Base Line studies for SDEU

Mauricio Suárez-Durán and Ioana C. Mariş

Université Libre de Bruxelles, Belgium

Abstract

Second batch of SDEU

Introduction

At the end

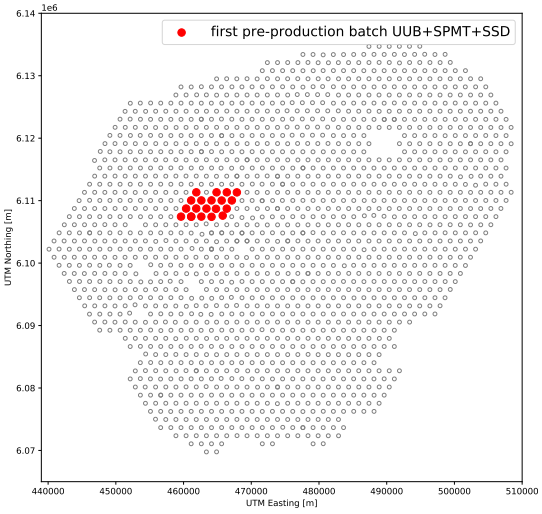

Figure 1: Stations for first pre-production batch including UUB, small PMT and SSD.

BXL: Fit method implemented in CDAS

In order to get a fit method user independent, we use the first derivative of the histogram (peak and/or charge) to find out the respective VEM value; we called this method BXL-method.

The BXL-method consist of 3 steps:

1. Smoothing the histogram,
2. Deriving the smoothed-histogram,
3. Smoothing the smoothed-derivative-histogram, i.e. the histogram getting in previous step.
4. Searching for the maximum, i.e. VEM-value.

Here, we use the moving average method to smooth the respective histogram, and central differences to derive them. The needed of two smoothing is illustrated in figures 2 and 3. There, it is possible to see how the first derivative of the histogram, without smoothing, is noisy, making difficult to search the respective VEM value. The same problem is seen for the derivative of the smoothed-histogram, of course less noisy than the former one, for this reason we apply another smooth, the third step.

To evaluate the BXL-method, we compared the VEM value obtained by this method with the one obtained by fitting a second order polynomial to the histogram (without smoot). The figures 4 and 5 show this difference for peak and charge histograms. For the peak case, the difference is $\sim 0.63\,\%$ for a VEM value of 153.03 FADC/8.33 ns for fitting (with a χ^2 reduced of 0.77), and 154 FADC/8.33 ns for BXL-method. Meanwhile for charge case $\sim 0.41\,\%$ of difference, with VEM values of 1249.13 FADC for fitting (with a χ^2 reduced of 1.01), and 1244.00 FADC for BXL-method.
After verified for a single histogram (peak and charge, respectively), we applied the method to all 863-station's peak and charge histograms, from 1st December 2020, to 31st July, 2021.

For peak cases, figures 6 (left and right), and 7 show the VEM values obtained by BXL-method and by fitting a second order polynomial, for each one of the three PMTs. As it can be seen, the VEM values getting by BXL-method agree with the ones from the fit method, differing in average less than $\sim 0.6\,\%$. These plots show that sometimes the BXL-method got a VEM value but fit method does not. Figures from 8 to 10 show the histograms for which the fitting method and/or BXL-method fail. From these results, it is possible to see that the BXL-method is more effective to find the VEM value. Nevertheless, figure 10 show that sometimes the peak histogram has not a peak for the VEM value, so the BXL-method fails just because there is not a local maximum.

Figures 11 (left and right), and 12 show the VEM values for charge histograms. There, as for peak cases, it can be seen the agreement between the VEM values getting by BXL-method with the ones from the fit method; with an average difference of the order of $\sim 0.7\,\%$. In these plots, it is possible to see some outliers for the fitting method. Figures 13 and 14 present some samples of these outliers, showing that the fitting method fails due to it does not set correctly the fitting range. The BXL-method shows to be more effective than the fitting method to find the VEM value in charge histograms.

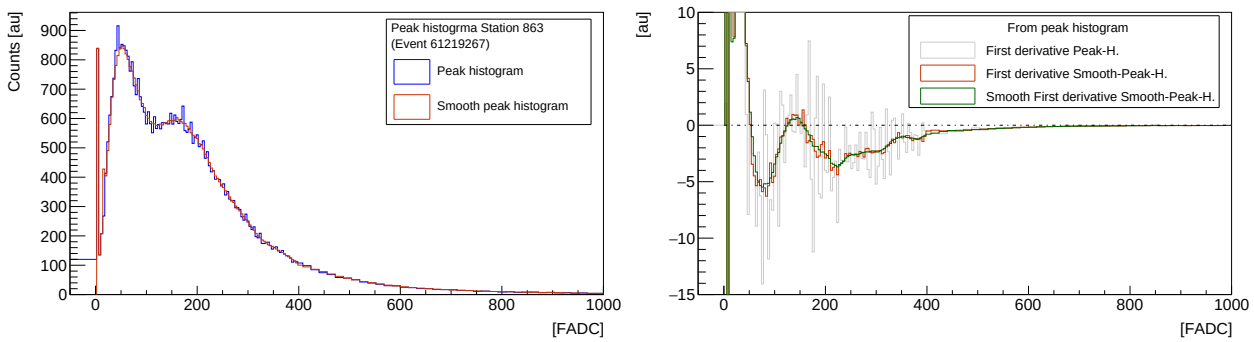

Figure 2: Fit BXL-method applied to a peak and charge histogram (UUB). Left, peak histogram in blue, and the same histogram smoothed in red. Right, derivative for peak histogram (gray); derivative for smoothed-histogram (red), and smooth of smoothed-derivative-histogram (green). It is possible to see how the green line allows to identify, very clear, the VEM position (dashed line).

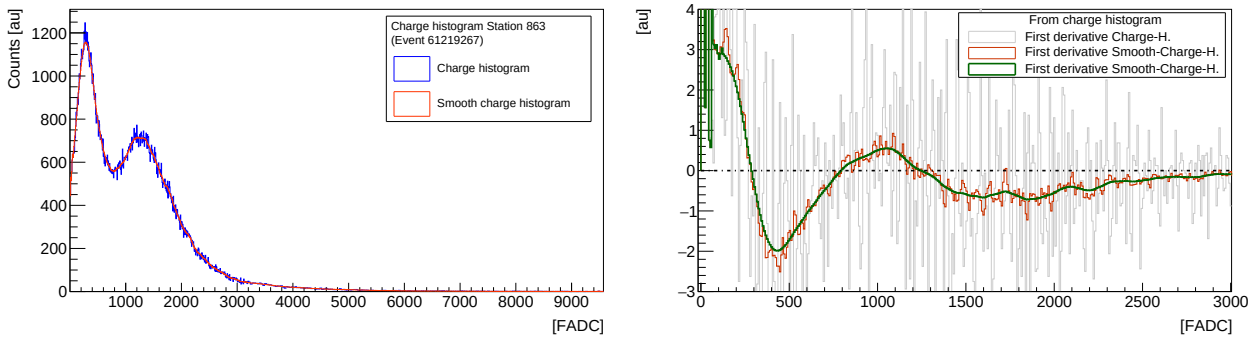

Figure 3: Fit BXL-method applied to a charge histogram (UUB). Left, charge histogram in blue, and the same histogram smoothed in red. Right, derivative for charge histogram (gray); derivative for smoothed-histogram (red), and smooth of smoothed-derivative-histogram (green). It is possible to see how the green line allows to identify, very clear, the VEM position (dashed line).

