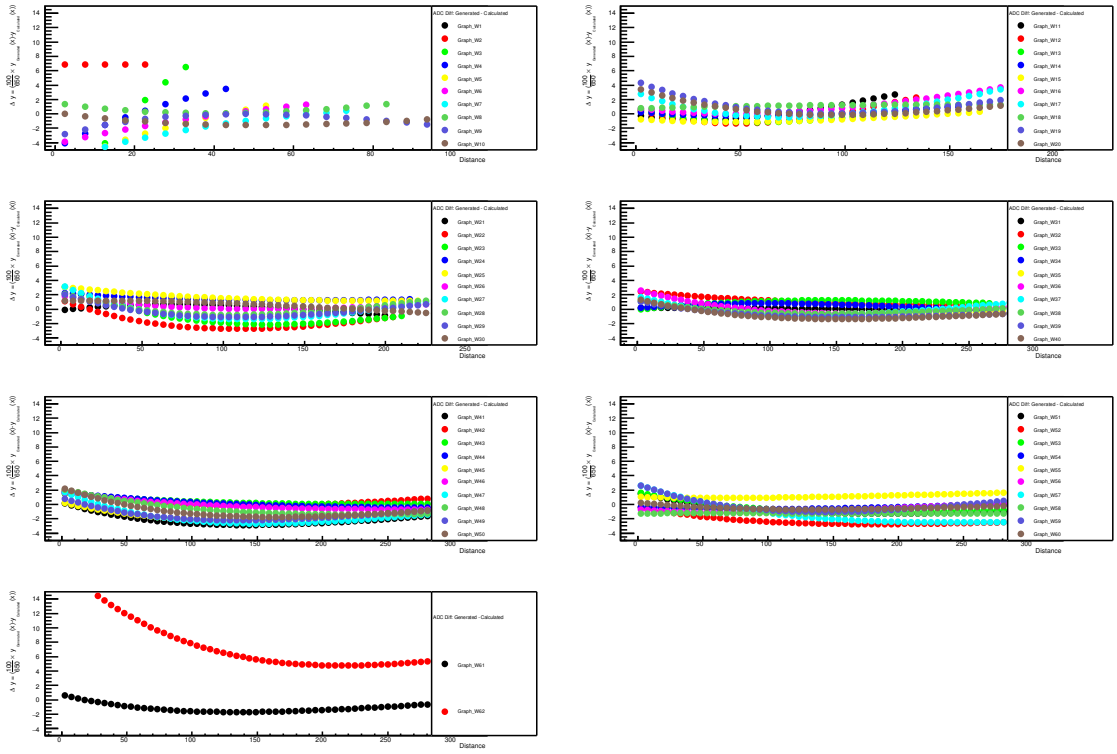
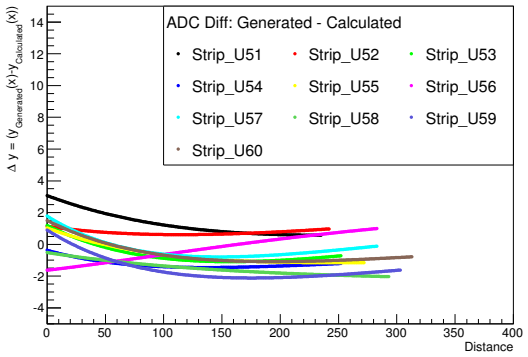


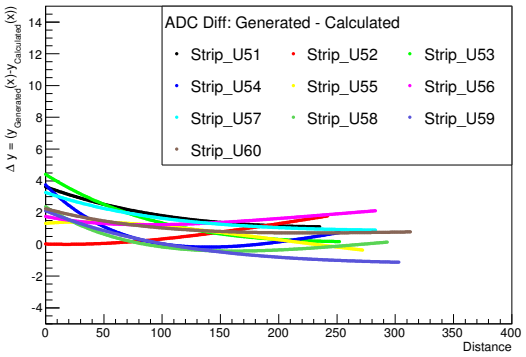
Figure 9.3: Shown is the difference of the generated and calculated attenuation curves as a function of distance for all W-strips

9.2 With Iteration

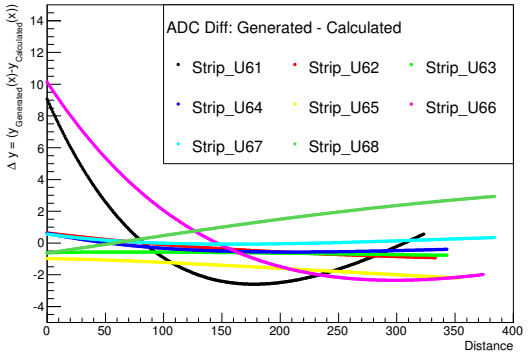
Another way to test the extracted calibration constants with respect to the generated coefficients is to compare results with and without iterations. The iterations are explained in Section 6.1. Figures 9.4-9.6 show the comparison. The plots on the left are without iterations while those on the right correspond to the coefficients produced from iterations. Comparisons of few longer strips for each view are only shown. The iterations are capable of reclaiming bad initial fits.



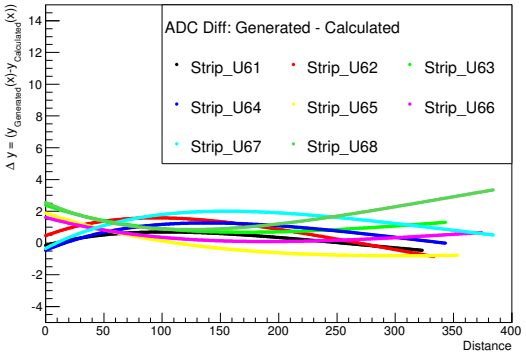
(a) diffU6mean



(b) diffU6root

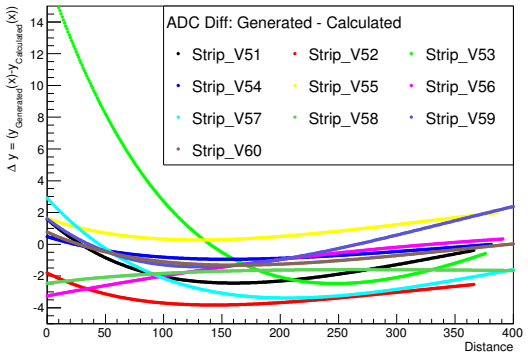


(c) diffU7mean

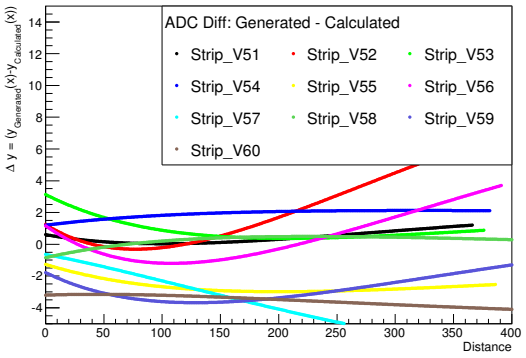


(d) diffU7root

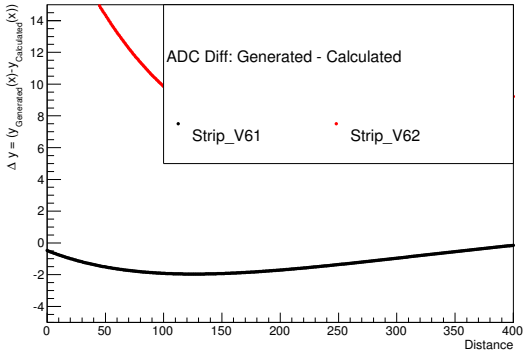
Figure 9.4: The plots on the left are based on coefficients extracted without any iteration while those on the right correspond to with iterations. U-strips 51-68 are compared.



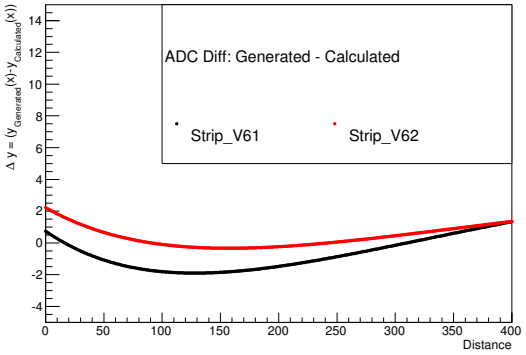
(a) diffV6mean



(b) diffV6root

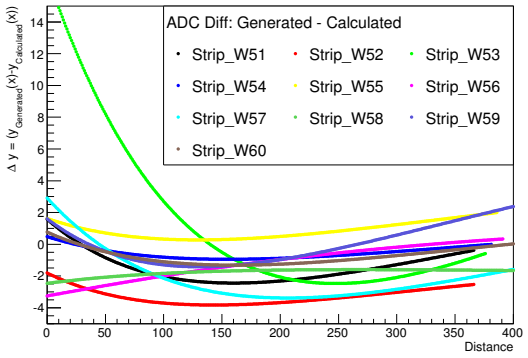


(c) diffV7mean

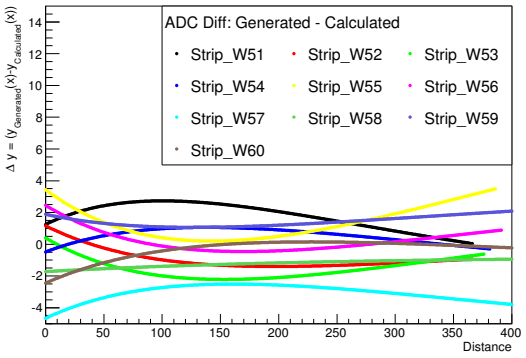


(d) diffV7root

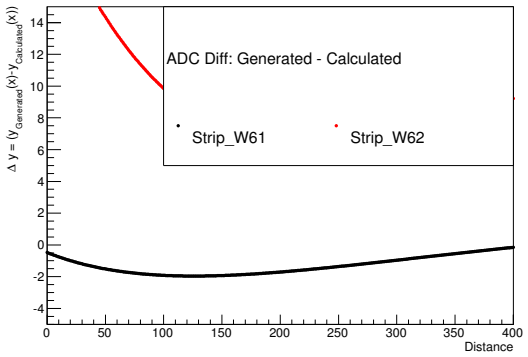
Figure 9.5: The plots on the left are based on coefficients extracted without any iteration while those on the right correspond to with iterations. V-strips 51-62 are compared.



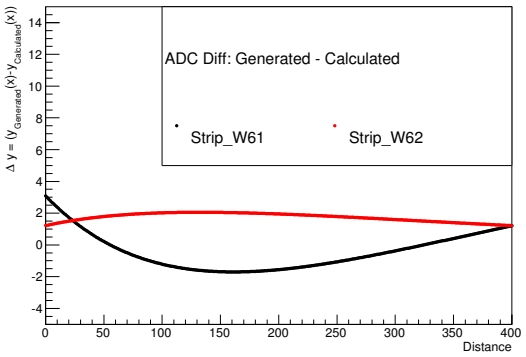
(a) diffW6mean



(b) diffW6root



(c) diffW7mean



(d) diffW7root

Figure 9.6: The plots on the left are based on coefficients extracted without any iteration while those on the right correspond to with iterations. W-strips 51-62 are compared.

10 Systematic Studies

Systematic uncertainties are discussed in this section. Variation in specific cuts may affect the result. Due to a large variation of statistical uncertainty involved in this analysis, a point to point systematic approach is not realistic. Therefore, an estimation on the systematic errors is made varying each cut and taking the average relative difference in the final result. The systematic uncertainty is quoted based as the shift of the average of the relative differences from zero. The average values are "Mean" values shown in the statistical box of each relative difference plot. The relative difference is given by

$$Relative\ Difference = \frac{R_{Nominal} - R_{variation}}{R_{Nominal}} \tag{9}$$

where $R_{Nominal}$ is the differential cross section quoted and $R_{variation}$ is the differential cross section (unless mentioned otherwise in the text) calculated by varying any specific cut. The systematic uncertainties are discussed in the following sections.

10.1 Fitting function

This includes the systematic effect based on different modules/sectors of the PCAL. The systematic studies are completed for all modules/sectors with their respective runs to analyze the effect upon switching to Landau function from Gaussian function to fit the signal.

Nominally, the ADC distribution is fit using a Gaussian function. The fit function was changed to a Landau function which also has three parameters similar to that of a Gaussian function. The events undergo similar fitting procedure after the centroids are extracted. Both sets of attenuation coefficients are then compared. As there are three coefficients, the gain $(A+C)$ is used to compare. An average systematic effect for this variation for all layers and all sectors is found to be $\sim 7\%$. For each module and layer, the systematic variation is summarized in Table **??**. For run 4416 (Module 6, Sector 5), the systematic variation for U-layer is shown in Fig. **??**.

Module	Sector	Run	Systematics U-strip (%)			Systematics V-strip (%)			Systematics W-strip (%)		
			run	average	U-strip	run	average	V-strip	run	average	W-strip
1	4	4103	1.64	1.76	3.92	1.76	6.69	10.35	29.44	21.56	7.24
		4108	1.89			12.95			13.68		
2	3	4167	9.66	9.66		36.17	36.17		13.61	13.61	
3	2	4250	6.31	6.31		16.95	16.95		2.47	2.47	
4	1	4285	2.90	2.21		0.17	0.32		3.00	2.20	
		4289	1.53			0.47			1.39		
5	6	4294	3.04	3.04		1.45	1.45		2.34	2.34	
6	5	4416	0.51	0.51		0.54	0.54		1.26	1.26	

Table 8: Sytematics for the attentuation co-efficients.

