Commissioning and Installation of Coordinate Detector for Super BigBite Spectrometer

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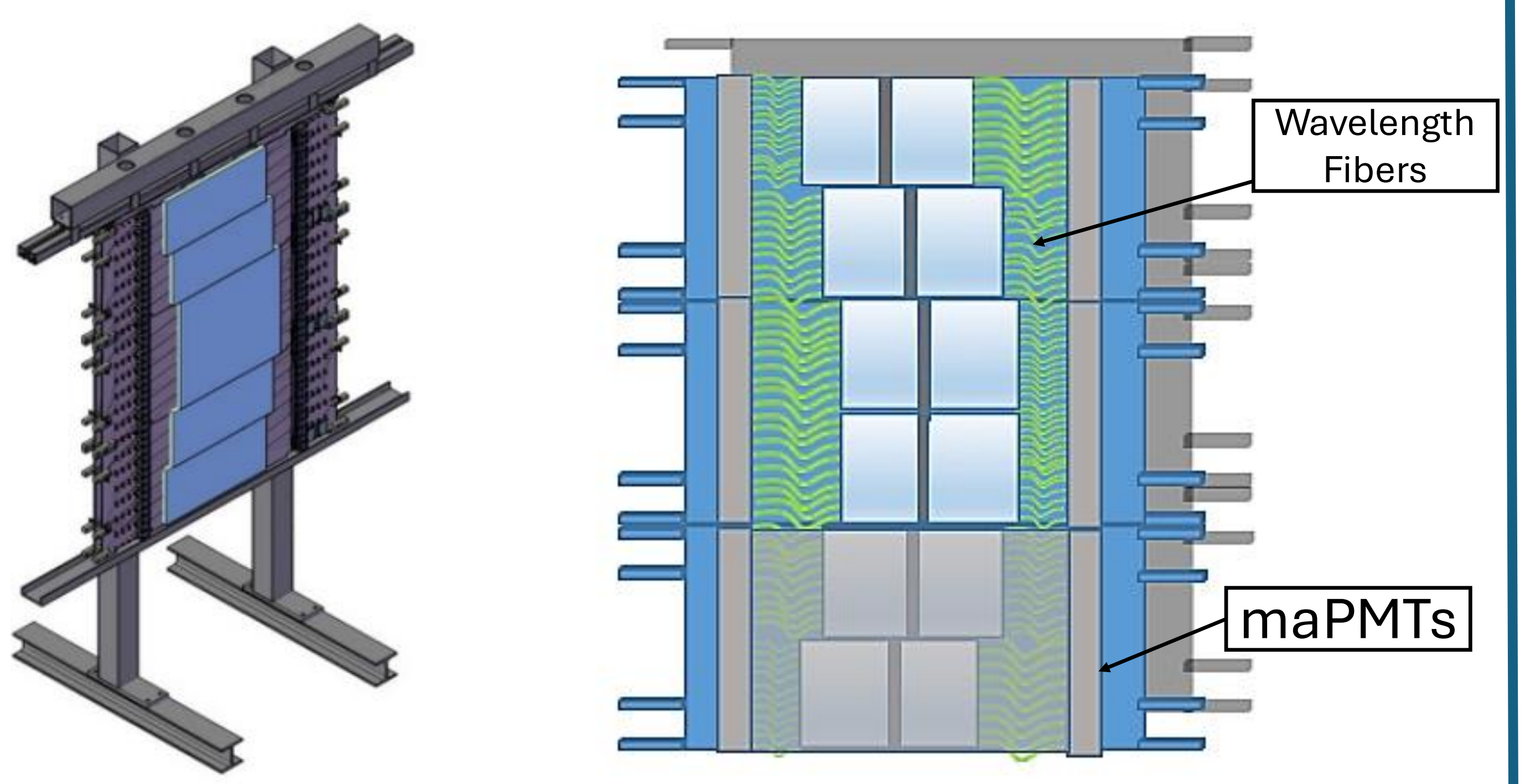
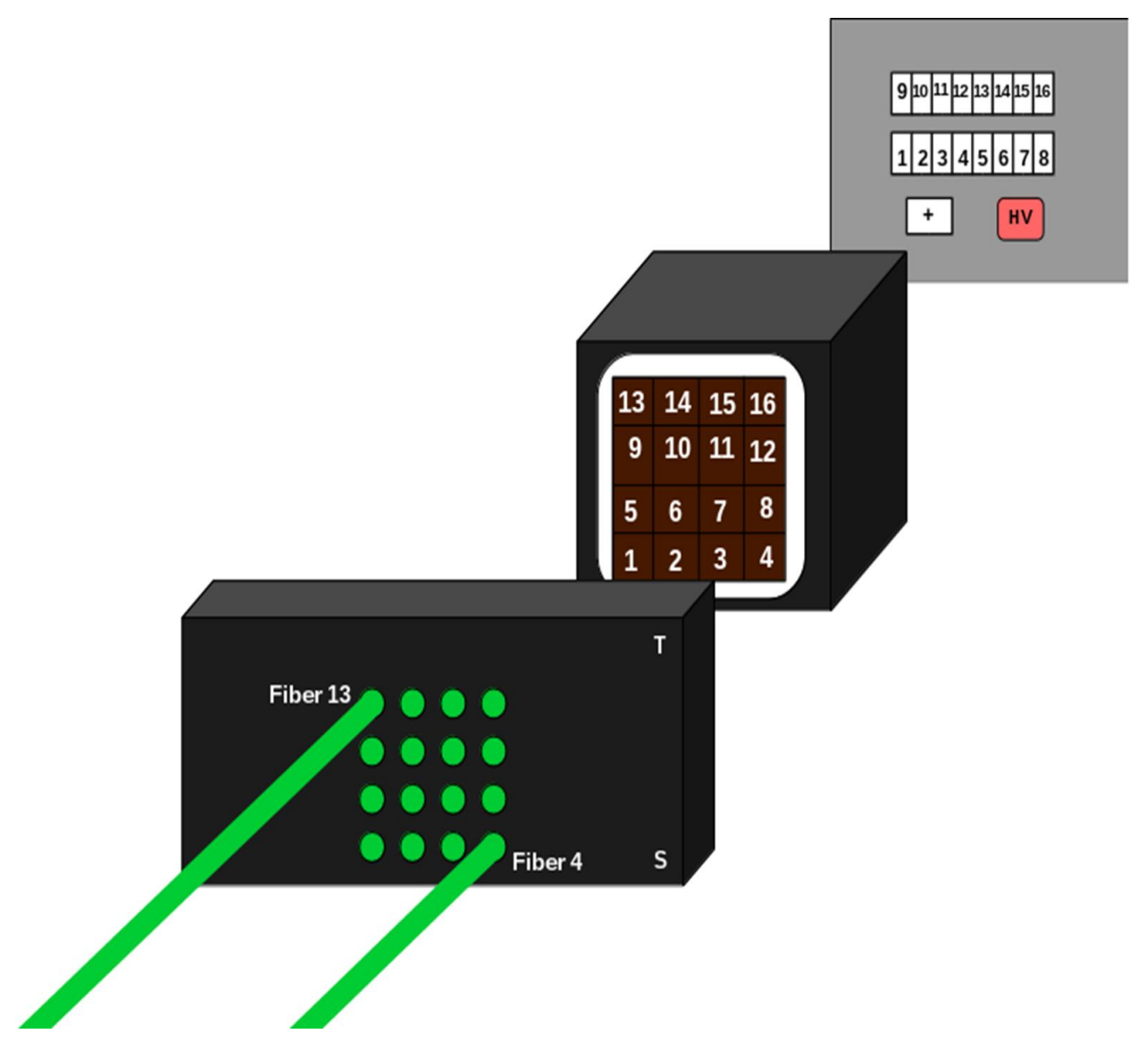
Abstract