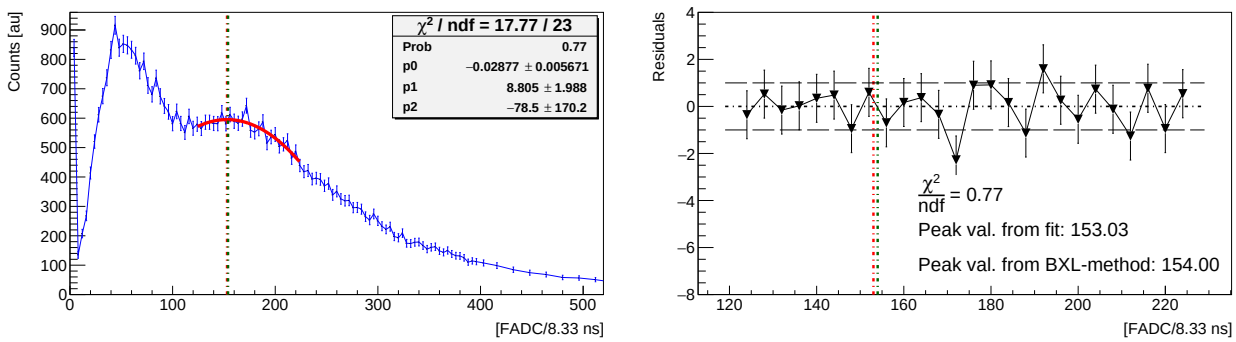

Figure 4: Comparison between the VEM value obtained for a peak histogram by fitting a second order polynomial (red line), and the same one by BXL-method. The red vertical dashed line correspond to VEM value from the polynomial fit (153.03 FADC/8.33 ns), and the green one from BXL-method (154.00 FADC/8.33 ns).

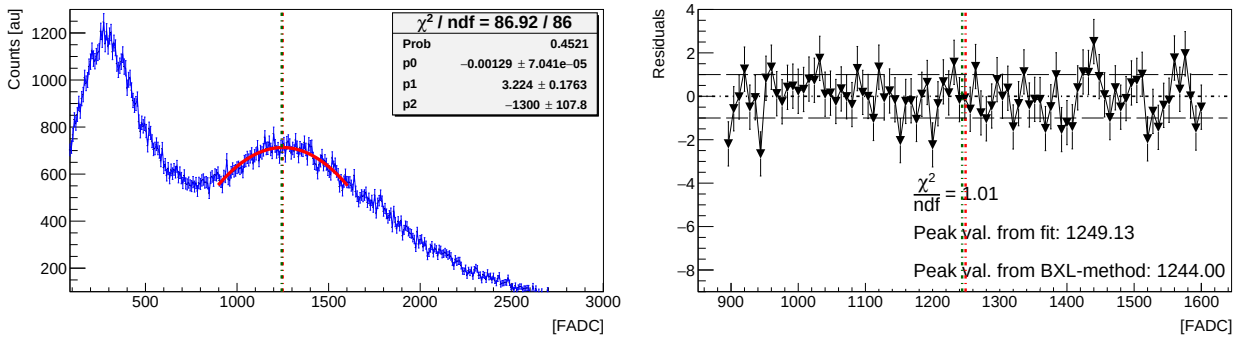

Figure 5: Comparison between the VEM value obtained for a charge histogram by fitting a second order polynomial (red line), and the same one by BXL-method. The red vertical dashed line correspond to VEM value from the polynomial fit (1249.13 FADC), and the green one from BXL-method (1244.00 FADC).

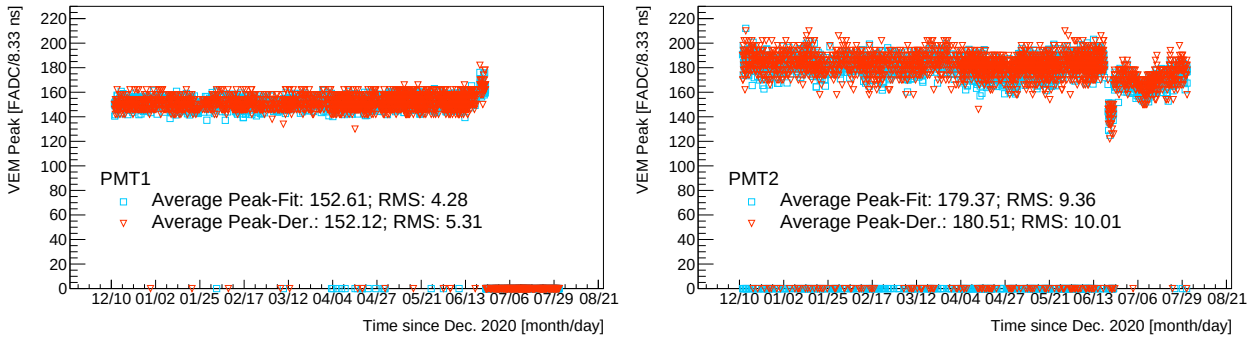

Figure 6: VEM values for 863-station's peak histograms (VEM Peak), from 1st December, 2020 to 31st July, 2021. The blue squares corresponds for values obtained by fitting a second order polynomial, and red triangles to the values from BXL-method. Right, VEM values for PMT1; left, VEM values for PMT2. It is possible to see that sometimes BXL-method gets a VEM value whereas that fitting method does not, and vice versa; see details about this in the text.

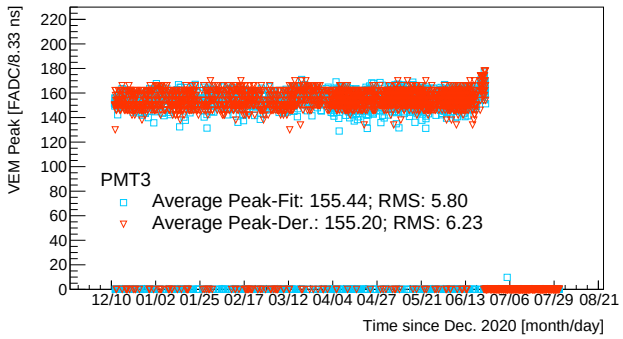

Figure 7: VEM values for PMT3 863-station's peak histograms (VEM Peak), from 1st December, 2020 to 31st July, 2021. The blue squares corresponds for values obtained by fitting a second order polynomial, and red triangles to the values from BXL-method. It is possible to see that sometimes BXL-method gets a VEM value whereas that fitting method does not, and vice versa; see details about this in the text.

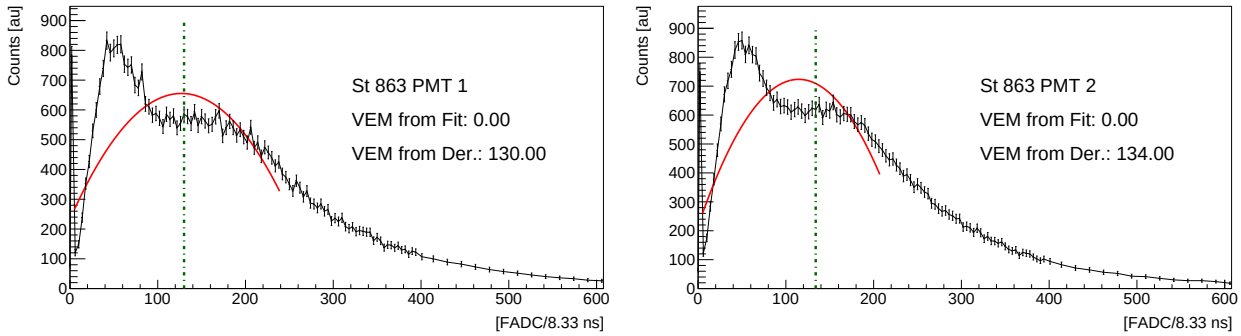

Figure 8: Peak histogram. Failed VEM value for PMT1 (left) and PMT2 (right) from fitting a second order polynomial, but a succesfull BXL-method, green dashed line.