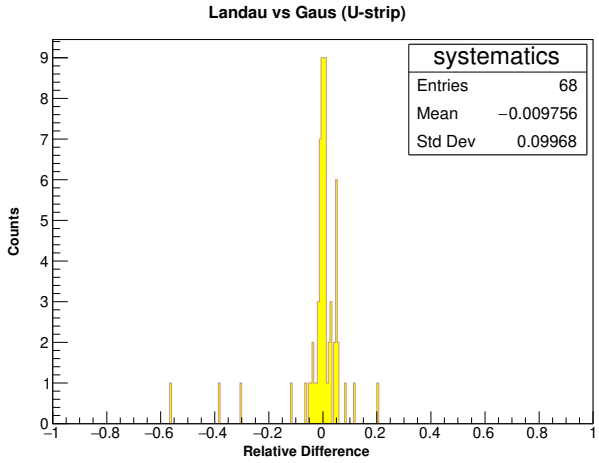


Figure 10.1: Shown in the systematic effect in the gain when using a Landau function over all passes relative to when using a Gaussian function for U-layers in run 4416.

11 Attenuation Tables

A complete list of all the calibration constants or attentuation co-efficients are outlined in the tables starting from module 1 to 6 for all run files. Each module has different run files to give different calibration constants and gain values. Module 1 (Sector 4) has two run files, 4103 and 4108. Similarly, Module 4 (Sector 1) runs two files, 4285 and 4289. The remaining modules, Module 2 (Sector 3), Module 3 (Sector 2), Module 5 (Sector 6) and Module 6 (Sector 5), have one run file each, 4167, 4205, 4294 and 4416, respectively. For each run file, tables with attenuation co-efficients for U, V and W strips are followed by the tables with gain for all three strips.

U-Strip	Parameter a	Parameter b	Parameter c
1	122.919	0	0
2	170.211	0	0
3	134.41	0	0
4	636.938	-0.009	0
5	538.232	-0.009	1.64457e-06
6	200	-0.0005	262.637
7	200	-0.0005	164.737
8	379.842	-0.009	2.98428e-10
9	497.1	-0.009	3.65389e-07
10	343.835	-0.009	2.84148e-09
11	312.303	-0.009	1.48162e-08
12	382.428	-0.009	1.46257e-08
13	200	-0.00251878	1.56529e-08
14	200	-0.0005	169.104
15	313.186	-0.009	1.20941e-07
16	477.021	-0.009	1.17817e-07
17	599.937	-0.009	8.32089e-09
18	546.97	-0.009	1.41572e-08
19	404.648	-0.009	1.44318e-10
20	200	-0.0005	88.5146
21	200	-0.0005	193.11
22	588.217	-0.009	3.59823e-11
23	619.742	-0.009	2.70314e-08
24	389.67	-0.009	167.58
25	200	-0.0005	163.247
26	607.979	-0.009	3.80002e-09
27	492.374	-0.009	111.779
28	652.037	-0.009	1.32103e-06
29	316.124	-0.009	242.654
30	650.022	-0.00523806	2.66878e-08
31	633.879	-0.00796825	1.4336e-06
32	200	-0.0005	169.514
33	736.983	-0.009	6.87175e-07
34	420.706	-0.009	207.207
35	499.938	-0.0020609	5.61255e-06
36	554.087	-0.00327593	1.0091e-09
37	643.934	-0.00388434	5.43388e-10
38	586.879	-0.00403669	6.24297e-09
39	590.012	-0.00352399	8.00508e-07
40	502.916	-0.00545295	81.1385
41	484.107	-0.00546465	103.657
42	649.429	-0.009	36.9958
43	607.301	-0.00386563	2.68119e-09
44	584.986	-0.00367039	3.81919e-07
45	406.447	-0.009	211.783
46	436.438	-0.00694662	163.005
47	581.851	-0.0037314	5.20197e-07
48	529.846	-0.0038352	2.23485e-06
49	588.834	-0.003449	6.80012e-12
50	429.14	-0.00668199	193.774
51	428.968	-0.00703646	189.579
52	514.185	-0.0056529	138.219
53	468.638	-0.00575677	144.055
54	507.678	-0.00494635	111.451
55	459.58	-0.00555016	129.946
56	444.378	-0.00826014	222.978
57	334.845	-0.009	256.869
58	308.021	-0.009	268.212
59	291.445	-0.009	293.055
60	339.499	-0.009	289.448
61	389.202	-0.00683806	236.559
62	221.645	-0.009	329.138
63	234.622	-0.009	331.453
64	409.819	-0.00467626	204.614
65	434.932	-0.00532401	212.368
66	462.129	-0.0047376	211.515
67	434.272	-0.00531021	233.238
68	429.352	-0.00447256	177.397

Table 9: Calibration Constants for Module 1 (Sector 4), run 4103, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	721.712	0	0
2	688.145	0	0
3	669.612	-0.009	0
4	702.387	-0.00833129	0.00208185
5	634.601	-0.00592179	0.000143512
6	294.523	-0.009	364.599
7	419.932	-0.00887951	247.011
8	288.797	-0.009	378.556
9	247.065	-0.009	392.266
10	256.083	-0.009	393.87
11	337.366	-0.009	309.14
12	724.169	-0.009	1.37957e-09
13	0	0	0
14	790.996	-0.00623021	5.04187e-08
15	389.412	-0.00766484	286.259
16	447.905	-0.00475777	219.696
17	200	-0.0005	272.667
18	679.321	-0.00338733	3.70535e-07
19	626.44	-0.00271378	4.60523e-08
20	640.943	-0.00257519	6.60412e-06
21	619.976	-0.00522484	2.54537e-05
22	638.817	-0.00264483	2.83097e-07
23	330.172	-0.00803744	325.128
24	900	-0.009	28.5122
25	900	-0.009	142.777
26	900	-0.009	57.5868
27	502.654	-0.009	117.063
28	900	-0.009	71.5666
29	200	-0.0005	242.385
30	499.55	-0.00321249	114.187
31	472.167	-0.00332002	147.06
32	740.569	-0.009	105.17
33	728.693	-0.00396597	8.24451e-08
34	613.404	-0.00287418	7.35164e-07
35	618.249	-0.00328545	9.45962e-09
36	517.185	-0.00256241	3.32563e-06
37	900	-0.009	60.6102
38	900	-0.009	75.6021
39	668.812	-0.00377814	1.10815e-09
40	595.781	-0.00307427	1.73931e-09
41	471.192	-0.00345981	8.34379e-07
42	771.199	-0.009	95.885
43	712.64	-0.00360942	2.85527e-10
44	504.661	-0.00414149	6.95722e-09
45	281.254	-0.00345844	5.32433
46	643.982	-0.00338139	7.47274e-10
47	216.969	-0.00389014	15.2388
48	511.946	-0.00617187	59.2696
49	695.483	-0.009	96.8114
50	454.592	-0.00509546	44.941
51	505.219	-0.00446108	10.8093
52	477.181	-0.00505983	36.0631
53	540.662	-0.00448072	8.00055e-09
54	493.471	-0.00602185	58.6526
55	603.9	-0.00687467	63.3494
56	488.022	-0.00529448	38.976
57	479.215	-0.00508524	40.0499
58	371.612	-0.00543032	49.2879
59	440.89	-0.00549248	49.9105
60	348.798	-0.00576967	67.5463
61	331.62	-0.00710202	77.3937
62	661.879	-0.00506947	126.243

Table 10: Calibration Constants for Module 1 (Sector 4), run 4103, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	100	0	0
2	153.059	0	0
3	234.242	-0.009	0
4	238.387	-0.009	2.3695e-07
5	244.004	-0.009	2.13188e-08
6	200	-0.0073104	48.4674
7	200.001	-0.00625744	105.239
8	200	-0.0062554	95.9087
9	215.738	-0.009	146.661
10	279.316	-0.009	161.298
11	737.347	-0.009	1.18033e-08
12	209.873	-0.009	162.405
13	228.721	-0.00354697	1.45925e-07
14	266.376	-0.00342787	4.68197e-08
15	582.158	-0.00387303	2.66805e-05
16	433.923	-0.00493116	131.061
17	664.935	-0.00450098	9.56624e-08
18	624.029	-0.00372951	7.96718e-07
19	577.703	-0.00318365	2.57077e-05
20	390.865	-0.00400947	1.38893e-09
21	605.036	-0.00346134	4.91876e-06
22	643.931	-0.00297016	7.63712e-06
23	563.762	-0.00280454	1.87505e-07
24	401.297	-0.00309037	1.54905e-06
25	612.286	-0.00329452	1.10818e-05
26	596.098	-0.00306233	4.2817e-06
27	564.301	-0.00279965	7.55089e-07
28	200	-0.0040586	54.2147
29	505.871	-0.00313302	2.01627e-05
30	900	-0.009	63.8264
31	322.261	-0.00359346	24.4391
32	609.453	-0.00333409	3.83943e-07
33	594.897	-0.00344158	22.5944
34	579.898	-0.00231484	1.06355e-06
35	458.857	-0.0044528	77.8388
36	399.429	-0.00582731	157.807
37	200	-0.009	49.6128
38	421.394	-0.00456611	134.548
39	484.138	-0.00507459	110.956
40	583.452	-0.00354279	4.85929e-07
41	566.237	-0.00415224	63.7083
42	664.576	-0.00341765	7.02217e-08
43	659.615	-0.00325873	5.60832e-08
44	210.031	-0.00754509	142.303
45	250.381	-0.00545277	105.081
46	603.651	-0.00315088	23.8037
47	663.001	-0.00390872	1.47578e-08
48	672.98	-0.00370536	2.37194e-07
49	579.404	-0.00346268	4.61473e-08
50	610.141	-0.00328729	4.20661e-08
51	618.714	-0.00357835	3.00507e-09
52	776.823	-0.009	41.0151
53	594.703	-0.00316763	2.90679e-07
54	569.717	-0.00320478	7.38687e-10
55	543.709	-0.00329961	4.23843e-08
56	574.331	-0.00308953	74.4554
57	609.224	-0.0031328	7.53064e-11
58	675.91	-0.00321222	1.40277e-11
59	610.831	-0.00326458	1.58085e-09
60	558.451	-0.00362162	6.13176e-11
61	890.876	-0.009	85.3766
62	349.985	-0.00180254	9.02455e-07

Table 11: Calibration Constants for Module 1 (Sector 4), run 4103, for the W layer.

U-Strip	Gain
1	1
2	3.81879
3	4.83594
4	2.91286
5	3.43911
6	3.63298
7	4.82627
8	1
9	3.65488
10	1
11	1
12	4.9521
13	1
14	4.46197
15	1
16	4.02406
17	3.36795
18	3.50586
19	4.86641
20	1
21	1
22	3.45526
23	3.19184
24	3.4239
25	1
26	3.20661
27	3.02631
28	3.23985
29	3.50609
30	3.18651
31	3.04769
32	1
33	2.68237
34	3.22264
35	4.08461
36	3.66181
37	3.21601
38	3.206
39	3.44208
40	3.23465
41	3.24525
42	2.84919
43	3.16476
44	3.10894
45	3.11703
46	3.29504
47	3.25768
48	3.987
49	3.39002
50	3.08467
51	2.97364
52	3.19168
53	3.00106
54	3.11819
55	3.21882
56	2.95675
57	2.95326
58	3.01392
59	3.061
60	2.97423
61	3.02203
62	3.04216
63	3.14504
64	3.12582
65	3.01092
66	3.0842
67	2.95239
68	2.70132

(a) Gains for the U layer.

V-Strip	Gain
1	3.47703
2	2.84451
3	2.95879
4	2.82315
5	2.98264
6	3.12223
7	3.01069
8	3.11587
9	3.14962
10	3.13113
11	3.0073
12	2.77256
13	1
14	2.64809
15	3.00291
16	3.16427
17	4.46934
18	3.03055
19	3.08713
20	3.15771
21	3.14581
22	3.07285
23	3.02816
24	1.52845
25	1.37937
26	1.48126
27	2.35661
28	1.42363
29	4.42301
30	3.26498
31	3.41153
32	1.70937
33	2.72648
34	3.27334
35	3.17678
36	3.20314
37	1.57908
38	1.50941
39	3.00326
40	3.12431
41	2.98599
42	1.6979
43	2.96433
44	2.94073
45	3.02475
46	3.11073
47	3.14928
48	2.66121
49	1.88076
50	3.0029
51	2.93165
52	2.94277
53	2.84107
54	2.75406
55	2.27261
56	2.86452
57	2.91202
58	2.85741
59	2.84149
60	2.78951
61	2.57193
62	2.49442

(b) Gains for the V layer.

W-Strip	Gain
1	1
2	4.24673
3	2.77491
4	2.72666
5	2.66389
6	2.61604
7	2.9901
8	2.94595
9	2.96998
10	2.81373
11	1.80932
12	2.87777
13	3.01098
14	3.04083
15	2.99707
16	3.10269
17	3.06057
18	3.07685
19	3.16351
20	2.99682
21	3.11864
22	2.94609
23	3.30204
24	3.08613
25	3.08863
26	3.10163
27	3.59663
28	3.0056
29	3.27932
30	1.5749
31	3.13959
32	3.55845
33	3.38057
34	3.31071
35	3.30424
36	3.22506
37	1.79788
38	3.14317
39	3.18239
40	3.25527
41	3.14052
42	3.11249
43	3.17459
44	2.9689
45	2.99289
46	3.14517
47	2.79994
48	3.1107
49	3.14789
50	3.2324
51	3.11499
52	2.18463
53	2.99545
54	3.03174
55	3.05023
56	2.44198
57	2.9599
58	2.85447
59	2.92453
60	2.4382
61	1.45023
62	2.35691

(c) Gains for the W layer.

