Achieving Charge Equalization for the Coordinate Detector used in the Super BigBite Spectrometer Collaboration

Katie Whitcomb, Christopher Newport University
Dr. Bogdan Wojtsekhowski, Jefferson Lab
Dr. Peter Monaghan, Christopher Newport University

Jefferson Lab
Thomas Jefferson National Accelerator Facility
U.S. DEPARTMENT OF ENERGY | Office of Science

CHRISTOPHER NEWPORT UNIVERSITY

Abstract

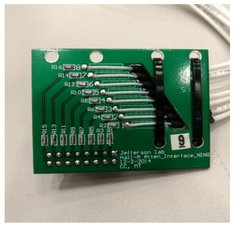
The SBS suite of experiments aims to accurately measure the electromagnetic form factors in a nucleon. Part of the SBS project includes the commissioning of the Coordinate Detector (CDet), a PMT based detector used to determine the vertical component of an electron's trajectory. The focus of this project is to equalize the ADC values for all pixels in each PMT so commissioning of CDet can progress. To normalize ADC values, the raw ADC values were recorded and used as input for a formula which outputs the resistors to be used in that pixel of the PMT. Overall, the formula used to calculate resistor values was effective, but occasionally, the initial raw ADC values appeared to be inaccurate. This resulted in recalculating resistances through several back calculations, which then produced the desired normalization. Based on these results, it is shown that charges can be effectively reduced and equalized, given the initial measurement of the mean ADC. As a result, the modules involved in CDet will continue to be commissioned.

Resistor Formula

$$R = \frac{R_{even} + R_{odd} + 50}{R_{even}}$$

Methods

- Connector boards, as shown to the right, were created to have 200 Ω resistors in the even numbered resistor positions (Reven) and wires straight through in the odd numbered resistor positions (Rodd).

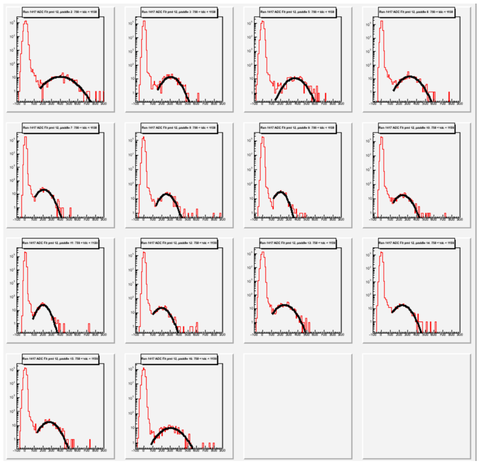


- These boards were then used to pass signals from the PMT to the NINO card
- From these signals, the mean amplitude of the ADC spectrum was determined by fitting the histogram with a Gaussian function.
- The reduction coefficient (represented by R in the Resistor Formula) was calculated for each pixel.
- After rearranging the formula above we obtain the formula below to determine the Rodd values.

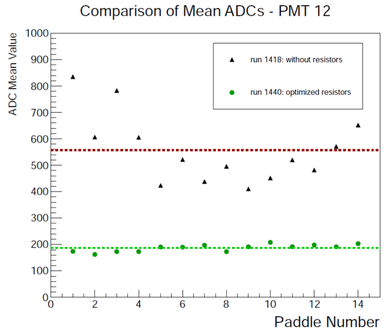
$$R_{odd} = R * R_{even} - (R_{even} + 50).$$

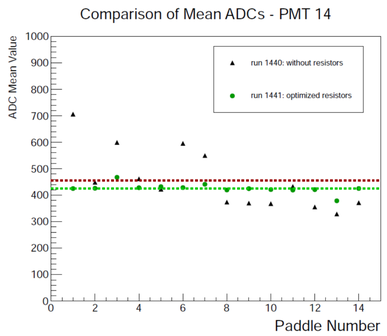
- The determined resistances are soldered onto the connector board and new data is taken.

Results

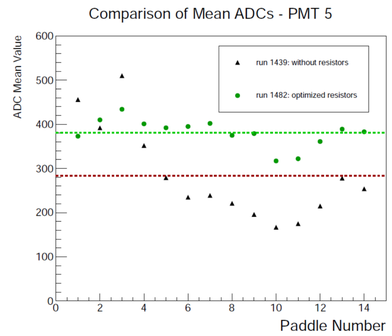


Above is an image of the ADC signals fitted by a gaussian for PMT 12 before resistors were added to obtain the raw ADC mean values.



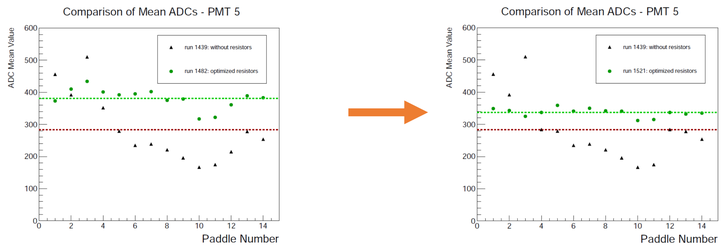


The "Comparison of Mean ADCs" plots show the mean ADC values before and after resistors were added. PMTs 12 and 14 (left) show good charge equalization whereas PMT 5 (below) needs adjustments made for normalization to be acceptable.



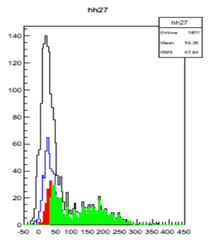
Problem Solving

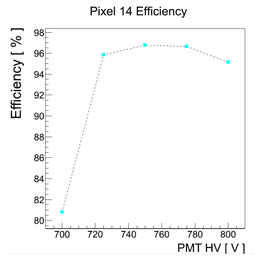
- For PMTs which needed resistor recalculation, there were two different tactics used to get the correct values.
  - ➢ Back calculating
    - ❖ Taking the ADC mean values after the first set of resistors were added and using the Resistor Formula to calculate the amount of reduction which was observed based on the resistors used.
  - ➢ Individual resistor adjustment
    - ❖ After back calculating, there were pixels which were not in range of the desired ADC mean value. Those pixels were then individually adjusted to have more or less resistance.
- Below is are images of the first set of resistances mean ADC values (left) and the mean ADC values after both back calculating and individual resistor adjustment (right) for PMT 5.



Further Application

Once the resistances have been determined and each channel has been correctly normalized, the next step in the commissioning process is determining at which high voltage value CDet produces the highest ratio of number of good ADC events compared to the total number of ADC events.





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