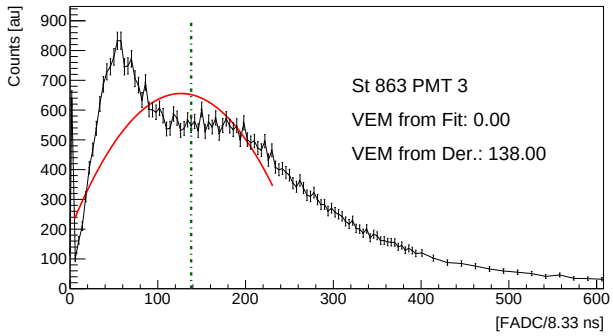

Figure 9: Peak histogram. Failed VEM value for PMT3 from fitting a second order polynomial, but a succesfull BXL-method, green dashed line.

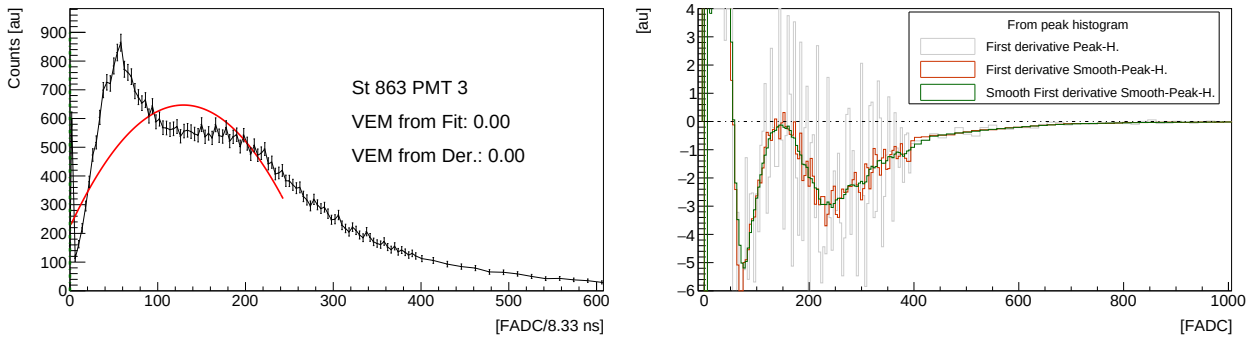

Figure 10: Peak histogram. Failed VEM value for PMT3 from fitting a second order polynomial, but a succesfull BXL-method, green dashed line.

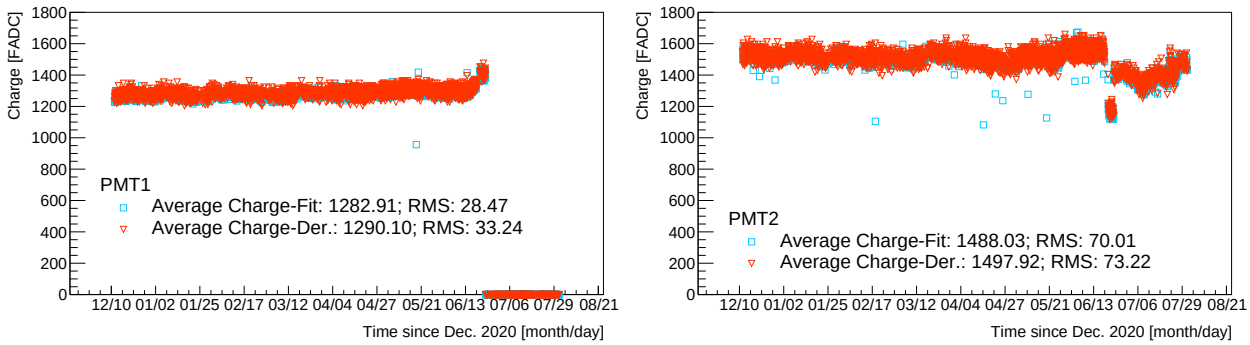

Figure 11: VEM values for 863-station's charge histograms (VEM Charge), from 1st December, 2020 to 31st July, 2021. The blue squares corresponds for values obtained by fitting a second order polynomial, and red triangles to the values from BXL-method. Right, VEM values for PMT1; left, VEM values for PMT2. It can be seen some outliers, both PMTs, for the fitting method. See details in the text.

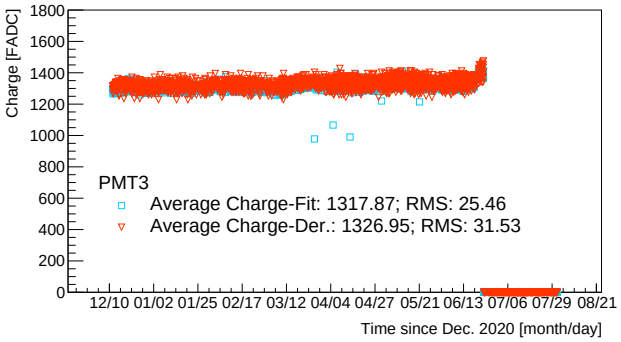

Figure 12: VEM values for 863-station's charge histograms (VEM Charge), PMT3 from 1st December, 2020 to 31st July, 2021. The blue squares corresponds for values obtained by fitting a second order polynomial, and red triangles to the values from BXL-method. It can be seen some outliers for fitting method. See details in the text.

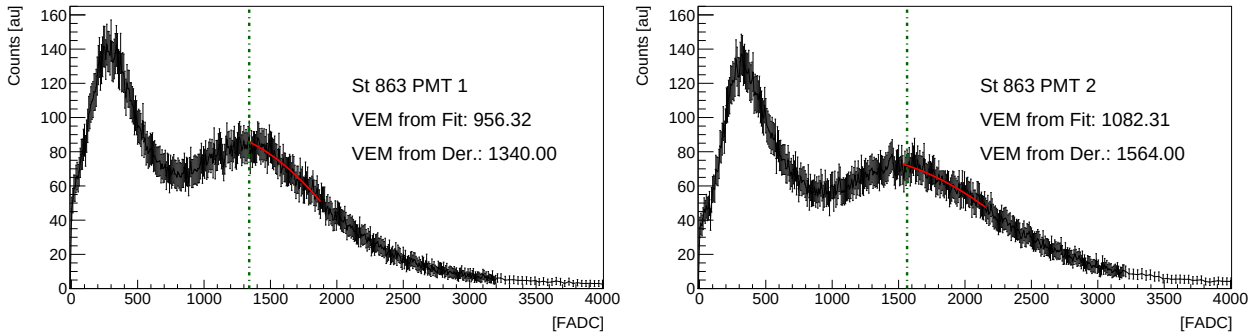

Figure 13: Charge histogram. Failed VEM value for PMT1 (left) and PMT2 (right) from fitting a second order polynomial, but a succesful BXL-method, green dashed line. For both PMTs, the fitting method fails in finding the proper interval.

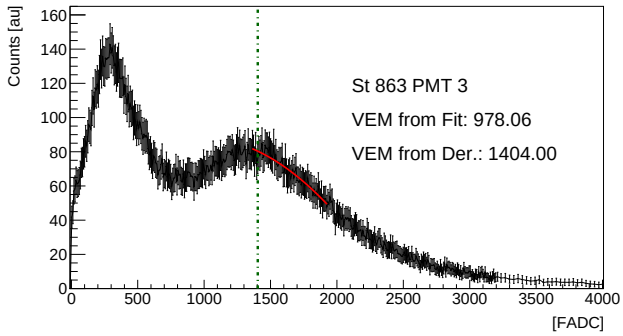

Figure 14: Charge histogram. Failed VEM value for PMT3 from fitting a second order polynomial, but a succesfull BXL-method, green dashed line. The fitting method fails in finding the proper interval.

OffLine Method

The OffLine algorithm to search for the VEM value (for peak and charge histograms) is implemented in the SdCalibrator module, using the *ad* files.