Table 12: Preliminary Gains for Module 1 (Sector 4), run 4103

U-Strip	Parameter a	Parameter b	Parameter c
1	143.835	0	0
2	523.036	0	0
3	480.933	-0.0005	0
4	299.297	-0.009	0
5	200.024	-0.0005	17.2218
6	200	-0.0005	132.482
7	557.429	-0.009	3.19175e-08
8	200	-0.0005	287.046
9	440.838	-0.009	1.10278e-10
10	530.619	-0.009	2.79388e-08
11	326.277	-0.009	1.05965e-10
12	449.886	-0.009	1.19887e-08
13	460.927	-0.009	1.82321e-10
14	369.278	-0.009	1.17926e-09
15	318.954	-0.00846496	7.71819e-05
16	626.05	-0.009	4.76047e-10
17	513.384	-0.009	6.18616e-11
18	200	-0.0005	194.585
19	574.29	-0.009	9.64101e-10
20	693.588	-0.009	7.87498e-08
21	501.034	-0.009	1.09501e-10
22	628.354	-0.009	5.25368e-08
23	200	-0.0005	106.619
24	218.034	-0.009	331.531
25	704.809	-0.00645322	3.70613e-07
26	586.709	-0.00387375	2.29543e-06
27	219.938	-0.009	225.38
28	651.733	-0.009	2.26413e-08
29	759.171	-0.009	1.64765e-09
30	584.146	-0.009	181.934
31	351.866	-0.009	272.827
32	323.605	-0.009	294.144
33	761.836	-0.009	1.07508e-09
34	729.04	-0.009	5.71093e-09
35	343.407	-0.00843989	259.231
36	613.001	-0.00449851	6.33153e-07
37	528.301	-0.00339273	3.30561e-06
38	621.286	-0.00443757	8.31238e-09
39	433.052	-0.009	269.706
40	649.065	-0.00472175	8.97824e-08
41	639.129	-0.00474603	3.66629e-07
42	829.943	-0.00835753	8.64959e-09
43	614.929	-0.00414999	3.40335e-07
44	597.928	-0.00402958	2.6364e-06
45	493.062	-0.00562377	121.047
46	436.856	-0.00822734	197.862
47	415.468	-0.009	225.913
48	452.524	-0.00819704	205.03
49	315.083	-0.009	242.625
50	420.094	-0.00870093	253.266
51	394.26	-0.009	244.082
52	395.638	-0.0087492	237.509
53	607.254	-0.00346527	1.84569e-06
54	447.933	-0.00679573	204.688
55	475.048	-0.00620687	169.678
56	427.92	-0.00778427	229.213
57	365.618	-0.00888713	267.291
58	351.937	-0.009	273.142
59	356.925	-0.00856824	281.053
60	468.722	-0.00427971	133.734
61	718.507	-0.009	107.514
62	449.906	-0.00468636	212.094
63	454.016	-0.00407119	154.15
64	421.075	-0.00485588	227.233
65	534.139	-0.00327026	68.1576
66	642.115	-0.00337631	9.01501e-11
67	552.732	-0.00236193	4.52488e-07
68	598.553	-0.00232345	18.6094

Table 13: Calibration Constants for Module 1 (Sector 4), run 4108, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	643.381	0	0
2	654.699	0	0
3	691.369	-0.009	0
4	697.255	-0.009	3.7912e-08
5	642.514	-0.009	2.22206e-08
6	646.652	-0.009	0.000180075
7	585.804	-0.009	95.3576
8	900	-0.009	180.983
9	453.745	-0.009	210.924
10	392.326	-0.009	239.799
11	356.776	-0.009	224.214
12	358.05	-0.009	257.872
13	417.925	-0.009	240.99
14	378.902	-0.009	268.004
15	382.811	-0.009	276.085
16	301.703	-0.009	302.578
17	228.089	-0.009	339.732
18	241.368	-0.00868235	352.328
19	507.924	-0.00242882	6.81543e-06
20	408.689	-0.00442566	213.212
21	345.887	-0.00318034	98.9582
22	900	-0.009	134.168
23	900	-0.009	146.499
24	900	-0.009	59.6248
25	429.268	-0.00235161	1.0209e-07
26	243.661	-0.00342341	201.68
27	900	-0.009	176.289
28	518.291	-0.00201728	4.71936e-08
29	284.765	-0.009	272.048
30	359.204	-0.009	296.754
31	432.516	-0.00325907	137.063
32	342.713	-0.00291617	123.449
33	442.971	-0.00307829	95.7587
34	579.116	-0.00276474	4.8772e-09
35	550.12	-0.00293216	2.50608e-07
36	572.083	-0.00290748	7.34693e-07
37	863.922	-0.009	79.9638
38	326.015	-0.00319228	33.2891
39	398.052	-0.00288368	2.1835e-06
40	674.768	-0.00375798	1.55431e-13
41	341.598	-0.00189925	1.32185e-08
42	672.417	-0.00334483	1.94662e-09
43	721.41	-0.00415344	2.5045e-09
44	653.113	-0.0032662	3.74824e-07
45	706.158	-0.0037053	4.23308e-07
46	437.149	-0.00613031	80.5674
47	433.444	-0.00476978	1.08678e-07
48	531.51	-0.00388482	76.4718
49	708.373	-0.00389859	1.65183e-07
50	429.984	-0.00548643	68.1921
51	600.799	-0.0033113	1.46675e-07
52	271.703	-0.00385337	61.747
53	782.718	-0.00426289	4.18664e-08
54	684.559	-0.00375141	9.51142e-09
55	294.48	-0.00344461	6.04603
56	700.575	-0.00383927	6.27091e-08
57	255.121	-0.00438687	55.1511
58	223.885	-0.00431944	42.3133
59	296.765	-0.00429595	42.6211
60	232.622	-0.00348821	28.4694
61	248.44	-0.00393876	25.5028
62	522.423	-0.00552146	171.298

Table 14: Calibration Constants for Module 1 (Sector 4), run 4108, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	100.749	0	0
2	293.003	0	0
3	900	-0.009	0
4	719.463	-0.009	0
5	617.917	-0.009	1.06456e-08
6	557.431	-0.009	1.09863e-06
7	561.214	-0.00301226	0.000297266
8	507.9	-0.00171322	0.123464
9	702.932	-0.009	2.52856e-05
10	512.385	-0.009	4.44513e-07
11	411.77	-0.00401682	1.91188e-06
12	406.866	-0.00410644	6.31447e-07
13	900	-0.009	35.0441
14	342.503	-0.00697382	193.744
15	900	-0.009	137.108
16	576.87	-0.00322663	0.000161216
17	900	-0.009	90.9112
18	264.248	-0.009	257.952
19	405.525	-0.005441	186.012
20	614.564	-0.00352483	3.34494e-07
21	383.014	-0.00573746	161.66
22	373.409	-0.00381054	90.2539
23	537.244	-0.00364829	68.7928
24	371.079	-0.006491	182.762
25	900	-0.00886881	119.728
26	900	-0.00891164	79.0437
27	445.686	-0.0036765	33.3837
28	900	-0.009	92.0292
29	900	-0.009	79.2775
30	784.679	-0.009	98.5903
31	670.316	-0.009	136.537
32	472.91	-0.00285111	47.4468
33	392.224	-0.00493975	111.597
34	407.186	-0.00439527	93.7536
35	500.285	-0.00306952	4.1789e-08
36	463.001	-0.00401282	116.796
37	530.547	-0.00276338	6.81561e-08
38	243.604	-0.00535931	203.005
39	515.732	-0.00375221	4.66294e-13
40	504.706	-0.00349874	8.77689e-08
41	583.052	-0.00359822	2.33147e-13
42	560.2	-0.00360053	2.38971e-08
43	624.973	-0.00324374	15.4546
44	882.48	-0.009	64.5712
45	560.997	-0.00341581	3.26794e-10
46	525.758	-0.00341288	2.20895e-09
47	641.943	-0.00321396	5.82867e-12
48	746.637	-0.00458177	9.92972e-10
49	494.623	-0.0034812	2.4907e-07
50	579.795	-0.00352952	1.58011e-08
51	633.978	-0.00331733	1.2722e-10
52	605.355	-0.00309428	2.62795e-10
53	619.443	-0.00348782	1.18661e-08
54	600.224	-0.00341956	2.30319e-07
55	610.382	-0.00346158	6.27903e-10
56	543.785	-0.0028682	1.25705e-09
57	900	-0.00751866	77.6103
58	674.54	-0.00318577	3.66013e-08
59	637.56	-0.00327993	7.2326e-10
60	626.508	-0.00337474	1.11469e-08
61	596.866	-0.00310263	3.06977e-12
62	627.843	-0.003355	6.1679e-10

Table 15: Calibration Constants for Module 1 (Sector 4), run 4108, for the W layer.

U-Strip	Gain
1	4.51908
2	1
3	3.10899
4	1
5	1
6	1
7	3.25252
8	3.94487
9	4.2401
10	3.71641
11	1
12	4.69563
13	3.70581
14	4.83512
15	1
16	3.17234
17	3.15672
18	1
19	3.67845
20	3.04576
21	4.11963
22	2.95227
23	1
24	3.84394
25	3.21139
26	3.60061
27	3.44642
28	3.05553
29	2.67706
30	3.11714
31	3.11791
32	3.21789
33	2.71413
34	2.74659
35	3.2355
36	3.21822
37	3.69162
38	2.96307
39	2.84652
40	2.94528
41	3.00281
42	2.29152
43	3.10857
44	2.9961
45	2.98439
46	2.87728
47	2.92845
48	2.93576
49	3.39359
50	2.92384
51	2.75993
52	2.90355
53	3.03064
54	2.99622
55	3.00891
56	2.96358
57	2.89249
58	2.91648
59	2.94334
60	3.0845
61	1.77394
62	3.03415
63	3.07948
64	3.00524
65	3.05104
66	2.95896
67	3.36045
68	2.79868

(a) Gains for the U layer.

V-Strip	Gain
1	3.60716
2	2.60454
3	2.52465
4	2.4809
5	2.50434
6	2.36951
7	2.616
8	1.37382
9	2.6187
10	2.68837
11	2.77923
12	2.69826
13	2.61871
14	2.65985
15	2.73353
16	2.84599
17	3.09028
18	3.0217
19	2.95951
20	3.1127
21	3.08993
22	1.35753
23	1.37262
24	1.81067
25	3.05702
26	3.11472
27	1.61739
28	3.0718
29	3.04913
30	2.87712
31	3.17109
32	3.12622
33	3.20516
34	3.20015
35	3.14863
36	3.04497
37	1.54976
38	3.18984
39	3.22542
40	2.78959
41	3.32834
42	2.94402
43	2.72751
44	2.99794
45	3.0196
46	2.82043
47	2.87516
48	3.11671
49	2.79597
50	2.89624
51	3.14847
52	3.13501
53	2.89625
54	3.00618
55	3.14991
56	2.98841
57	3.2036
58	3.15787
59	3.14735
60	3.25835
61	3.23047
62	2.77094

(b) Gains for the V layer.

W-Strip	Gain
1	1
2	1
3	3.47229
4	2.76516
5	2.90499
6	1.94185
7	3.12662
8	3.4412
9	2.37837
10	2.3941
11	2.90791
12	2.847
13	1.93018
14	2.82682
15	1.69587
16	3.09007
17	1.58958
18	2.83461
19	2.98676
20	2.95963
21	2.8933
22	2.7974
23	2.90325
24	2.89172
25	1.59593
26	1.36143
27	3.14634
28	1.47922
29	1.55877
30	1.70421
31	1.9377
32	3.66876
33	3.19237
34	3.02719
35	3.3262
36	3.158
37	3.15144
38	3.09486
39	3.10345
40	3.1168
41	3.09749
42	3.03981
43	3.15333
44	1.44136
45	2.93659
46	2.85255
47	3.12865
48	2.56826
49	2.97699
50	2.89976
51	3.03284
52	3.46208
53	2.6833
54	2.85716
55	2.84134
56	2.17425
57	1.44334
58	2.7371
59	2.75463
60	2.51837
61	2.94775
62	2.0396

(c) Gains for the W layer.

Table 16: Preliminary Gains for Module 1 (Sector 4), run 4108

U-Strip	Parameter a	Parameter b	Parameter c
1	100	0	0
2	106.015	0	0
3	200	-0.009	0
4	222.547	-0.009	0
5	200	-0.009	7.91223e-10
6	200	-0.009	1.29707e-10
7	200	-0.009	1.06498e-09
8	207.471	-0.009	1.21817e-07
9	200	-0.00568862	4.59649e-10
10	727.444	-0.009	6.80584e-08
11	200	-0.00383487	8.74842e-08
12	200	-0.0005	308.883
13	200.001	-0.0005	223.84
14	644.778	-0.0065943	6.822e-06
15	678.402	-0.00219688	2.94698e-08
16	686.409	-0.009	2.08889e-07
17	475.505	-0.00555936	166.709
18	503.46	-0.00430446	1.45817e-05
19	300.242	-0.009	292.576
20	519.511	-0.00301526	5.33278e-07
21	566.876	-0.00212009	1.49976e-06
22	534.572	-0.00615942	155.731
23	633.631	-0.00285646	2.23599e-09
24	801.633	-0.00802202	7.73892e-10
25	623.872	-0.00342762	1.06249e-05
26	598.956	-0.00255051	7.92842e-06
27	324.217	-0.00697475	259.627
28	280.375	-0.009	332.891
29	592.54	-0.0031876	2.81706e-06
30	553.109	-0.00285859	1.03373e-05
31	495.812	-0.00364553	1.01768e-05
32	560.869	-0.00410755	9.86002e-08
33	594.736	-0.00343421	8.89715e-07
34	764.915	-0.00721763	5.15844e-08
35	417.546	-0.00524939	179.691
36	368.841	-0.00649767	201.866
37	354.789	-0.009	255.756
38	364.066	-0.00682907	205.109
39	366.285	-0.00809671	239.497
40	601.04	-0.00409142	8.77977e-09
41	620.856	-0.00363532	7.21858e-08
42	456.083	-0.00612037	161.439
43	503.658	-0.00584428	126.314
44	494.508	-0.00361799	7.70892e-08
45	388.672	-0.009	244.912
46	512.74	-0.00302008	5.85754e-09
47	751.816	-0.009	2.0754e-07
48	471.791	-0.00501251	47.3784
49	432.869	-0.00397653	99.2629
50	366.1	-0.00727868	209.41
51	346.12	-0.00609262	172.808
52	347.914	-0.00588884	158.8
53	314.233	-0.00600732	168.396
54	281.067	-0.009	227.58
55	331.63	-0.00783946	202.07
56	353	-0.00508272	114.267
57	313.787	-0.009	245.757
58	368.713	-0.00872115	257.219
59	311.56	-0.009	240.013
60	324.432	-0.009	222.062
61	299.173	-0.00838666	240.557
62	306.996	-0.00828553	267.27
63	300.977	-0.009	284.533
64	370.911	-0.00565648	216.91
65	369.572	-0.00546778	225.382
66	375.714	-0.00695281	250.178
67	549.579	-0.00264292	1.78224e-08
68	342.417	-0.00706987	262.465

