Characterization of Multianode Photomultiplier Tubes for a Ring Imaging Cherenkov Detector

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Abstract

Jefferson Lab’s CLAS12 detector is undergoing the addition of a RICH (ring imaging Cherenkov) detector which will allow enhanced particle identification in the momentum range of 3 to 8 GeV/c. The emitted Cherenkov photons are detected by a triangular-shaped grid of 391 multianode photomultiplier tubes (MAPMTs) made by Hamamatsu. The custom readout electronics consist of MAROC (multianode read out chip) boards controlled by FPGA (Field Programmable Gate Array) boards, and adapters used to connect the MAROC boards and MAPMTs. The focus of this project is the characterization of the MAPMTs with the new front end electronics. Future work involves using the collected data in calibration procedures and analyzing that data to resolve the best location for each MAPMT.

Setup

- The Black Box Setup and MAPMTs

A black box setup was constructed with a picosecond diode laser along with low and high voltages.

Data Analysis

- MAROC Gain and Scale

MAROC gain versus the signal amplitude (or charge) averaged over the probability density function, shows that the gain and scale have a linear relationship, as desired.

Results

- Single Photoelectron (SPE) Spectra

Analysis of single photoelectron (SPE) spectra (extracted from the characterization data), provides important information about the MAPMT. By utilizing and fitting a mathematical model developed at Jefferson Lab, we are able to extract various parameters of the MAPMT.

Conclusion

All MAPMTs (391 + 39 spares) have been characterized prior to the completion of the detector. Following characterization, the MAPMTs are able to be calibrated for optimal performance in the RICH detector.

- Continued Characterization, Calibration

A gain map is used to implement the gain values for each channel in the MAROCs. By analyzing the scale for each pixel in the MAPMT, the gain map was created. The goal creating a new MAROC gain map is to allow the MAPMT to have equal scale for all pixels.