This algorithm will be applied if the maximum of counts in the histogram is bigger than 500 (a number setting by default SdCarlibrator class), and ignoring the last 5 bins. As first step to fit the histogram the fitting range is setting from the shoulderLow to shoulderHigh. Where the shoulderLow is established as the first bin with the maximum number of counts, starting from the start bin, i.e. the start bin is defined as the one with more than 40 counts (a number setting by default), from this bin, the algorithm looking for the first bin with a number of counts such that the next three bins have a number of counts lower than the 75 % of counts of this first bin; this last percentage can be setting by the user.

Peak Histograms

Comparison between OffLine SdCalibrator (ad files) and our method for CDAS files. For peak, 2 chi2/Ndof < 3.5.

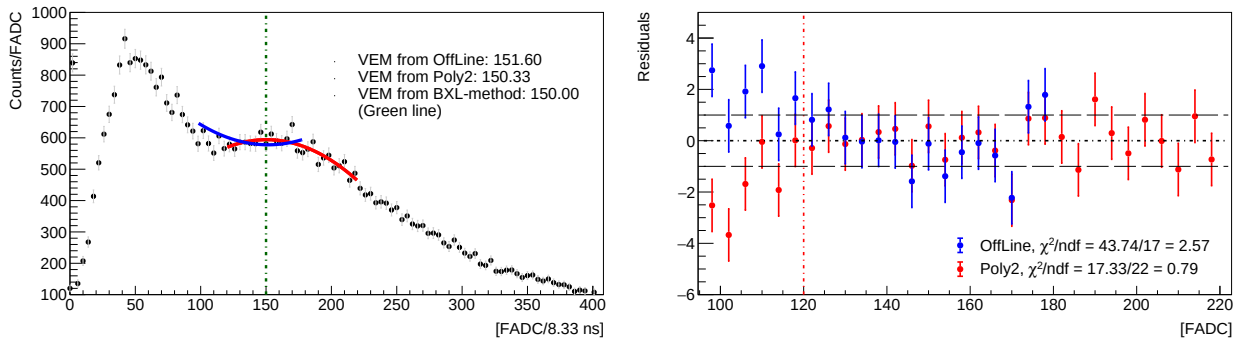

Figure 15: Peak histogram. Right, Comparison for VEM value using OffLine (blue line), second order polynomial fitting (red line), and BXL-method (green dashed line). Left, residuals for OffLine (blue points) and second order polynomial fit (red points). As it can be seen, the polynomial and BXL-method set properly the VEM value, but OffLine fit is not correct.

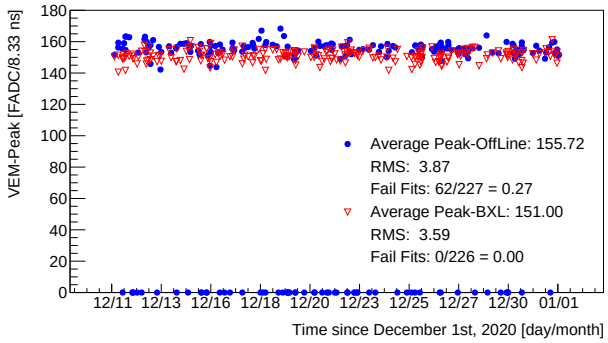

Figure 16: Comparison for VEM peak values obtained by OffLine and BXL-method, from 1st of December, 2020 to 31st of July, 2021. Here, the OffLine algorithm fails to fit some histograms (blue dots at zero counts) but BXL-method is successful for all histograms.

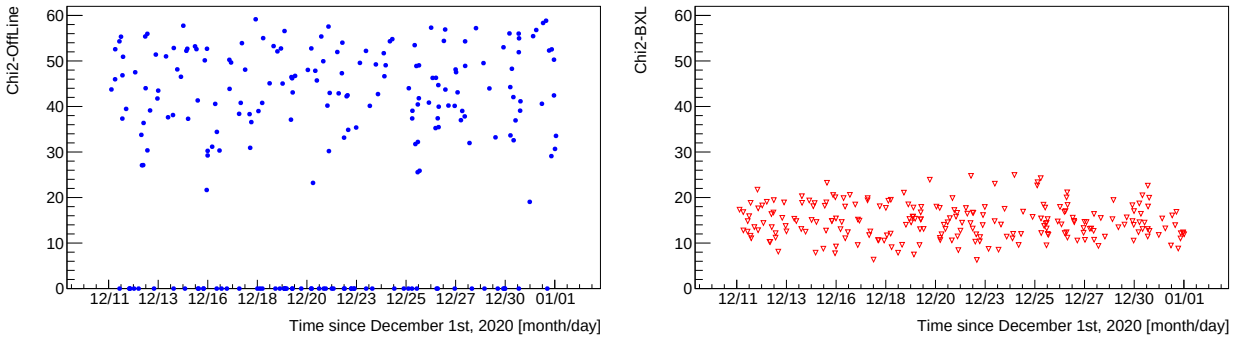

Figure 17: Stations for first pre-production batch including UUB, small PMT and SSD.

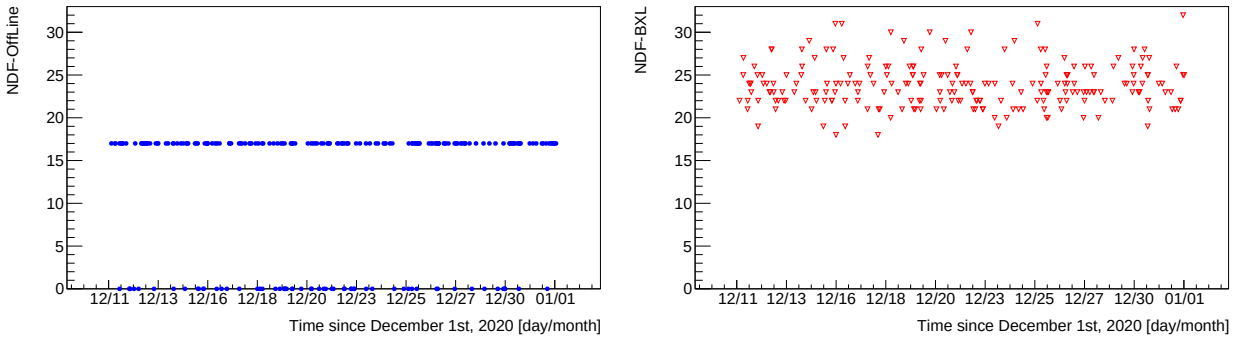

Figure 18: Stations for first pre-production batch including UUB, small PMT and SSD.

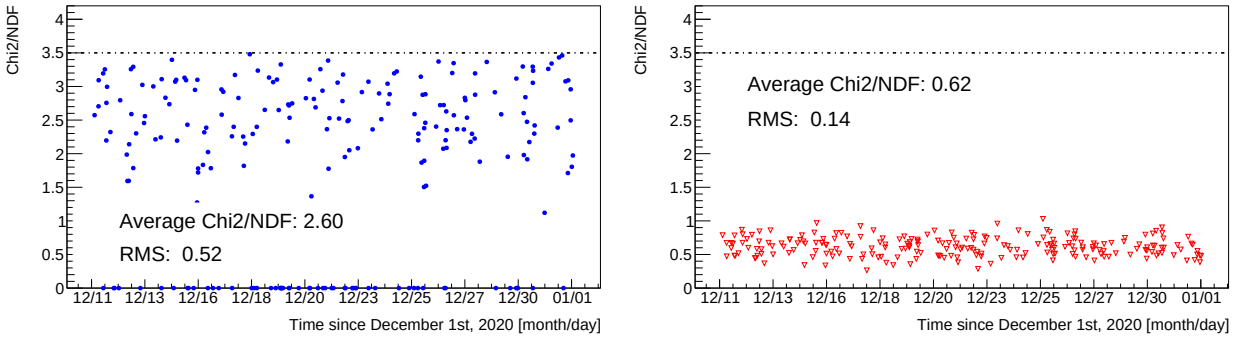

Figure 19: Stations for first pre-production batch including UUB, small PMT and SSD.