Table 17: Calibration Constants for Module 2 (Sector 3), run 4167, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	100	0	0
2	623.449	0	0
3	313.057	-0.0005	0
4	472.46	-0.009	6.23833e-07
5	638.967	-0.009	4.51858e-09
6	612.949	-0.009	1.28176e-06
7	301.495	-0.00899995	312.318
8	423.791	-0.009	219.003
9	293.3	-0.009	341.37
10	320.743	-0.009	308.421
11	624.007	-0.00481531	1.09566e-05
12	416.401	-0.009	233.579
13	422.961	-0.009	251.939
14	303.996	-0.009	255.661
15	399.514	-0.0064604	197.014
16	541.271	-0.00421944	29.7844
17	200	-0.0005	298.812
18	295.048	-0.00773128	236.898
19	329.568	-0.009	187.559
20	480.42	-0.00477516	108.525
21	518.094	-0.009	226.994
22	374.485	-0.009	156.83
23	361.452	-0.00779841	147.344
24	368.968	-0.009	222.17
25	420.157	-0.00342195	6.90356e-05
26	414.605	-0.00812132	235.705
27	527.552	-0.00496323	124.549
28	534.838	-0.00425766	82.3235
29	501.185	-0.00409156	1.73482e-07
30	462.499	-0.00413767	108.505
31	610.064	-0.0033456	1.38944e-06
32	351.475	-0.00495086	97.2416
33	372.414	-0.00340461	12.1861
34	511.572	-0.00422503	3.25112e-09
35	488.839	-0.00420475	3.48283e-10
36	513.866	-0.00426976	9.24019e-08
37	580.7	-0.00315053	4.85565e-07
38	485.621	-0.00542479	42.744
39	476.351	-0.00428617	5.21666e-10
40	501.72	-0.00732616	171.668
41	514.221	-0.00398234	8.97105e-07
42	480.121	-0.0056927	159.797
43	372.779	-0.00382615	64.749
44	457.354	-0.00321157	6.44081e-07
45	452.642	-0.00418941	2.2911e-09
46	486.807	-0.00415953	1.99496e-10
47	561.894	-0.00270574	2.36851e-08
48	381.406	-0.0052281	105.898
49	501.106	-0.00449436	9.37482
50	467.457	-0.00409336	5.98566e-10
51	412.631	-0.0047145	98.6027
52	462.226	-0.00364707	27.8252
53	306.022	-0.00309774	1.3967e-07
54	559.854	-0.00345255	29.062
55	380.194	-0.00384931	1.14418e-06
56	662.403	-0.00338031	5.95084e-07
57	396.163	-0.00398316	2.4037
58	243.044	-0.00371007	11.7261
59	426.747	-0.00474235	21.8144
60	242.13	-0.00408511	32.6531
61	370.848	-0.00438518	23.9245
62	718.602	-0.00746355	172.774

Table 18: Calibration Constants for Module 2 (Sector 3), run 4167, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	138.864	0	0
2	862.864	0	0
3	866.991	0	0
4	593.842	-0.0005	0
5	577.956	-0.009	9.36473e-12
6	663.963	-0.00680358	0.000885092
7	900	-0.009	104.303
8	546.322	-0.00371961	0.000195832
9	200	-0.0005	318.564
10	511.012	-0.00209622	0.000150996
11	900	-0.009	1.79324e-08
12	900	-0.009	14.9514
13	900	-0.00721659	4.47035
14	588.429	-0.009	1.91103e-10
15	757.936	-0.009	1.20778e-07
16	565.189	-0.009	44.172
17	646.26	-0.00622467	6.87096e-06
18	649.333	-0.00452579	2.81504e-07
19	772.417	-0.00517187	2.04365e-09
20	689.813	-0.00422365	2.25813e-06
21	900	-0.009	131.821
22	682.062	-0.00478347	9.32587e-13
23	673.028	-0.00413934	1.19735e-07
24	387.551	-0.009	259.197
25	426.436	-0.00721777	195.853
26	428.044	-0.00415233	6.51825e-08
27	308.453	-0.00596883	76.5293
28	500.743	-0.0041319	6.68423e-07
29	386.553	-0.00398999	56.5683
30	362.503	-0.00443706	81.2497
31	513.925	-0.00431622	1.22121e-06
32	453.215	-0.00505259	148.935
33	621.096	-0.00344444	6.29625e-08
34	601.638	-0.00383018	1.06307e-06
35	607.431	-0.00308086	6.10619e-06
36	507.196	-0.00307613	1.0479e-06
37	608.392	-0.009	159.788
38	505.221	-0.00428509	1.16228e-09
39	492.911	-0.00573014	49.7152
40	510.771	-0.00371838	3.81195e-11
41	453.769	-0.00482642	102.364
42	522.022	-0.00399225	74.124
43	548.893	-0.00374861	65.2152
44	596.418	-0.00359014	1.67319e-06
45	582.089	-0.00357546	30.8869
46	668.782	-0.009	105.598
47	555.636	-0.00428739	109.773
48	680.768	-0.009	99.1
49	515.108	-0.00393736	79.1448
50	583.897	-0.00306568	1.63968e-09
51	573.019	-0.00369314	89.8409
52	825.318	-0.009	168.864
53	604.5	-0.0069737	127.558
54	577.245	-0.00371405	80.5334
55	752.232	-0.009	116.984
56	631.925	-0.00345537	6.81514e-08
57	736.186	-0.00764947	139.883
58	843.395	-0.009	117.486
59	594.345	-0.00319411	5.24996e-09
60	480.084	-0.00599904	170.12
61	476.606	-0.00200941	5.50318e-07
62	493.511	-0.00396762	53.5903

Table 19: Calibration Constants for Module 2 (Sector 3), run 4167, for the W layer.

U-Strip	Gain
1	1
2	1
3	3.25
4	2.92074
5	3.25
6	3.25
7	3.25
8	3.13296
9	3.25
10	2.97629
11	3.25
12	4.05376
13	4.9842
14	3.27632
15	3.55747
16	2.9198
17	3.28939
18	3.40489
19	3.16614
20	3.36206
21	3.38186
22	3.0212
23	3.33395
24	2.63525
25	3.34728
26	3.39922
27	3.12428
28	3.10571
29	3.173
30	3.38545
31	3.34017
32	2.92936
33	3.21109
34	2.49958
35	3.307
36	3.25559
37	3.21383
38	3.00569
39	3.06434
40	3.12175
41	3.09595
42	3.02781
43	2.97809
44	3.13937
45	3.02817
46	3.26751
47	2.59186
48	2.99435
49	3.24595
50	2.9783
51	3.17559
52	3.05594
53	3.06284
54	2.99142
55	2.9559
56	3.07947
57	2.90267
58	2.86074
59	2.87519
60	2.83213
61	2.94396
62	2.93373
63	3.00032
64	3.03691
65	3.07766
66	2.97189
67	3.24445
68	2.62156

(a) Gains for the U layer.

V-Strip	Gain
1	1
2	3.0209
3	4.36089
4	2.96593
5	2.70819
6	2.72557
7	3.02719
8	2.83768
9	3.00864
10	2.98207
11	2.91172
12	2.86801
13	2.82908
14	2.93147
15	2.9599
16	3.01159
17	3.67056
18	2.99934
19	2.95158
20	3.05238
21	2.41122
22	2.6293
23	3.05134
24	3.01577
25	3.11566
26	2.99299
27	3.00385
28	3.09066
29	3.01586
30	3.17496
31	3.14157
32	2.99368
33	3.03136
34	2.921
35	3.09294
36	2.92049
37	3.26148
38	2.78292
39	2.99522
40	2.69217
41	3.05129
42	2.82324
43	3.1853
44	3.24149
45	2.9324
46	2.88245
47	3.53063
48	3.02224
49	2.95523
50	2.98019
51	3.22735
52	3.33998
53	3.36281
54	3.18328
55	3.02328
56	3.15778
57	2.95187
58	3.07449
59	2.77519
60	3.08989
61	2.84072
62	2.12531

(b) Gains for the V layer.

W-Strip	Gain
1	4.68085
2	2.98923
3	3.33275
4	3.17316
5	2.95384
6	2.54335
7	1.59274
8	2.98361
9	3.38636
10	3.381
11	1.52184
12	1.91781
13	1.96672
14	3.07268
15	2.38381
16	2.90922
17	2.75258
18	2.77377
19	2.50684
20	2.77961
21	1.86975
22	2.67044
23	2.84125
24	2.95966
25	2.91232
26	2.91057
27	2.98019
28	2.90872
29	3.0546
30	2.95213
31	3.00758
32	3.04104
33	2.95612
34	3.01196
35	3.17628
36	3.13322
37	2.28381
38	2.97306
39	2.80423
40	2.96636
41	3.02615
42	3.06773
43	3.06334
44	3.03346
45	3.14406
46	1.94762
47	3.10607
48	1.94615
49	3.13491
50	3.15235
51	3.1394
52	1.84569
53	2.46366
54	3.12028
55	1.80282
56	3.01781
57	2.06183
58	1.66725
59	3.12168
60	2.94824
61	4.06043
62	2.75788

(c) Gains for the W layer.

Table 20: Preliminary Gains for Module 2 (Sector 3), run 4167

U-Strip	Parameter a	Parameter b	Parameter c
1	111.977	0	0
2	198.195	0	0
3	199.034	0	0
4	176.805	0	0
5	208.003	-0.00821558	0
6	766.642	0	0
7	658.109	-0.009	0
8	627.265	-0.0005	0
9	649.001	-0.009	5.6659e-05
10	575.834	-0.00265277	8.28884
11	465.748	-0.00520289	7.24073e-05
12	719.571	-0.009	2.07334e-05
13	574.767	-0.009	9.35317e-07
14	200	-0.0005	294.995
15	200.001	-0.0005	435.078
16	508.448	-0.00414656	0.000130974
17	200	-0.00739639	8.55707e-09
18	200	-0.00482288	1.03897e-07
19	673.897	-0.00746848	2.49358e-07
20	642.284	-0.00486672	6.05598e-05
21	556.413	-0.00334381	7.53488e-05
22	574.436	-0.00396779	8.26542e-06
23	382.787	-0.00584529	133.17
24	500.42	-0.00463087	1.18381e-05
25	604.871	-0.00317148	7.46497e-05
26	559.849	-0.00314078	8.63242e-09
27	716.973	-0.00381671	1.38623e-05
28	403.231	-0.009	250.97
29	845.96	-0.009	94.0071
30	307.805	-0.00890703	293.825
31	370.744	-0.009	347.178
32	376.489	-0.009	406.897
33	538.252	-0.00258909	3.45389e-07
34	425.56	-0.00393234	6.62861e-06
35	441.314	-0.00342122	4.61713e-06
36	359.271	-0.00453005	39.7737
37	424.097	-0.00368011	1.80627e-07
38	400.823	-0.00843365	317.139
39	592.5	-0.00328745	4.04665e-05
40	281.959	-0.00745876	128.162
41	558.996	-0.00416495	19.1454
42	413.419	-0.00588732	200.114
43	407.221	-0.00497997	135.274
44	386.394	-0.0060567	167.013
45	379.657	-0.00706719	189.507
46	389.322	-0.00614572	189.429
47	429.415	-0.00769142	225.331
48	441.102	-0.00684681	209.978
49	372.181	-0.009	247.576
50	405.42	-0.0075461	228.372
51	422.968	-0.00543167	161.682
52	439.026	-0.00616777	170.762
53	441.89	-0.00620014	161.227
54	401.408	-0.00655113	170.072
55	443.924	-0.00736677	198.804
56	451.871	-0.006565	173.982
57	364.886	-0.00796642	205.579
58	425.071	-0.0074611	228.311
59	374.696	-0.009	247.127
60	363.754	-0.00889098	261.775
61	442.759	-0.00638877	204.599
62	200	-0.009	433.317
63	299.704	-0.009	261.286
64	468.665	-0.00593615	206.218
65	467.066	-0.00458646	164.622
66	465.553	-0.00452262	173.53
67	458.281	-0.00436011	168.923
68	601.789	-0.00261346	3.48596e-06

Table 21: Calibration Constants for Module 3 (Sector 2), run 4205, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	593.079	0	0
2	547.481	0	0
3	582.365	-0.009	0
4	631.979	-0.009	4.06864e-07
5	632.857	-0.009	3.18245e-07
6	202.566	-0.0044593	146.408
7	538.33	-0.00411387	0.00425658
8	353.224	-0.00816352	240.38
9	325.437	-0.00840534	272.696
10	612.133	-0.00383695	0.00458371
11	564.586	-0.00431863	2.06497e-06
12	388.135	-0.006255	191.159
13	351.309	-0.00692572	239.668
14	552.098	-0.00390993	51.2056
15	200	-0.0005	372.9
16	343.74	-0.009	294.103
17	513.89	-0.00211886	6.96445e-06
18	341.374	-0.00657087	242.539
19	310.631	-0.0084288	280.894
20	461.51	-0.00490955	147.491
21	433.12	-0.00516368	215.427
22	543.489	-0.00296287	0.000111566
23	440.955	-0.00699786	254.032
24	312.373	-0.009	276.744
25	399.295	-0.00730804	256.101
26	488.763	-0.00525642	197.507
27	316.16	-0.009	260.806
28	464.823	-0.00663017	246.731
29	374.629	-0.00712077	200.417
30	328.664	-0.00552548	82.7293
31	472.504	-0.00673489	229.81
32	436.391	-0.00766396	231.17
33	249.159	-0.00471731	47.2843
34	258.426	-0.0047295	43.0609
35	290.421	-0.00359905	3.19187
36	432.547	-0.00702218	207.318
37	496.214	-0.00396044	2.07831
38	425.008	-0.00749978	211.705
39	472.318	-0.0065334	163.244
40	518.746	-0.00398101	6.46318e-09
41	441.194	-0.00595444	198.364
42	465.129	-0.00443765	125.98
43	532.938	-0.0042598	5.15595e-08
44	203.103	-0.00348718	4.86796e-07
45	453.982	-0.00493057	141.808
46	338.339	-0.00672175	202.751
47	566.433	-0.00494713	23.7651
48	701.576	-0.00340741	5.80481e-09
49	530.684	-0.00542534	190.439
50	532.288	-0.00402589	1.11248e-05
51	711.654	-0.00339038	5.16206e-08
52	200	-0.00774479	49.3877
53	504.388	-0.00555646	162.931
54	511.254	-0.00387948	2.30693e-08
55	352.521	-0.00490138	117.68
56	435.427	-0.00447843	45.3039
57	455.583	-0.00460524	45.1249
58	473.244	-0.00475077	44.8508
59	438.926	-0.00478093	61.2683
60	200	-0.009	65.7628
61	433.687	-0.00539031	77.3644
62	592.105	-0.00287537	4.90518e-08