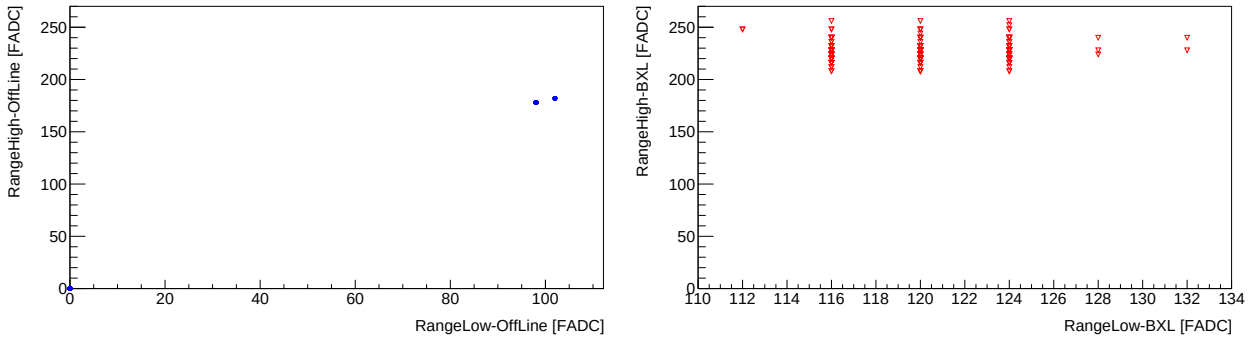

Figure 20: Stations for first pre-production batch including UUB, small PMT and SSD.

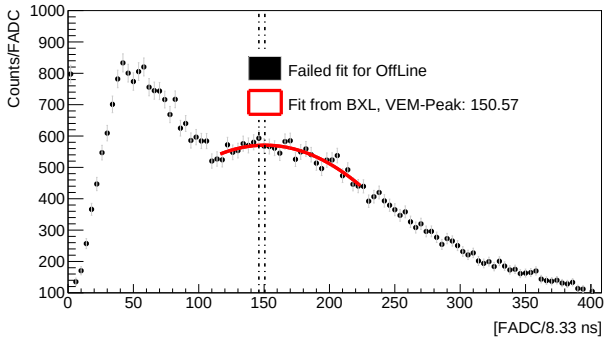

Figure 21: Failed fit Peak histogram for OffLine; event Id. 61411290, Dec 25, 2020.

Charge Histograms

Comparison between OffLine SdCalibrator (ad files) and our method for CDAS files. For charge, chi2/Ndof < 5.5. 2

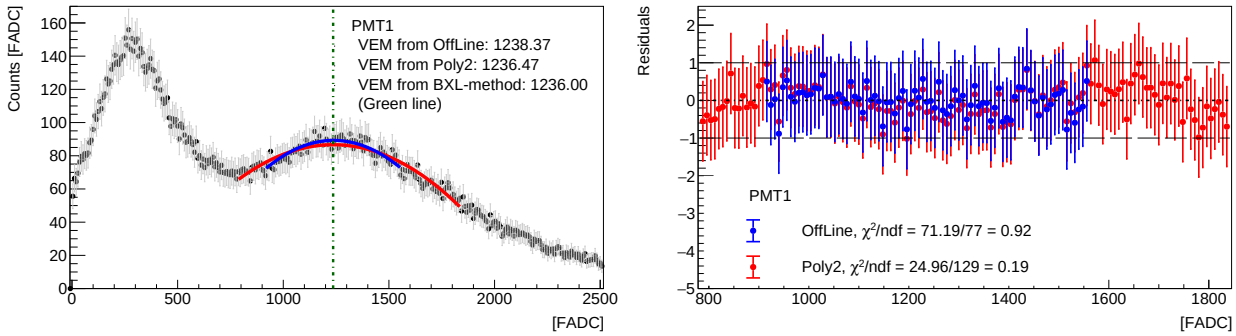

Figure 22: Charge histogram. Right, Comparison for VEM value using OffLine (blue line), second order polynomial fitting (red line), and BXL-method (green dashed line). Left, residuals for OffLine (blue points) and second order polynomial fit (red points). As it can be seen, the polynomial and BXL-method set properly the VEM value, but OffLine fit is not correct.

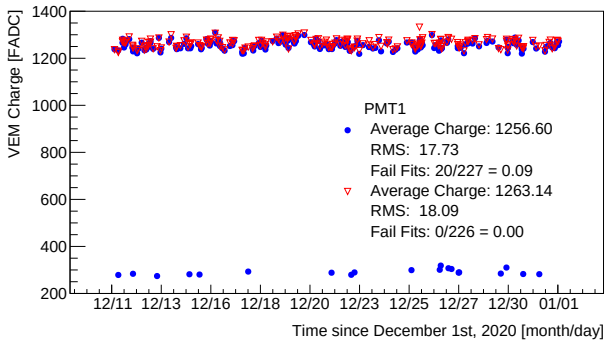

Figure 23: Comparison for VEM charge values obtained by OffLine and BXL-method, from 1st of December, 2020 to 31st of July, 2021. Here, the OffLine algorithm fails to fit some histograms (blue dots at zero counts) but BXL-method is successful for all histograms.

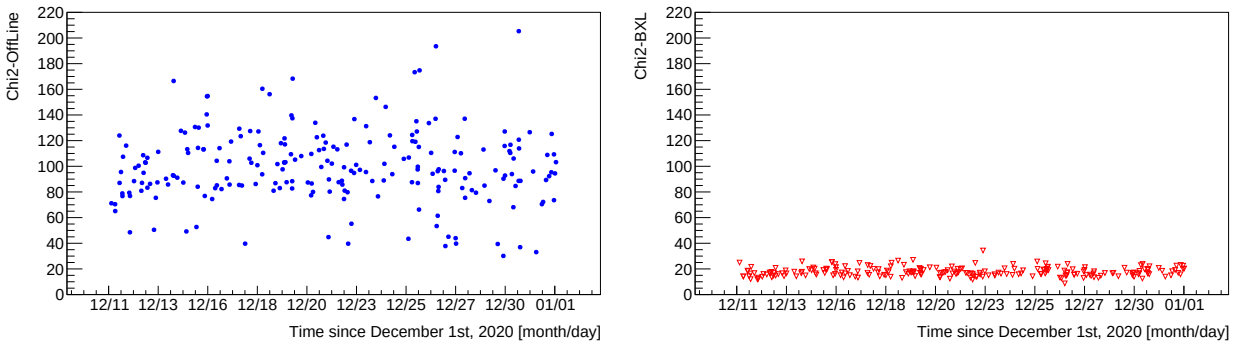

Figure 24: Stations for first pre-production batch including UUB, small PMT and SSD.

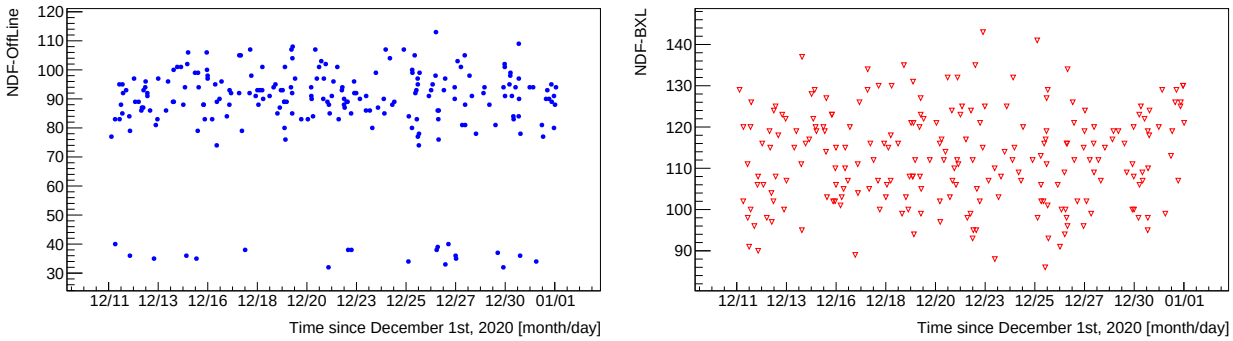

Figure 25: Stations for first pre-production batch including UUB, small PMT and SSD.

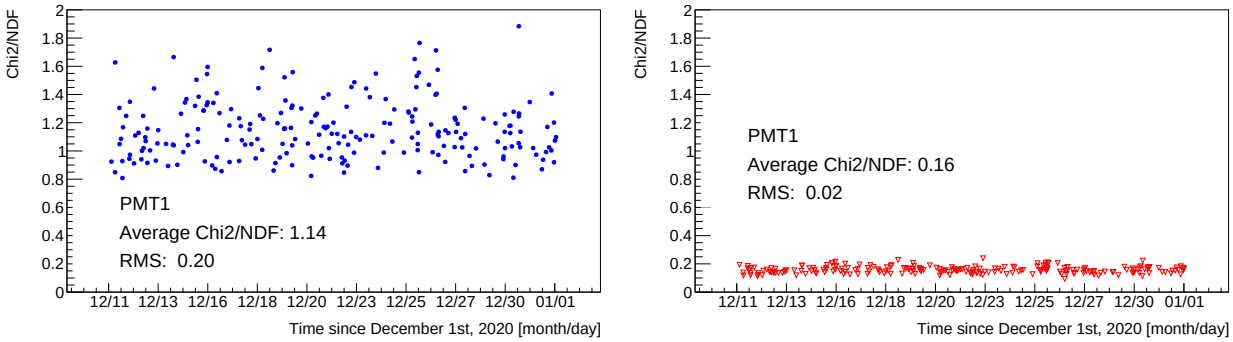

Figure 26: Stations for first pre-production batch including UUB, small PMT and SSD.

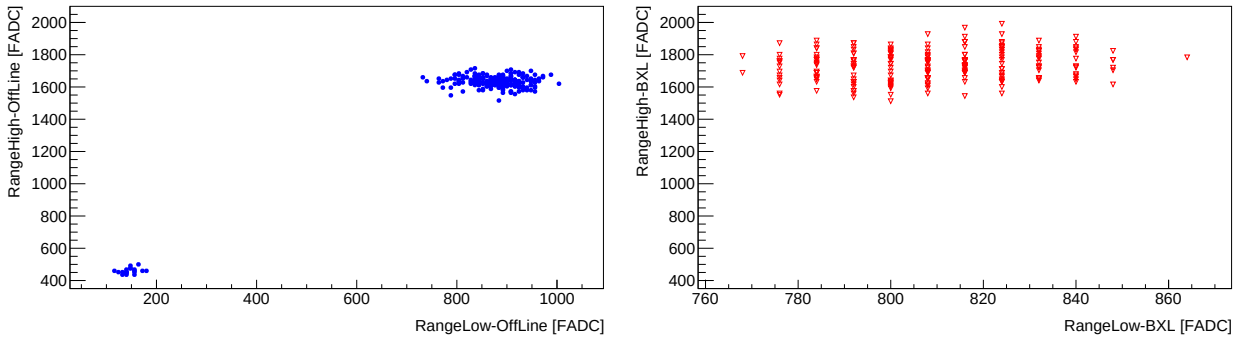

Figure 27: Stations for first pre-production batch including UUB, small PMT and SSD.

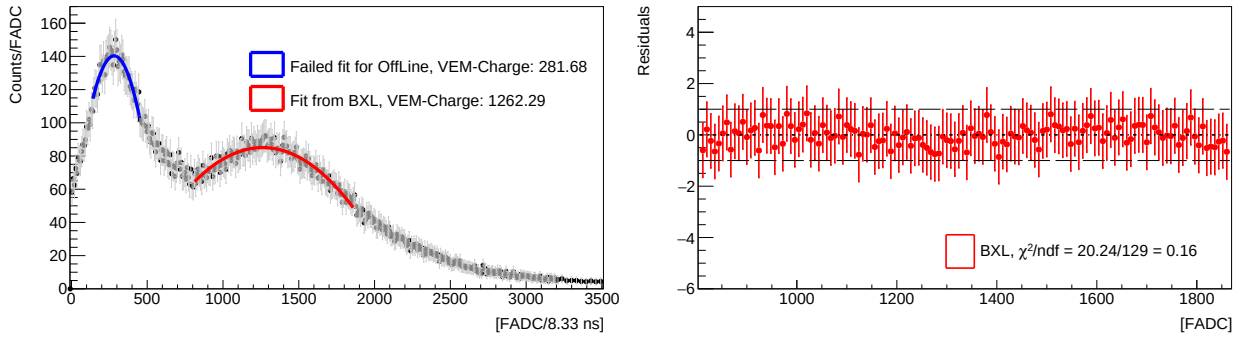

Figure 28: OffLine failed fit for Charge histogram, 863 station, event 61269719, pmt1. In red, the fit obtenined in CDAS.

Comparison for 863 and 1740 stations

863 Station Peak

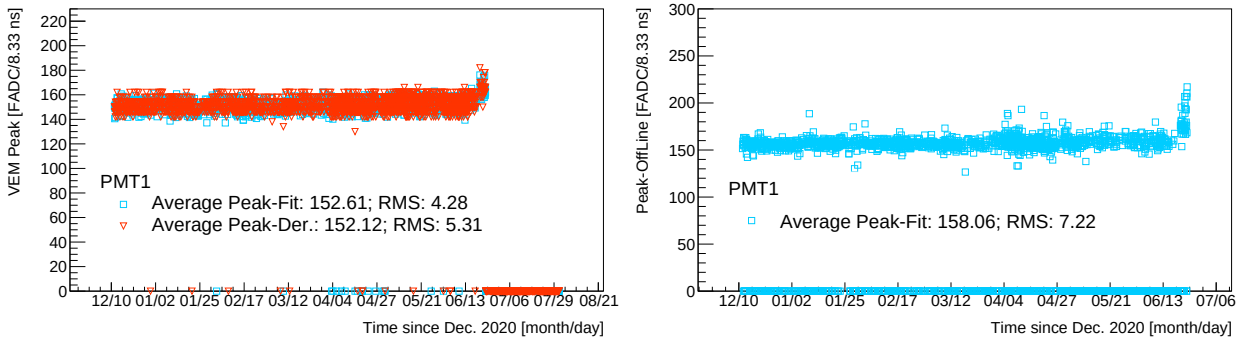

Figure 29: Stations for first pre-production batch including UUB, small PMT and SSD.

2

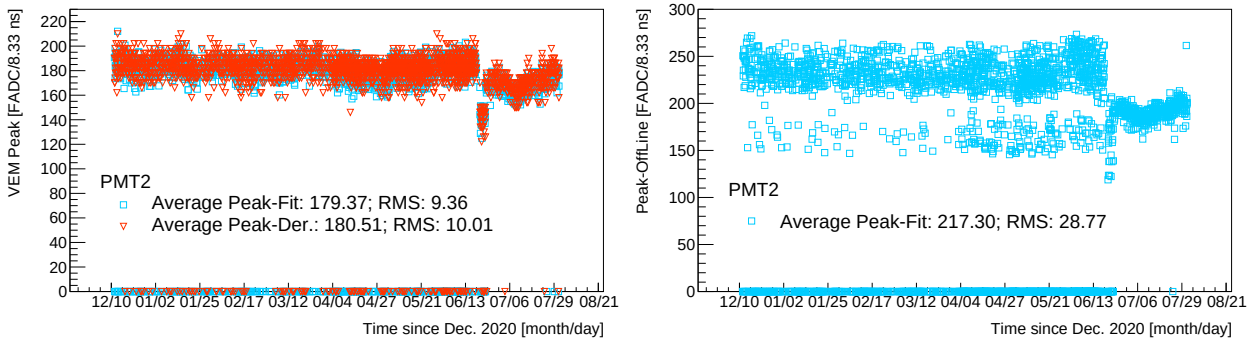

Figure 30: Stations for first pre-production batch including UUB, small PMT and SSD.