Table 22: Calibration Constants for Module 3 (Sector 2), run 4205, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	190.644	0	0
2	792.152	0	0
3	788.057	0	0
4	981.147	0	0
5	666.992	-0.0005	0
6	683.485	-0.009	3.75987e-07
7	563.919	-0.009	4.18958e-08
8	487.241	-0.00255771	37.467
9	693.841	-0.009	5.36747e-08
10	657.81	-0.00415804	1.56871e-05
11	869.859	-0.009	4.29379e-11
12	808.906	-0.009	7.46269e-07
13	360.369	-0.009	253.034
14	853.847	-0.00668269	8.19849e-07
15	566.643	-0.00514644	1.83516e-06
16	480.886	-0.00486747	86.6267
17	621.645	-0.00417486	8.55769e-05
18	544.267	-0.00477506	9.82271e-09
19	278.462	-0.00883585	149.845
20	571.474	-0.00350622	3.39999e-05
21	497.713	-0.00358954	1.47427e-06
22	513.701	-0.00430634	105.862
23	605.295	-0.00340512	2.5996e-05
24	572.554	-0.00332802	1.43233e-07
25	536.34	-0.0034033	8.78165e-06
26	469.742	-0.00555793	143.946
27	703.547	-0.00488097	0.000160275
28	600.45	-0.00334896	3.48359e-07
29	497.644	-0.00480334	144.375
30	900	-0.0088299	145.733
31	548.111	-0.0041126	89.1983
32	636.238	-0.00331682	1.76881e-10
33	643.434	-0.00326257	2.99779e-08
34	674.469	-0.00409555	3.03707e-07
35	505.261	-0.00368532	81.7252
36	626.723	-0.00597979	153.177
37	632.983	-0.0032144	2.93022e-08
38	607.465	-0.00335812	4.30762e-06
39	520.851	-0.00470186	133.18
40	502.915	-0.00492507	114.857
41	567.082	-0.00460153	6.20788e-09
42	580.584	-0.00471121	6.14929e-08
43	563.621	-0.00441236	1.53962e-06
44	655.224	-0.00320636	1.25168e-05
45	583.299	-0.00602714	51.1472
46	453.218	-0.009	247.826
47	531.26	-0.00458362	131.628
48	504.705	-0.00262695	27.0317
49	550.86	-0.00631233	166.145
50	528.944	-0.00419641	2.98069e-07
51	563.185	-0.00506795	20.4956
52	527.481	-0.0024289	5.00061e-10
53	481.632	-0.00570076	197.52
54	484.164	-0.00399908	103.512
55	493.493	-0.00504576	164.278
56	467.162	-0.00443498	166.651
57	488.389	-0.0054651	168.822
58	519	-0.00459248	139.201
59	487.448	-0.00209066	7.31848e-07
60	743.05	-0.009	127.17
61	470.629	-0.00543416	165.048
62	520.079	-0.00481371	133.562

Table 23: Calibration Constants for Module 3 (Sector 2), run 4205, for the W layer.

U-Strip	Gain
1	1
2	3.2796
3	3.26577
4	3.67637
5	3.12496
6	3.92113
7	3.16729
8	3.45576
9	2.77245
10	3.29583
11	2.98692
12	2.66322
13	2.34792
14	3.5292
15	3.26299
16	2.9647
17	2.64062
18	2.64062
19	2.62995
20	2.9069
21	2.95961
22	2.86104
23	3.14835
24	2.72923
25	3.01129
26	3.02531
27	2.94641
28	2.83453
29	3.12217
30	2.86786
31	2.94252
32	3.09085
33	3.2074
34	2.82754
35	2.83631
36	2.92876
37	2.90789
38	2.94236
39	2.96114
40	2.81979
41	2.89996
42	2.96058
43	2.92991
44	2.84747
45	2.83952
46	2.9748
47	2.82005
48	2.88788
49	2.7608
50	2.92766
51	3.04204
52	2.88177
53	2.95816
54	2.89961
55	2.94947
56	2.9479
57	3.00126
58	2.97285
59	2.87356
60	3.00336
61	2.97395
62	3.06368
63	2.87924
64	2.89113
65	3.04828
66	3.02265
67	2.81104
68	2.53481

(a) Gains for the U layer.

V-Strip	Gain
1	2.83978
2	3.23417
3	3.00392
4	2.83936
5	2.41725
6	1
7	3.0295
8	3.02552
9	2.91005
10	2.97141
11	2.88145
12	2.94889
13	2.94389
14	3.02664
15	3.10431
16	2.97109
17	3.62756
18	2.95362
19	2.92173
20	3.03135
21	3.06512
22	3.40039
23	2.97712
24	2.8533
25	3.01
26	3.07823
27	2.93847
28	2.96886
29	3.04624
30	2.97323
31	3.00792
32	2.88892
33	2.9563
34	2.89417
35	3.06297
36	2.96487
37	3.00708
38	2.78966
39	2.80112
40	2.83343
41	2.88221
42	2.94287
43	2.76845
44	2.95536
45	3.09771
46	2.99973
47	2.55041
48	3.04883
49	2.92946
50	2.74412
51	2.99256
52	2.21017
53	2.87604
54	2.87731
55	2.92183
56	2.88597
57	2.81749
58	2.75273
59	2.81543
60	1.98828
61	2.70076
62	2.72679

(b) Gains for the V layer.

W-Strip	Gain
1	3.40949
2	3.41026
3	3.60948
4	3.14303
5	3.16721
6	2.21576
7	2.28245
8	3.05707
9	2.71595
10	2.90111
11	2.42856
12	2.25951
13	2.81157
14	2.4741
15	2.68962
16	2.86831
17	2.86311
18	2.82027
19	2.75918
20	2.97483
21	3.0732
22	2.95792
23	2.98769
24	2.97877
25	3.09912
26	2.88247
27	2.59371
28	3.08015
29	3.08741
30	1.77552
31	3.02128
32	3.06893
33	3.08934
34	2.77658
35	3.23125
36	2.53853
37	2.99015
38	3.14197
39	2.97749
40	3.0514
41	2.72567
42	2.68233
43	2.61275
44	3.0695
45	2.45042
46	2.83627
47	3.05368
48	3.67021
49	2.88188
50	2.8508
51	2.63554
52	3.67972
53	3.0723
54	3.18956
55	3.01376
56	3.16357
57	3.04273
58	3.09339
59	3.98314
60	1.80503
61	3.08001
62	2.37144

(c) Gains for the W layer.

Table 24: Preliminary Gains for Module 3 (Sector 2), run 4205

U-Strip	Parameter a	Parameter b	Parameter c
1	779.134	0	0
2	653.679	0	0
3	657.55	0	0
4	650.951	-0.00855307	0
5	550.845	-0.00899836	108.62
6	658.623	-0.009	1.57254e-05
7	645.115	-0.009	2.05761e-08
8	643.478	-0.00369346	0.207046
9	651.914	-0.00459315	0.000708448
10	653.537	-0.00533849	1.07209e-05
11	632.45	-0.0020429	2.78552e-08
12	662.64	-0.00455261	3.38594e-05
13	654.141	-0.00303651	3.08039e-05
14	662.611	-0.00439854	4.20625e-06
15	639.024	-0.00355127	0.000149625
16	650.663	-0.00363549	2.21028e-05
17	650.034	-0.00280929	1.69718e-06
18	654.027	-0.00329741	3.57812e-06
19	642.123	-0.00320033	9.78874e-07
20	654.297	-0.00364035	4.9269e-06
21	658.851	-0.00368412	2.56562e-05
22	650.295	-0.00368353	7.25695e-06
23	653.767	-0.00384955	1.03074e-07
24	647.306	-0.0043189	5.45605e-06
25	653.035	-0.00404118	5.87228e-07
26	656.183	-0.00380635	3.30382e-07
27	653.422	-0.00363127	2.25593e-08
28	652.585	-0.00357877	5.81701e-10
29	657.641	-0.00339957	4.10567e-05
30	649.348	-0.00349377	1.53261e-06
31	652.145	-0.00359151	2.17143e-05
32	585.151	-0.00396193	70.007
33	649.097	-0.00346952	4.72498e-05
34	616.479	-0.00410946	38.0547
35	650.542	-0.00351248	1.65763e-07
36	556.081	-0.0046285	94.4623
37	652.708	-0.00370724	3.28408e-06
38	449.818	-0.00652085	199.702
39	475.514	-0.00596164	176.682
40	440.414	-0.00573611	170.589
41	511.177	-0.00523001	139.988
42	563.334	-0.00428811	86.6237
43	645.904	-0.00378512	2.39278
44	592.609	-0.00434662	58.1099
45	469.891	-0.00645805	182.054
46	521.575	-0.005632	130.026
47	500.548	-0.0057163	150.206
48	563.844	-0.00452225	85.927
49	537.908	-0.00464968	113.677
50	465.68	-0.00706215	185.048
51	606.838	-0.00398066	46.565
52	593.111	-0.00399605	59.5544
53	525.41	-0.00516285	125.991
54	454.067	-0.00680474	196.875
55	502.671	-0.00582941	149.157
56	447.407	-0.00672716	205.817
57	466.199	-0.00652013	184.717
58	469.628	-0.00642358	180.666
59	478.669	-0.00598436	171.314
60	499.431	-0.00579114	154.883
61	478.103	-0.00564893	174.821
62	505.788	-0.00470686	146.944
63	512.366	-0.00458175	139.275
64	509.704	-0.00457119	140.536
65	564.438	-0.00371674	85.2902
66	568.023	-0.00380376	81.2587
67	497.857	-0.0046089	152.209
68	454.876	-0.00474773	189.125

Table 25: Calibration Constants for Module 4 (Sector 1), run 4285, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	647.742	0	0
2	636.018	0	0
3	647.553	-0.009	0
4	647.732	-0.009	1.1331e-06
5	655.382	-0.00882402	0.000661766
6	652.861	-0.00620595	4.61066e-05
7	650.941	-0.00472933	0.00260951
8	405.823	-0.009	251.741
9	374.083	-0.00899999	278.157
10	461.441	-0.00691183	189.349
11	430.767	-0.00784409	217.748
12	401.875	-0.00843953	246.174
13	497.695	-0.00586793	153.661
14	460.515	-0.00574799	188.531
15	395.589	-0.00758324	254.414
16	403.155	-0.0072536	243.925
17	596.583	-0.00407901	49.7137
18	426.893	-0.00699051	228.206
19	447.192	-0.00569883	198.926
20	595.415	-0.00382787	55.2964
21	561.097	-0.00379108	87.0405
22	613.818	-0.00344972	33.6538
23	544.59	-0.00449466	103.958
24	522.526	-0.00488227	131.2
25	516.333	-0.0050014	133.003
26	507.375	-0.00474901	140.477
27	543.075	-0.00443188	109.653
28	467.631	-0.00571319	184.499
29	507.235	-0.00507056	141.889
30	472.95	-0.00593921	179.09
31	515.543	-0.00500542	133.059
32	534.347	-0.00475995	117.975
33	553.268	-0.00415789	96.9269
34	543.764	-0.00461449	106.003
35	564.395	-0.00419136	84.9742
36	514.886	-0.00486165	135.576
37	542.746	-0.00521469	109.705
38	490.067	-0.00550706	158.344
39	505.567	-0.00564256	144.943
40	523.223	-0.00516211	127.468
41	489.036	-0.00551988	162.917
42	534.302	-0.00429925	118.164
43	490.432	-0.00503325	158.677
44	534.589	-0.00456091	115.976
45	517.008	-0.00510425	135.651
46	526.434	-0.00453601	124.974
47	502.184	-0.00523952	151.584
48	517.893	-0.00485615	136.289
49	527.085	-0.0049361	127.981
50	546.359	-0.00409989	106.589
51	525.936	-0.00491982	122.187
52	552.072	-0.00459392	101.692
53	545.567	-0.00453219	105.109
54	533.769	-0.00457035	116.002
55	517.005	-0.00480929	130.39
56	542.079	-0.00473598	109.472
57	536.17	-0.00437473	114.419
58	527.64	-0.00480379	123.75
59	531.264	-0.00469725	118.372
60	534.459	-0.0045221	118.944
61	534.794	-0.00484955	117.582
62	540.406	-0.00429801	121.012