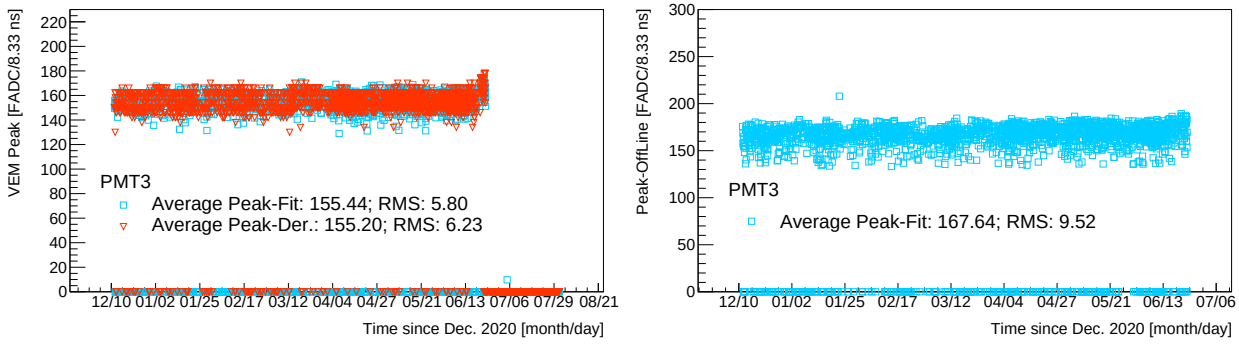

Figure 31: Stations for first pre-production batch including UUB, small PMT and SSD.

863 Station Charge

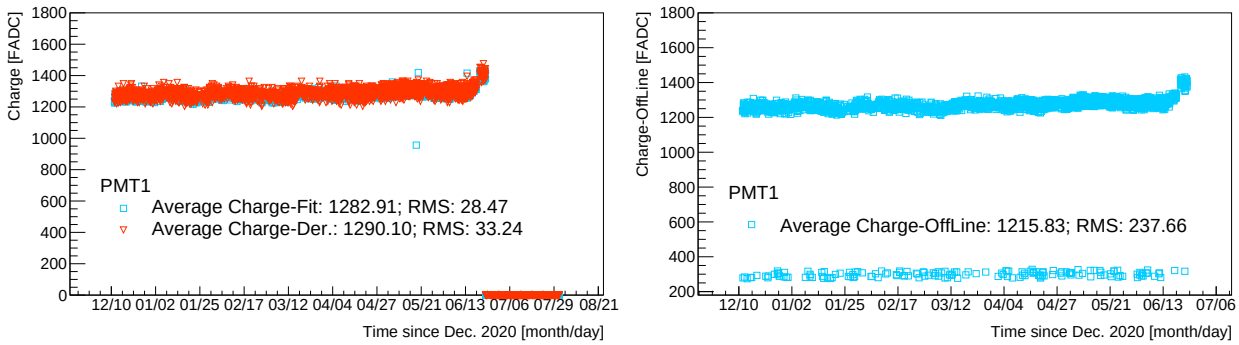

Figure 32: Stations for first pre-production batch including UUB, small PMT and SSD.

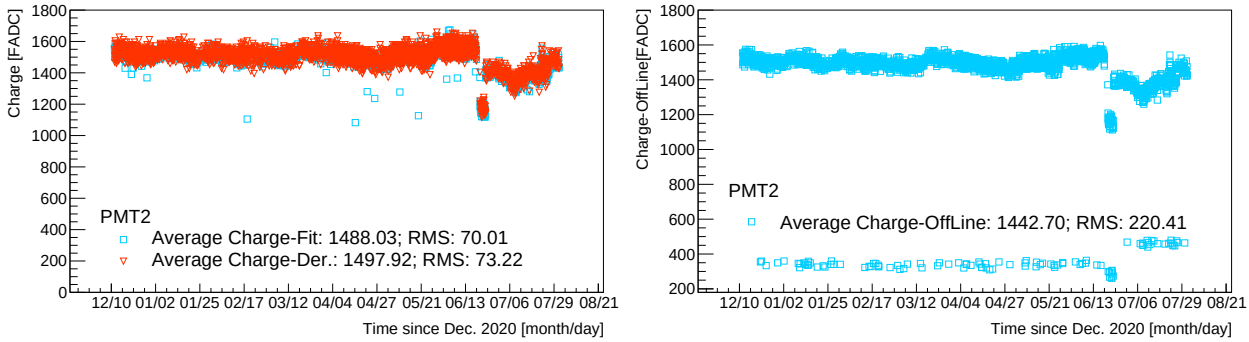

Figure 33: Stations for first pre-production batch including UUB, small PMT and SSD.

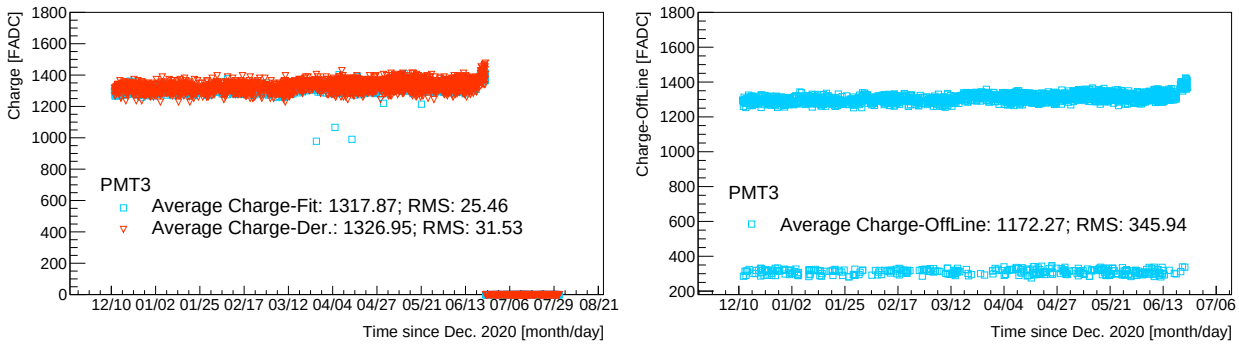

Figure 34: Stations for first pre-production batch including UUB, small PMT and SSD.

1740 Station Peak

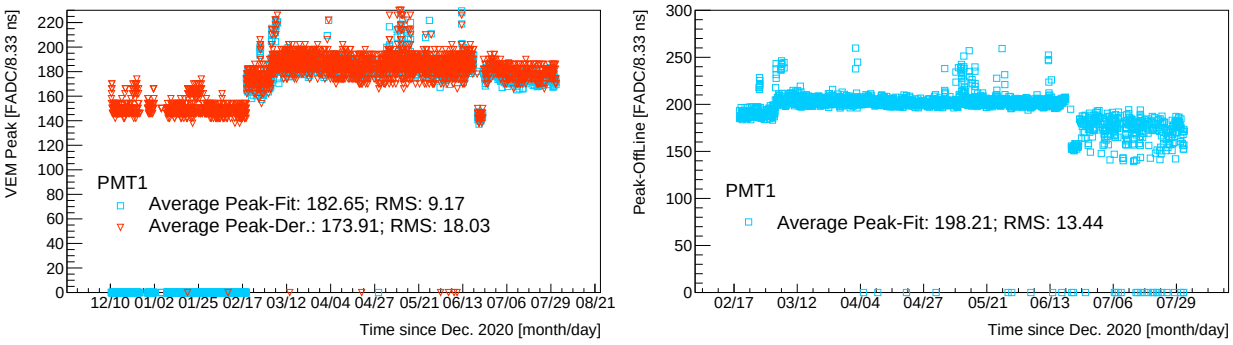

Figure 35: Stations for first pre-production batch including UUB, small PMT and SSD.