Table 26: Calibration Constants for Module 4 (Sector 1), run 4285, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	631.641	0	0
2	640.12	0	0
3	646.726	-0.009	0
4	654.366	-0.00899998	8.15553e-05
5	669.592	-0.00748993	0.000405504
6	644.308	-0.00591435	0.000169479
7	467.437	-0.00759047	180.582
8	415.244	-0.009	250.855
9	360.893	-0.00899961	291.544
10	382.055	-0.00832475	283.549
11	387.18	-0.009	262.223
12	394.063	-0.00842664	256.812
13	382.128	-0.009	271.991
14	422.12	-0.00623093	227.025
15	434.245	-0.0065296	218.398
16	494.89	-0.00567871	154.691
17	421.398	-0.0081774	229.037
18	649.527	-0.00395131	1.95447e-06
19	456.193	-0.00660956	195.023
20	465.636	-0.00630886	174.831
21	496.729	-0.00563724	153.759
22	514.8	-0.00577261	136.821
23	513.643	-0.00541314	138.929
24	586.724	-0.00438869	60.978
25	534.899	-0.00506258	112.072
26	550.698	-0.00500817	104.72
27	483.209	-0.00549172	166.096
28	507.753	-0.00531838	140.15
29	499.223	-0.00547173	148.506
30	537.301	-0.00498339	112.979
31	497.654	-0.00522992	148.425
32	516.165	-0.00478181	133.094
33	544.383	-0.00483659	107.956
34	559.28	-0.00435321	88.2274
35	513.499	-0.00491031	136.986
36	558.347	-0.00430136	90.7336
37	517.042	-0.00546059	135.553
38	517.27	-0.00509614	134.221
39	510.47	-0.00544994	140.946
40	520.064	-0.00524153	138.236
41	534.271	-0.00510417	119.168
42	517.238	-0.0048243	134.182
43	531.139	-0.00476151	120.307
44	533.15	-0.00459542	116.529
45	509.953	-0.00529846	141.087
46	519.665	-0.00465176	130.655
47	484.796	-0.00571588	165.128
48	538.48	-0.00449165	114.668
49	510.848	-0.00542759	139.364
50	498.22	-0.0051868	152.871
51	506.952	-0.00542858	146.202
52	476.298	-0.00584396	179.816
53	516.869	-0.0053816	134.176
54	511.445	-0.00489572	133.984
55	530.92	-0.00478697	120.169
56	498.426	-0.00535851	156.793
57	544.104	-0.00486973	106.188
58	525.216	-0.00497858	125.543
59	512.664	-0.00521989	136.668
60	534.701	-0.00488123	114.371
61	488.113	-0.00546614	164.942
62	457.949	-0.00512142	203.106

Table 27: Calibration Constants for Module 4 (Sector 1), run 4285, for the W layer.

U-Strip	Gain
1	3.29068
2	0.902456
3	0.895837
4	0.799685
5	0.783477
6	0.765744
7	0.808338
8	0.866994
9	0.882153
10	0.872081
11	0.857006
12	0.751756
13	0.843622
14	0.831121
15	0.890279
16	0.882367
17	0.834772
18	0.834178
19	0.855239
20	0.843284
21	0.787185
22	0.927254
23	0.850707
24	0.906382
25	0.901363
26	0.929684
27	0.984985
28	0.855724
29	0.961307
30	0.86072
31	0.941669
32	0.93656
33	0.900876
34	0.893206
35	0.880592
36	0.865629
37	0.979293
38	0.936351
39	0.910226
40	0.899946
41	0.915605
42	0.944923
43	0.927104
44	0.93279
45	0.93845
46	0.912896
47	0.975993
48	0.98749
49	0.94424
50	0.921292
51	0.971597
52	0.946236
53	0.976168
54	0.923775
55	1.02805
56	0.95479
57	0.963421
58	0.954874
59	0.944533
60	1.02664
61	0.976709
62	0.956226
63	0.994245
64	0.971411
65	0.972936
66	1.0327
67	0.958046
68	0.944724

(a) Gains for the U layer.

V-Strip	Gain
1	2.50772
2	1.42266
3	1.00787
4	0.94949
5	0.889153
6	0.881668
7	0.959576
8	0.976082
9	1.03991
10	1.0372
11	1.01069
12	1.03519
13	1.021
14	0.971705
15	1.02432
16	1.0191
17	1.06765
18	1.05594
19	1.00668
20	1.03356
21	1.01545
22	1.02723
23	1.0338
24	1.05629
25	1.00083
26	0.951715
27	1.03368
28	0.981107
29	0.982209
30	1.00583
31	0.996361
32	0.965374
33	1.02115
34	1.07652
35	1.05771
36	1.01251
37	1.03183
38	1.02695
39	1.03661
40	1.08303
41	0.98269
42	1.07701
43	0.965463
44	1.0336
45	1.10087
46	1.04959
47	1.02692
48	1.01999
49	1.02152
50	0.95889
51	1.0557
52	1.04981
53	1.01339
54	0.979641
55	0.956232
56	1.02851
57	0.983207
58	1.03431
59	0.973371
60	0.983367
61	1.03606
62	0.862646

(b) Gains for the V layer.

W-Strip	Gain
1	0.748664
2	0.998989
3	0.991684
4	0.893061
5	0.945657
6	1.02031
7	1.01876
8	0.996333
9	0.975942
10	0.926892
11	0.986773
12	0.998906
13	1.01196
14	1.01941
15	0.951056
16	1.03321
17	1.08565
18	1.01951
19	1.02569
20	1.04032
21	1.02673
22	1.04771
23	1.01618
24	1.03441
25	1.0424
26	1.03318
27	1.01167
28	1.03583
29	1.06326
30	0.995679
31	1.01755
32	0.966396
33	1.05249
34	1.10032
35	1.00875
36	0.999566
37	1.04474
38	1.05723
39	1.07752
40	1.0753
41	1.11269
42	1.08976
43	1.0476
44	1.06307
45	1.0485
46	1.0318
47	0.991146
48	1.05062
49	1.04882
50	1.04705
51	1.07778
52	1.51721
53	1.11814
54	1.06341
55	1.1025
56	1.08355
57	1.07422
58	1.11741
59	1.12368
60	1.15188
61	1.1421
62	0.984899

(c) Gains for the W layer.

Table 28: Preliminary Gains for Module 4 (Sector 1), run 4285

U-Strip	Parameter a	Parameter b	Parameter c
1	214.254	0	0
2	650.613	0	0
3	656.604	-0.009	0
4	667.984	-0.00707054	0
5	653.412	-0.00788249	0.58841
6	646.348	-0.00680681	0.00156657
7	646.556	-0.00858252	0.106719
8	459.709	-0.009	197.044
9	399.585	-0.009	250.093
10	420.73	-0.009	234.012
11	336.027	-0.009	311.161
12	651.747	-0.00440695	7.07049e-07
13	652.44	-0.00428495	1.6561e-07
14	650.112	-0.00502665	9.76941e-07
15	650.888	-0.00414671	1.98711e-07
16	649.456	-0.00418786	6.7532e-06
17	651.279	-0.00330969	3.41664e-07
18	649.674	-0.00309281	3.48207e-06
19	651.757	-0.00336632	6.41858e-06
20	652.314	-0.00366916	1.35752e-08
21	651.245	-0.00362365	4.43169e-09
22	652.378	-0.00387711	8.07737e-07
23	652.997	-0.00375117	1.18847e-09
24	651.193	-0.00417899	8.50308e-07
25	651.063	-0.00403928	0
26	650.267	-0.00368618	1.07307e-06
27	647.546	-0.0037139	1.83034e-06
28	651.952	-0.0036307	1.25134e-06
29	651.647	-0.00329579	1.12783e-07
30	650.49	-0.0033584	1.20269e-05
31	650.703	-0.0034394	2.74004e-06
32	650.859	-0.00350037	3.18015e-05
33	623.833	-0.00359722	27.1935
34	632.294	-0.00376724	19.9203
35	649.797	-0.0033788	2.60373e-06
36	597.885	-0.00397564	52.5128
37	650.1	-0.00359116	4.48487e-06
38	454.175	-0.0060494	196.042
39	585.803	-0.00414643	64.1071
40	522.396	-0.00473001	128.633
41	544.18	-0.00457738	105.954
42	589.472	-0.00405621	61.6752
43	644.562	-0.00367173	4.9703
44	637.566	-0.00367913	12.4821
45	401.666	-0.00556923	127.352
46	542.088	-0.00505731	109.14
47	512.722	-0.00530555	135.983
48	536.741	-0.00480592	113.801
49	551.429	-0.00435499	94.0636
50	460.734	-0.00693314	189.209
51	596.237	-0.00395591	52.9599
52	586.585	-0.00391493	62.6934
53	507.653	-0.00532709	143.478
54	456.654	-0.00650254	195.678
55	493.099	-0.00583445	158.427
56	491.09	-0.00558842	161.867
57	460.767	-0.00655847	190.986
58	464.08	-0.00623486	187.26
59	473.818	-0.0057705	178.857
60	492.813	-0.00569065	157.582
61	469.017	-0.00561204	181.595
62	490.615	-0.00483595	160.621
63	509.807	-0.00451691	142.102
64	513.939	-0.00439651	136.539
65	552.097	-0.00365985	98.7573
66	554.84	-0.00390023	96.3915
67	497.033	-0.00466217	154.088
68	500.216	-0.0041083	151.332

Table 29: Calibration Constants for Module 4 (Sector 1), run 4289, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	642.461	0	0
2	656.99	0	0
3	638.829	-0.009	0
4	646.012	-0.009	4.95074e-07
5	654.467	-0.00883855	1.29124e-05
6	650.835	-0.00592644	1.78185e-06
7	391.958	-0.00899997	258.924
8	391.421	-0.00899999	258.973
9	434.13	-0.00693389	216.532
10	369.545	-0.00899937	280.836
11	425.66	-0.00752388	224.823
12	406.385	-0.00811118	243.544
13	423.039	-0.00699165	226.903
14	395.113	-0.00690793	254.505
15	365.488	-0.00822133	284.497
16	424.289	-0.00633446	229.236
17	468.835	-0.00542621	181.412
18	422.325	-0.00636811	226.689
19	613.38	-0.00342669	30.0595
20	625.934	-0.00331363	5.78841e-09
21	470.587	-0.00474527	179.771
22	516.351	-0.00431343	136.372
23	501.455	-0.0046313	146.623
24	474.205	-0.00516448	176.02
25	495.243	-0.00498229	157.46
26	489.979	-0.00491149	173.799
27	497.02	-0.0048862	156.052
28	477.517	-0.00494881	172.749
29	493.942	-0.00507055	156.913
30	499.329	-0.00492807	149.437
31	477.645	-0.00536847	177.375
32	533.27	-0.00448545	116.793
33	536.021	-0.0043073	115.891
34	527.348	-0.00469404	126.363
35	529.477	-0.00437297	118.685
36	577.938	-0.00372118	70.5922
37	539.051	-0.00492456	111.459
38	499.534	-0.00486132	148.488
39	513.537	-0.00509418	135.488
40	515.13	-0.00474517	132.939
41	479.958	-0.00524014	169.861
42	497.853	-0.00454449	152.067
43	481.865	-0.00469679	167.821
44	506.063	-0.00479877	144.707
45	507.193	-0.00508997	141.696
46	497.124	-0.00481504	153.547
47	507.242	-0.00470415	142.289
48	526.751	-0.0043531	123.922
49	531.829	-0.00450699	118.242
50	529.61	-0.0041555	119.376
51	527.244	-0.0046584	122.451
52	540.73	-0.00454259	109.899
53	541.757	-0.00439326	107.797
54	542.937	-0.0042584	108.448
55	536.203	-0.0042365	121.27
56	546.472	-0.00440982	103.712
57	520.264	-0.00415704	129.435
58	541.734	-0.0041788	110.325
59	525.619	-0.00439575	124.59
60	541.752	-0.00407842	110.864
61	522.851	-0.00424283	125.08
62	501.377	-0.00417328	152.557

Table 30: Calibration Constants for Module 4 (Sector 1), run 4289, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	639.834	0	0
2	665.397	0	0
3	651.281	-0.009	0
4	649.608	-0.009	0.000148337
5	646.119	-0.00731276	0.000727153
6	645.703	-0.00593385	0.000876628
7	614.525	-0.00526486	34.7891
8	414.607	-0.009	234.975
9	354.032	-0.009	295.276
10	497.742	-0.0053537	152.386
11	406.352	-0.00835698	246.171
12	462.253	-0.00654669	188.092
13	438.852	-0.00682691	213.562
14	410.35	-0.00634833	239.979
15	432.607	-0.00628159	217.078
16	465.883	-0.00595407	179.792
17	430.518	-0.00735129	221.674
18	598.588	-0.00425542	51.2405
19	452.338	-0.00658679	201.121
20	452.215	-0.00669587	200.312
21	480.8	-0.00563855	170.048
22	559.45	-0.00462617	92.314
23	549.308	-0.0043941	102.01
24	538.031	-0.00499451	116.825
25	456.699	-0.00686879	198.194
26	496.2	-0.00549567	154.455
27	444.723	-0.00599976	203.977
28	495.403	-0.00518816	154.07
29	510.036	-0.00507355	142.894
30	508.432	-0.00506558	140.485
31	488.462	-0.0051656	162.576
32	462.582	-0.00551748	187.533
33	513.151	-0.00514607	134.023
34	521.468	-0.00468005	127.998
35	525.826	-0.00439315	122.697
36	517.99	-0.0045317	131.461
37	521.569	-0.00504553	128.48
38	500.669	-0.00504444	148.864
39	498.964	-0.00516112	150.605
40	528.93	-0.00448265	119.977
41	541.144	-0.00439886	109.51
42	531.456	-0.00441021	119.015
43	522.171	-0.00463653	129.031
44	531.054	-0.00437283	118.437
45	517.943	-0.0046245	132.197
46	496.185	-0.00475332	155.217
47	487.966	-0.00497563	162.906
48	511.733	-0.00444072	138.768
49	517.663	-0.0048401	132.805
50	501.575	-0.00462466	149.747
51	492.743	-0.0051442	159.049
52	460.922	-0.00525998	197.13
53	523.394	-0.00477801	127.211
54	515.95	-0.00461186	134.956
55	533.131	-0.00448898	117.716
56	516.54	-0.00458342	133.923
57	539.106	-0.00438303	110.41
58	524.644	-0.00452067	126.14
59	524.973	-0.00477883	125.871
60	536.057	-0.00457689	114.142
61	491.142	-0.00492072	156.38
62	478.761	-0.00416603	176.515

Table 31: Calibration Constants for Module 4 (Sector 1), run 4289, for the W layer.

U-Strip	Gain
1	3.03379
2	1.14799
3	1.08754
4	1.06331
5	0.97075
6	0.93879
7	0.93698
8	0.950611
9	0.942473
10	0.975458
11	0.976903
12	0.959776
13	0.947133
14	0.934344
15	0.993093
16	0.969984
17	0.985537
18	0.959537
19	0.932235
20	0.944059
21	0.980051
22	0.968196
23	1.03189
24	0.947267
25	0.972082
26	0.985354
27	0.961847
28	0.985293
29	0.982867
30	0.942865
31	0.967177
32	0.976333
33	0.978744
34	0.946934
35	0.98247
36	1.01052
37	0.984336
38	0.941974
39	0.979019
40	0.969792
41	0.973185
42	0.975636
43	0.946656
44	0.955212
45	0.950371
46	0.972511
47	0.977216
48	1.03373
49	0.990393
50	0.987435
51	0.998536
52	0.992779
53	0.990623
54	0.996045
55	1.00477
56	1.06466
57	0.999814
58	1.00862
59	0.972407
60	0.992402
61	0.994447
62	1.03149
63	1.03359
64	1.02009
65	0.992861
66	1.04497
67	1.00293
68	0.979726

(a) Gains for the U layer.

V-Strip	Gain
1	2.71193
2	1.3952
3	0.99372
4	0.964708
5	0.900512
6	0.960582
7	0.984237
8	0.989645
9	1.01552
10	0.991431
11	0.990284
12	1.01794
13	0.982751
14	0.972755
15	0.969156
16	1.00669
17	1.02522
18	0.991681
19	1.04149
20	1.03112
21	0.998755
22	1.02462
23	1.03335
24	1.04547
25	1.01209
26	1.01473
27	1.02542
28	1.00749
29	1.05465
30	1.03008
31	1.01675
32	1.04067
33	1.0502
34	1.04286
35	1.02491
36	1.02113
37	1.03789
38	1.03718
39	1.04539
40	1.06531
41	1.05142
42	1.03773
43	1.04308
44	1.02922
45	1.04018
46	1.05045
47	1.04468
48	1.0656
49	1.06982
50	1.05078
51	1.01047
52	1.02602
53	1.05194
54	1.05617
55	1.09142
56	1.03268
57	1.03063
58	1.05022
59	1.0305
60	1.05289
61	1.00595
62	0.936243

(b) Gains for the V layer.

W-Strip	Gain
1	0.768864
2	1.08135
3	0.973598
4	0.93072
5	0.918744
6	0.933452
7	0.979372
8	0.98791
9	0.968598
10	0.991784
11	0.992794
12	0.976978
13	1.02293
14	1.00429
15	0.970926
16	1.01303
17	1.01217
18	1.03786
19	1.04159
20	0.990046
21	1.01812
22	1.02444
23	1.07635
24	1.03131
25	1.00574
26	1.01211
27	1.00088
28	1.01399
29	1.04914
30	1.03202
31	1.0325
32	1.00155
33	1.02797
34	1.01417
35	1.02589
36	1.0333
37	1.04666
38	1.04295
39	1.0272
40	1.05286
41	1.06604
42	1.05809
43	1.03147
44	1.04987
45	1.04174
46	1.06116
47	1.02211
48	1.04875
49	1.05282
50	1.06856
51	1.0559
52	1.49418
53	1.06588
54	1.0648
55	1.08688
56	1.12274
57	1.06315
58	1.09399
59	1.11003
60	1.06701
61	1.0992
62	1.0211

(c) Gains for the W layer.

Table 32: Preliminary Gains for Module 4 (Sector 1), run 4289

U-Strip	Parameter a	Parameter b	Parameter c
1	1000	0	0
2	726.011	0	0
3	654.677	0	0
4	654.786	0	0
5	629.642	-0.009	7.88759e-05
6	365.269	-0.00899999	292.242
7	470.111	-0.00473408	177.058
8	471.513	-0.00119754	157.066
9	667.76	-0.00417428	0.176684
10	484.217	-0.00102994	156.959
11	514.321	-0.00257349	160.813
12	669.568	-0.00198395	0.0227662
13	667.339	-0.00363325	0.00129802
14	651.511	-0.00221912	0.0312648
15	491.263	-0.00249884	163.456
16	662.523	-0.0028404	0.000968236
17	649.488	-0.00371786	0.00189949
18	645.529	-0.00309595	3.76917e-05
19	299.037	-0.009	355.128
20	653.346	-0.00343686	0.000996392
21	269.715	-0.009	352.163
22	332.53	-0.009	306.953
23	636.306	-0.00323002	2.70883e-05
24	365.024	-0.009	305.852
25	368.123	-0.009	293.004
26	644.227	-0.00457645	28.9581
27	349.209	-0.009	310.891
28	648.355	-0.00363158	8.73987e-06
29	656.82	-0.00348504	0.000124271
30	375.474	-0.00682583	278.701
31	363.877	-0.00899998	277.167
32	396.137	-0.009	264.029
33	447.44	-0.00649603	208.154
34	608.446	-0.00380931	53.0577
35	590.242	-0.0041118	64.1173
36	640.853	-0.00384005	0.0124149
37	580.146	-0.0042954	52.587
38	533.867	-0.00509955	138.699
39	656.772	-0.00378292	1.61081e-07
40	651.805	-0.00343737	0.00312854
41	526.426	-0.00489209	135.619
42	586.287	-0.00421511	66.9285
43	447.195	-0.00652825	203.175
44	492.099	-0.00559387	162.795
45	453.85	-0.00701668	198.822
46	488.387	-0.00606178	160.535
47	648.5	-0.00383462	3.25856e-07
48	421.111	-0.00811262	227.671
49	501.99	-0.00575652	167.409
50	545.33	-0.00516914	125.556
51	546.806	-0.00493007	104.74
52	499.416	-0.00563521	156.144
53	507.67	-0.00514381	144.871
54	504.899	-0.00567575	149.942
55	447.931	-0.00727964	209.195
56	472.899	-0.0069306	200.664
57	447.412	-0.00688345	203.249
58	453.954	-0.00708823	199.506
59	464.784	-0.00614351	187.032
60	473.266	-0.0059667	183.065
61	494.144	-0.00486446	158.185
62	469.706	-0.00541621	182.639
63	484.595	-0.00491674	173.542
64	517.44	-0.00455056	137.867
65	506.779	-0.00408389	147.686
66	526.281	-0.003793	123.747
67	513.7	-0.00421938	137.984
68	616.559	-0.00257501	21.7176

Table 33: Calibration Constants for Module 5 (Sector 6), run 4294, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	711.233	0	0
2	789.288	0	0
3	657.901	-0.009	0
4	652.321	-0.009	2.44977e-05
5	649.954	-0.00816524	0.000315142
6	647.99	-0.00634679	0.000567572
7	410.169	-0.009	242.108
8	394.409	-0.009	265.061
9	386.4	-0.009	265.375
10	547.455	-0.00520221	100.251
11	404.13	-0.009	255.487
12	449.887	-0.00692996	194.021
13	425.37	-0.00733224	230.754
14	426.802	-0.00611183	225.787
15	447.31	-0.00663685	204.374
16	404.489	-0.00745909	260.827
17	446.387	-0.00626656	207.515
18	421.654	-0.00621742	220.912
19	609.487	-0.00355209	38.2902
20	557.865	-0.00438596	103.018
21	486.898	-0.00460582	173.872
22	399.786	-0.00842313	251.739
23	432.017	-0.00662053	214.79
24	494.172	-0.00530375	157.8
25	442.614	-0.00671418	199.215
26	449.468	-0.00599499	210.918
27	548.474	-0.00423505	108.628
28	550.462	-0.00452291	114.152
29	415.295	-0.00766798	239.985
30	493.157	-0.00517101	152.338
31	419.084	-0.00690747	231.563
32	450.206	-0.00587432	196.796
33	534.898	-0.00385746	111.789
34	459.203	-0.00588879	192.116
35	490.47	-0.00487381	159.021
36	467.708	-0.00571322	182.623
37	481	-0.00599202	180.163
38	463.994	-0.00573649	178.253
39	492.06	-0.00541579	154.41
40	478.904	-0.00546076	166.344
41	467.8	-0.00579286	169.636
42	468.124	-0.00504106	180.575
43	471.259	-0.00534896	175.323
44	529.855	-0.00484431	120.103
45	467.55	-0.00615984	184.354
46	491.546	-0.00498368	148.107
47	516.18	-0.0052484	135.427
48	524.004	-0.00481276	135.747
49	494.529	-0.00611836	162.664
50	469.874	-0.00524199	180.835
51	482.821	-0.00562019	162.963
52	516.727	-0.00447877	115.936
53	276.722	-0.0005	453.153
54	457.172	-0.00562339	181.224
55	483.172	-0.00550816	167.216
56	526.21	-0.00500124	124.453
57	486.058	-0.00566626	168.344
58	538.41	-0.00509395	111.394
59	507.071	-0.0052831	146
60	517.282	-0.0054671	133.451
61	502.505	-0.00493921	150.838
62	437.568	-0.00594549	218.631

Table 34: Calibration Constants for Module 5 (Sector 6), run 4294, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	722.919	0	0
2	663.635	0	0
3	637.048	-0.009	0
4	655.278	-0.009	2.6418e-05
5	644.203	-0.007205	0.012154
6	640.726	-0.00543186	5.93408e-05
7	379.268	-0.009	263.854
8	434.289	-0.009	223.504
9	641.499	-0.00454868	0.000771681
10	382.109	-0.009	265.049
11	420.467	-0.009	229.571
12	401.542	-0.009	247.892
13	617.709	-0.00441119	35.7794
14	428.986	-0.00648907	223.109
15	407.077	-0.00692811	246.697
16	639.981	-0.00355691	7.45367e-07
17	533.071	-0.00532121	124.893
18	409.369	-0.00871299	255.642
19	408.252	-0.00806966	274.475
20	597.298	-0.0037481	44.4814
21	412.321	-0.00612887	235.231
22	424.11	-0.00699689	224.012
23	478.733	-0.0056738	182.968
24	416.23	-0.00818852	235.485
25	449.855	-0.00601977	196.156
26	465.902	-0.00593435	177.219
27	467.266	-0.00602069	199.342
28	555.165	-0.00461672	104.491
29	446.27	-0.00698095	195.168
30	509.653	-0.00577246	147.843
31	507.996	-0.0051388	138.549
32	459.466	-0.00611421	191.513
33	483.49	-0.00573665	176.18
34	525.401	-0.00483809	128.859
35	493.755	-0.00609279	172.337
36	452.132	-0.00604965	199.086
37	539.394	-0.00468203	113.891
38	533.162	-0.00486772	114.221
39	467.338	-0.00643041	185.493
40	519.036	-0.00497518	135.336
41	457.698	-0.005971	192.595
42	459.326	-0.00568004	207.419
43	476.994	-0.00558902	181.992
44	506.724	-0.00466548	139.419
45	469.707	-0.00575409	178.376
46	489.903	-0.00461041	165.771
47	496.062	-0.00521977	150.46
48	497.628	-0.00503383	155.343
49	500.026	-0.00557744	150.296
50	526.869	-0.00450748	122.345
51	477.646	-0.00521289	164.331
52	498.645	-0.00494931	144.094
53	513.652	-0.00555607	140.836
54	508.295	-0.00525323	145.04
55	476.684	-0.00591227	175.192
56	516.524	-0.00486013	134.09
57	491.873	-0.00558878	165.728
58	481.233	-0.00536472	167.571
59	492.81	-0.00522031	143.435
60	514.919	-0.00525974	136.673
61	506.791	-0.00515492	138.637
62	667.778	-0.00280511	3.00993e-09

Table 35: Calibration Constants for Module 5 (Sector 6), run 4294, for the W layer.

U-Strip	Gain
1	1.84934
2	1.08255
3	1.0987
4	1.07757
5	1.05203
6	1.10948
7	0.981181
8	1.17147
9	0.982314
10	1.11248
11	1.13358
12	1.05661
13	1.05574
14	1.12464
15	1.09567
16	1.12886
17	1.0718
18	1.06653
19	1.04577
20	1.08062
21	1.03354
22	0.991976
23	1.0771
24	1.02761
25	1.04417
26	0.965694
27	1.03759
28	1.06282
29	1.06081
30	1.09269
31	1.07414
32	1.03181
33	1.04543
34	0.997584
35	1.0824
36	1.02221
37	1.0509
38	1.06271
39	1.02047
40	1.07972
41	1.03029
42	1.02885
43	1.05923
44	1.00731
45	1.00077
46	1.09293
47	1.0492
48	1.05598
49	1.06438
50	1.05075
51	1.04611
52	1.09836
53	1.03082
54	1.04395
55	1.00911
56	1.02599
57	0.995125
58	0.975407
59	0.966418
60	1.04376
61	1.04878
62	1.0202
63	0.997759
64	1.03638
65	1.03726
66	1.02426
67	1.03146
68	0.993384

(a) Gains for the U layer.

V-Strip	Gain
1	2.35763
2	1.39697
3	0.987761
4	0.93857
5	0.928631
6	0.94301
7	0.973016
8	1.0089
9	0.988546
10	1.03316
11	1.00923
12	1.00641
13	0.990913
14	1.0201
15	0.990166
16	1.02539
17	1.02236
18	1.02609
19	1.03863
20	1.01935
21	1.0408
22	0.989534
23	1.01879
24	1.06277
25	1.04125
26	1.05559
27	1.06621
28	1.05521
29	1.00878
30	1.07023
31	0.995943
32	1.01355
33	1.02118
34	1.05476
35	1.07784
36	1.01028
37	1.01509
38	0.999295
39	1.0372
40	1.04556
41	1.04124
42	1.07394
43	1.01768
44	1.06023
45	1.02301
46	1.12659
47	1.06771
48	1.05798
49	1.01189
50	1.05569
51	1.04301
52	1.29144
53	2.21289
54	1.22412
55	1.0954
56	0.985845
57	1.0493
58	1.07479
59	1.04025
60	1.00834
61	1.06979
62	0.956554

(b) Gains for the V layer.