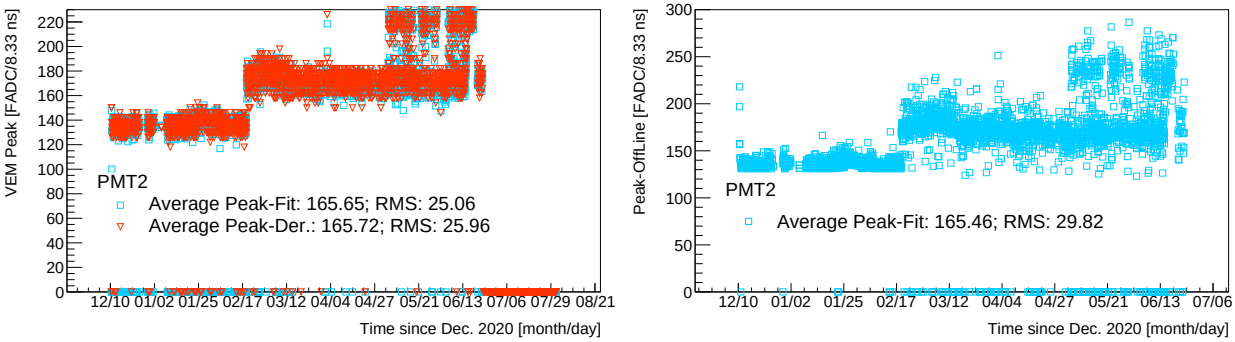

Figure 36: Stations for first pre-production batch including UUB, small PMT and SSD.

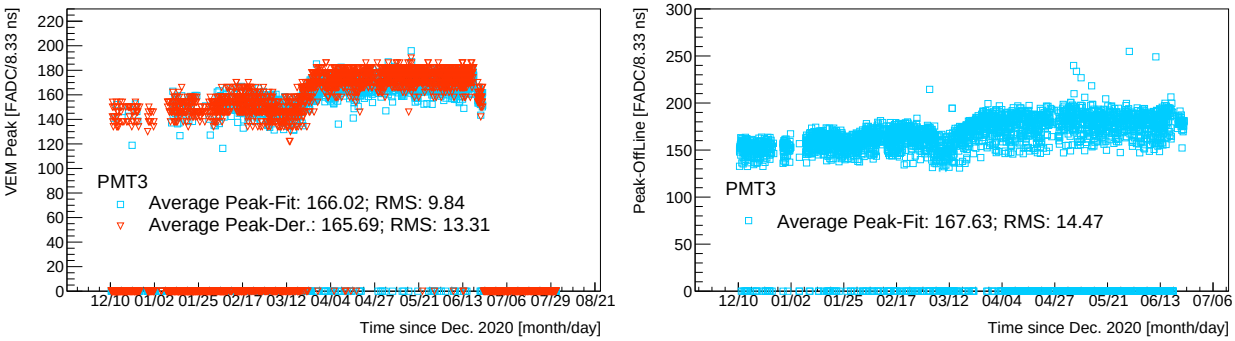

Figure 37: Stations for first pre-production batch including UUB, small PMT and SSD.

1740 Station Charge

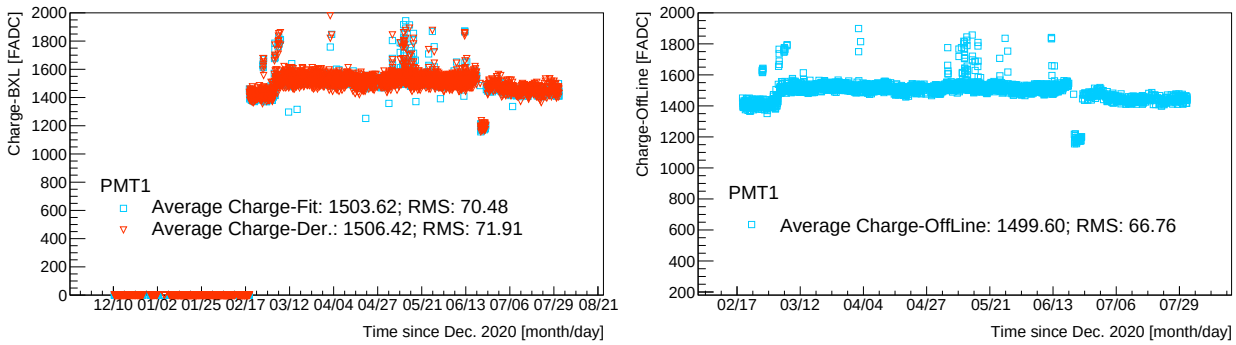

Figure 38: Stations for first pre-production batch including UUB, small PMT and SSD.

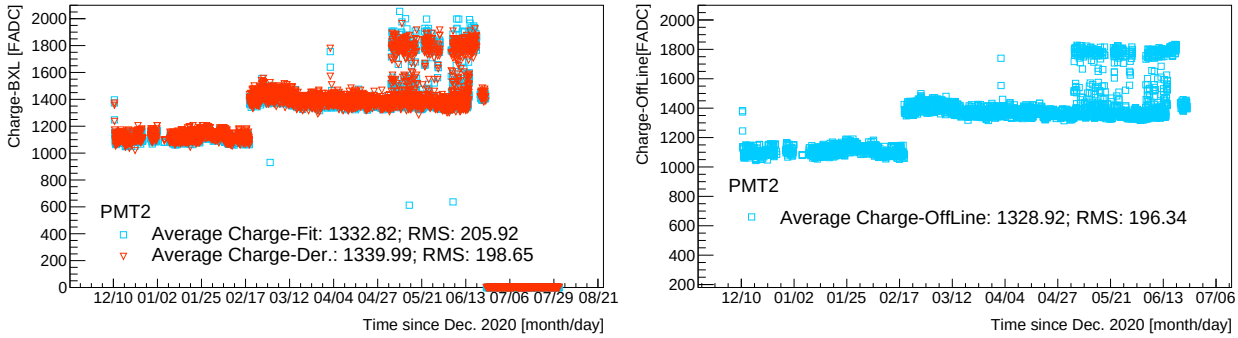

Figure 39: Stations for first pre-production batch including UUB, small PMT and SSD.

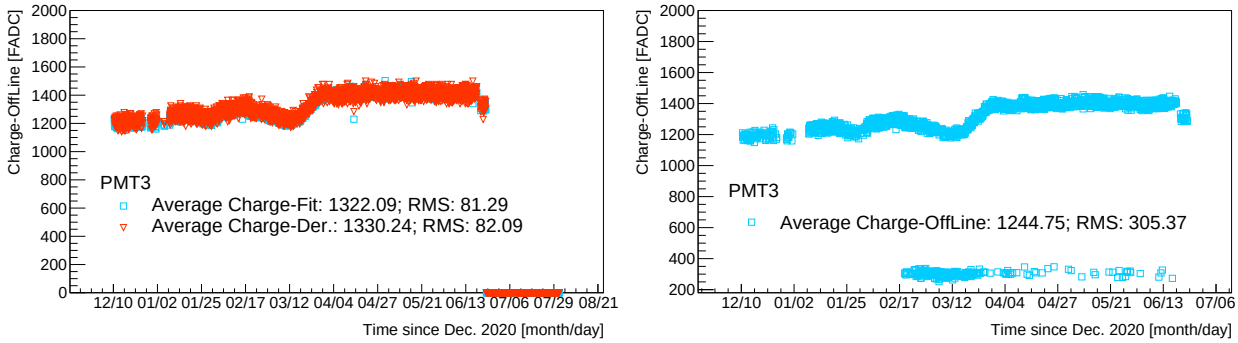

Figure 40: Stations for first pre-production batch including UUB, small PMT and SSD.