W-Strip	Gain
1	1.02973
2	1.12367
3	0.943167
4	0.919044
5	0.941442
6	0.994902
7	0.990086
8	0.977988
9	1.07093
10	0.978045
11	0.958558
12	1.01718
13	1.02875
14	0.988786
15	0.978909
16	1.04039
17	0.984767
18	0.970382
19	1.02358
20	1.03868
21	1.1085
22	1.0175
23	1.01614
24	1.03667
25	1.05621
26	1.01269
27	1.03545
28	1.00515
29	0.980431
30	1.01877
31	1.04208
32	1.02171
33	0.989744
34	1.02185
35	1.00444
36	1.04319
37	1.03024
38	1.03618
39	1.04839
40	1.00124
41	1.01863
42	1.00346
43	1.06685
44	1.00675
45	1.05102
46	1.07471
47	1.04851
48	1.10533
49	1.05742
50	1.02789
51	1.03497
52	1.03226
53	1.00645
54	1.0566
55	1.06817
56	1.07192
57	1.11879
58	1.05503
59	1.0399
60	1.0663
61	1.13436
62	0.967609

(c) Gains for the W layer.

Table 36: Preliminary Gains for Module 5 (Sector 6), run 4294

U-Strip	Parameter a	Parameter b	Parameter c
1	711.978	0	0
2	677.132	0	0
3	640.455	0	0
4	657.46	-0.009	0
5	629.33	-0.00597103	0.107003
6	640.015	-0.00635225	0.00894852
7	669.493	-0.00862377	0.000297612
8	641.337	-0.00207725	0.00926621
9	425.531	-0.000510827	213.91
10	658.422	-0.00351371	7.169e-05
11	655.462	-0.00303172	2.11506e-06
12	654.028	-0.00396065	0.000160967
13	637.217	-0.00259598	1.11447e-08
14	657.684	-0.00457593	3.86005e-05
15	656.737	-0.00373304	7.76794e-05
16	652.789	-0.00314225	7.13787e-05
17	647.58	-0.00304765	6.63884e-05
18	646.666	-0.00303213	0.000130478
19	654.472	-0.00309298	6.55173e-05
20	649.582	-0.00284132	1.47302e-05
21	649.979	-0.00306679	3.58207e-07
22	649.824	-0.00332415	1.05828e-06
23	649.971	-0.00311296	2.50703e-05
24	653.851	-0.00320758	1.98373e-07
25	648.971	-0.00311626	3.54902e-06
26	653.85	-0.00299088	5.64542e-05
27	363.331	-0.00663464	286.137
28	650.796	-0.00318302	1.28681e-06
29	406.393	-0.00584087	239.529
30	565.398	-0.00384757	87.7923
31	648.607	-0.00311166	4.67764e-06
32	467.21	-0.00523301	186.898
33	566.008	-0.00395553	83.507
34	645.398	-0.00324879	2.34172e-05
35	574.874	-0.00398662	80.7086
36	649.698	-0.00339321	3.2814e-05
37	487.947	-0.00539466	166.228
38	457.243	-0.00593159	192.219
39	452.32	-0.00469699	195.22
40	388.711	-0.00699006	266.321
41	498.939	-0.00442341	149.848
42	455.626	-0.00555823	201.962
43	544.073	-0.00430126	106.97
44	386.465	-0.00790834	263.464
45	427.564	-0.00647128	220.195
46	475.912	-0.00493297	178.322
47	413.829	-0.00619822	239.781
48	443.742	-0.00591012	208.114
49	503.36	-0.00456215	147.498
50	445.555	-0.00618225	210.007
51	410.951	-0.00697171	240.323
52	550.232	-0.00438282	98.6988
53	478.172	-0.00560893	173.255
54	429.386	-0.0067175	221.255
55	449.421	-0.00581791	200.311
56	451.978	-0.00610665	198.622
57	441.118	-0.00646739	209.542
58	423.615	-0.00623823	227.838
59	455.524	-0.00572948	193.987
60	434.817	-0.00578459	213.312
61	456.777	-0.00598776	193.335
62	460.302	-0.00606432	192.633
63	467.815	-0.0048998	181.813
64	513.849	-0.00441182	136.352
65	510.361	-0.00452243	144.736
66	497.764	-0.00437702	152.748
67	462.178	-0.00464577	186.832
68	396.238	-0.00526547	249.933

Table 37: Calibration Constants for Module 6 (Sector 5), run 4416, for the U layer.

V-Strip	Parameter a	Parameter b	Parameter c
1	638.991	0	0
2	638.523	0	0
3	649.303	-0.009	0
4	649.628	-0.009	5.67394e-05
5	655.984	-0.00791974	0.000237662
6	647.585	-0.00617902	0.000167631
7	338.892	-0.009	310.352
8	655.178	-0.00429237	0.000365299
9	650.538	-0.00347463	0.00130019
10	402.743	-0.0076469	253.02
11	655.884	-0.00375366	1.96623e-06
12	549.548	-0.00481424	101.593
13	387.201	-0.00752459	262.664
14	466.547	-0.00520228	184.74
15	502.334	-0.00464145	148.715
16	362.863	-0.00857354	288.071
17	418.364	-0.00573052	231.861
18	617.248	-0.0036648	35.3574
19	490.416	-0.00454277	158.738
20	428.324	-0.00638853	220.655
21	432.541	-0.00629412	220.72
22	489.52	-0.00470682	163.343
23	435.852	-0.00590521	213.051
24	519.996	-0.00443828	128.015
25	457.808	-0.00543165	190.324
26	481.774	-0.00496127	170.344
27	568.656	-0.00402098	82.8334
28	463.179	-0.00537356	184.042
29	467.994	-0.00570088	183.317
30	492.925	-0.00495578	155.816
31	476.545	-0.00514471	171.458
32	504.247	-0.0046773	144.506
33	440.95	-0.00567156	208.815
34	425.622	-0.006101	224.001
35	453.606	-0.00566689	195.891
36	462.264	-0.00478144	187.1
37	456.829	-0.00529656	188.141
38	505.263	-0.00463519	146.676
39	505.321	-0.00446037	146.586
40	465.705	-0.00468739	184.131
41	453.823	-0.00537485	197.44
42	481.803	-0.00478201	167.986
43	466.977	-0.00474049	184.425
44	501.828	-0.00474026	145.627
45	508.931	-0.00480262	141.381
46	501.619	-0.00489173	148.119
47	498.437	-0.00510102	155.132
48	475.964	-0.00474908	174.942
49	472.221	-0.00505888	177.983
50	480.749	-0.00500343	171.361
51	501.622	-0.00461345	149.565
52	493.264	-0.00478837	156.842
53	500.162	-0.00471411	148.514
54	489.398	-0.00524807	161.951
55	480.583	-0.00514135	170.376
56	479.376	-0.00434223	171.235
57	487.56	-0.00479307	161.903
58	477.157	-0.00485596	172.398
59	481.649	-0.00535953	169.099
60	482.134	-0.00524655	167.708
61	478.249	-0.00528632	168.512
62	393.92	-0.00629993	242.762

Table 38: Calibration Constants for Module 6 (Sector 5), run 4416, for the V layer.

W-Strip	Parameter a	Parameter b	Parameter c
1	0	0	0
2	652.529	0	0
3	650.012	-0.009	0
4	649.407	-0.00812253	0.016143
5	652.846	-0.00596303	0.000243103
6	647.752	-0.00533383	6.90374e-05
7	582.918	-0.00547388	61.1657
8	555.546	-0.00505797	94.4905
9	373.047	-0.0074511	276.359
10	644.157	-0.00373469	3.7196
11	346.517	-0.009	303.54
12	343.149	-0.009	307.46
13	365.707	-0.00819492	284.343
14	407.389	-0.00560146	242.756
15	463.536	-0.00479129	186.016
16	652.668	-0.00327941	2.81462e-06
17	601.65	-0.0035547	34.9924
18	582.287	-0.00425281	69.3129
19	545.587	-0.00400115	106.577
20	632.264	-0.0033025	19.5444
21	466.831	-0.00499382	188.41
22	505.067	-0.00496889	147.486
23	466.867	-0.00533182	182.104
24	559.197	-0.00445127	103.043
25	479.911	-0.00556115	166.513
26	540.399	-0.00427959	110.259
27	568.446	-0.00389151	79.9925
28	544.062	-0.00385524	104.499
29	436.443	-0.00544667	213.531
30	438.154	-0.00676734	211.612
31	472.458	-0.00576248	179.568
32	592.317	-0.00393676	65.0242
33	498.851	-0.00500695	147.421
34	476.025	-0.00482371	173.655
35	498.412	-0.00500849	150.417
36	512.235	-0.00504215	137.353
37	453.981	-0.00601373	196.499
38	453.742	-0.00493613	196.292
39	460.085	-0.00596951	191.612
40	488.844	-0.00463905	161.019
41	486.116	-0.00522324	165.752
42	475.36	-0.00486768	173.674
43	461.354	-0.00503716	188.505
44	510.067	-0.00443563	141.768
45	479.46	-0.00511864	173.284
46	484.691	-0.00537667	169.882
47	466.826	-0.00577461	185.86
48	472.994	-0.00499565	177.059
49	495.2	-0.00475449	156.936
50	491.278	-0.00480281	157.918
51	471.787	-0.00503685	177.534
52	474.825	-0.00515885	177.516
53	467.539	-0.0052268	183.145
54	427.017	-0.00604497	224.566
55	488.414	-0.00544287	166.221
56	513.821	-0.00515916	139.626
57	476.845	-0.00518118	171.664
58	501.837	-0.00525802	151.773
59	488.994	-0.00521942	163.029
60	469.485	-0.00541395	178.175
61	465.958	-0.00573041	180.067
62	360.043	-0.00721068	300.701

Table 39: Calibration Constants for Module 6 (Sector 5), run 4416, for the W layer.

U-Strip	Gain
1	4.0074
2	1.0073
3	1.02241
4	1.08825
5	1.07332
6	0.963269
7	0.903381
8	1.13596
9	1.01912
10	1.0245
11	1.01282
12	0.976782
13	1.08212
14	0.97009
15	1.01697
16	1.04596
17	1.05175
18	0.97854
19	0.943439
20	0.926994
21	1.00462
22	0.989359
23	1.0441
24	1.01062
25	1.00383
26	1.15298
27	1.10764
28	1.11821
29	0.987882
30	1.01182
31	1.01387
32	0.957264
33	1.00813
34	1.00357
35	0.953304
36	0.973294
37	1.00528
38	1.07193
39	0.984086
40	0.961332
41	1.08694
42	1.02961
43	1.05009
44	0.897939
45	1.00225
46	1.05873
47	0.987803
48	1.05158
49	1.05331
50	1.15578
51	1.05986
52	1.08223
53	0.993059
54	0.985184
55	1.0325
56	1.00114
57	0.969659
58	0.977159
59	0.945468
60	0.925353
61	1.00668
62	1.06969
63	0.999862
64	1.037
65	1.14592
66	1.00782
67	0.997135
68	0.917613

(a) Gains for the U layer.

V-Strip	Gain
1	1.16665
2	1.11768
3	0.994756
4	0.907835
5	0.924911
6	0.877027
7	0.966399
8	1.04961
9	0.96039
10	1.05329
11	0.946664
12	0.965615
13	0.977679
14	0.943391
15	0.948165
16	1.00907
17	0.988929
18	1.03399
19	1.07297
20	0.968471
21	1.01288
22	0.915262
23	0.974771
24	1.0807
25	1.05688
26	1.04357
27	1.00589
28	0.973001
29	0.982623
30	0.994185
31	1.03339
32	1.0325
33	1.00706
34	0.957581
35	0.986221
36	0.972685
37	0.969276
38	1.03715
39	1.04673
40	0.936058
41	0.961508
42	0.986776
43	0.988672
44	1.0078
45	0.9787
46	1.03956
47	1.053
48	0.969435
49	1.02445
50	0.980685
51	0.978273
52	0.992871
53	0.966034
54	1.00801
55	0.987913
56	0.932487
57	0.945865
58	0.946911
59	0.988048
60	0.954419
61	0.973532
62	0.817466

(b) Gains for the V layer.

W-Strip	Gain
1	1
2	1.11989
3	0.970928
4	0.944626
5	0.996267
6	0.98092
7	0.933754
8	0.979194
9	0.970219
10	1.02901
11	0.956698
12	0.934273
13	0.931009
14	0.963187
15	0.923286
16	1.00914
17	1.00836
18	1.0509
19	1.04396
20	1.00469
21	0.983755
22	0.995075
23	1.00494
24	1.07626
25	1.00018
26	1.01357
27	1.06526
28	0.994454
29	0.971716
30	0.99133
31	0.951659
32	1.10194
33	0.981473
34	1.01057
35	1.02413
36	1.06841
37	0.933067
38	1.03356
39	1.01472
40	1.04121
41	1.06754
42	1.03612
43	0.988279
44	1.00383
45	1.00515
46	1.0964
47	1.03346
48	1.00927
49	1.0144
50	1.05608
51	0.979353
52	0.96891
53	1.03392
54	1.04823
55	1.08108
56	1.11782
57	1.01607
58	1.01129
59	1.04383
60	0.983975
61	1.04365
62	0.988167

(c) Gains for the W layer.

Table 40: Preliminary Gains for Module 6 (Sector 5), run 4416

References

[1] G. Asryan et al., *https://clasweb.jlab.org/wiki/images/d/d0/Pcal_geometry_note.pdf*

[2] *https://clasweb.jlab.org/wiki/index.php/PCAL_Cosmic_Ray_Tests*