Hall A at Jefferson Lab is operating a modular electromagnetic spectrometer, called Super BigBite (SBS), to investigate the charge distribution within nucleons. SBS uses a coordinate detector (CDet) to track the scattered electron position. The detector measures vertical displacement to determine the out-of-plane angle of the electron's trajectory.

Detector Design



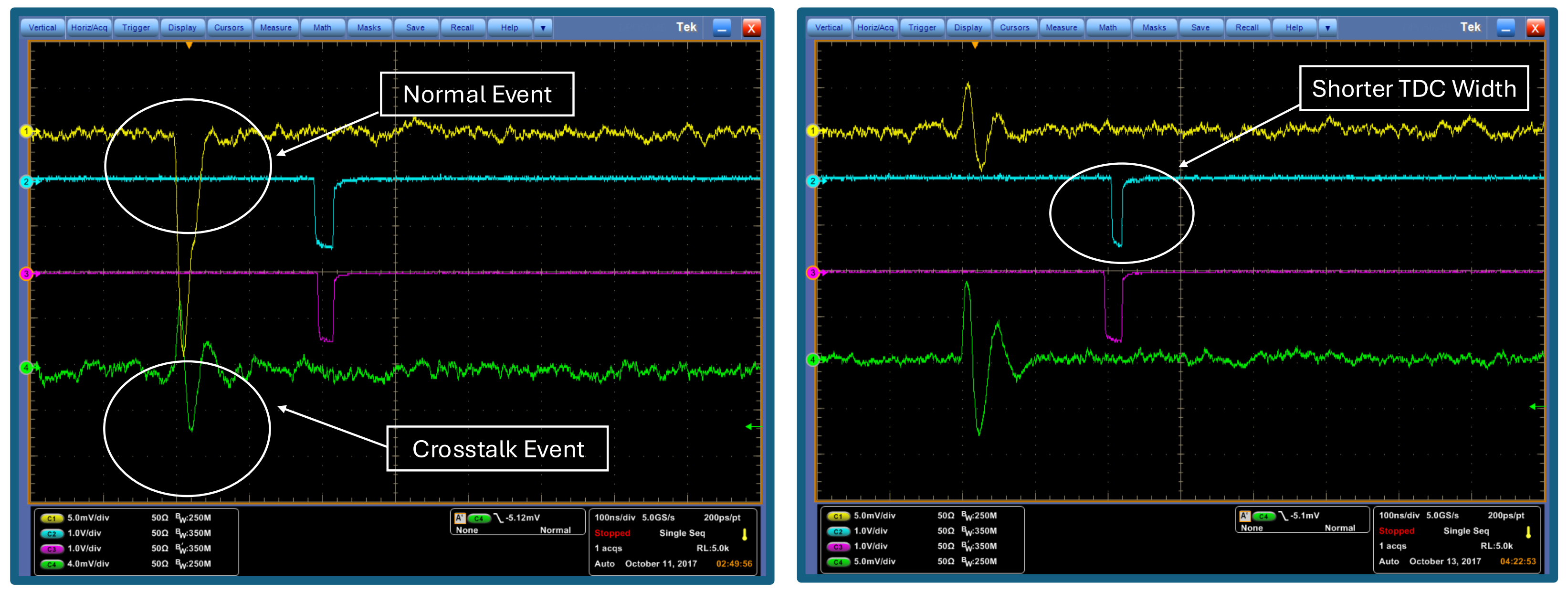
An integral aspect of the detector design is the use of Multi-Anode Photomultiplier Tubes (maPMTs). These convert photons into charge signal, which is later used for analog (ADC) and logical (TDC) signals.



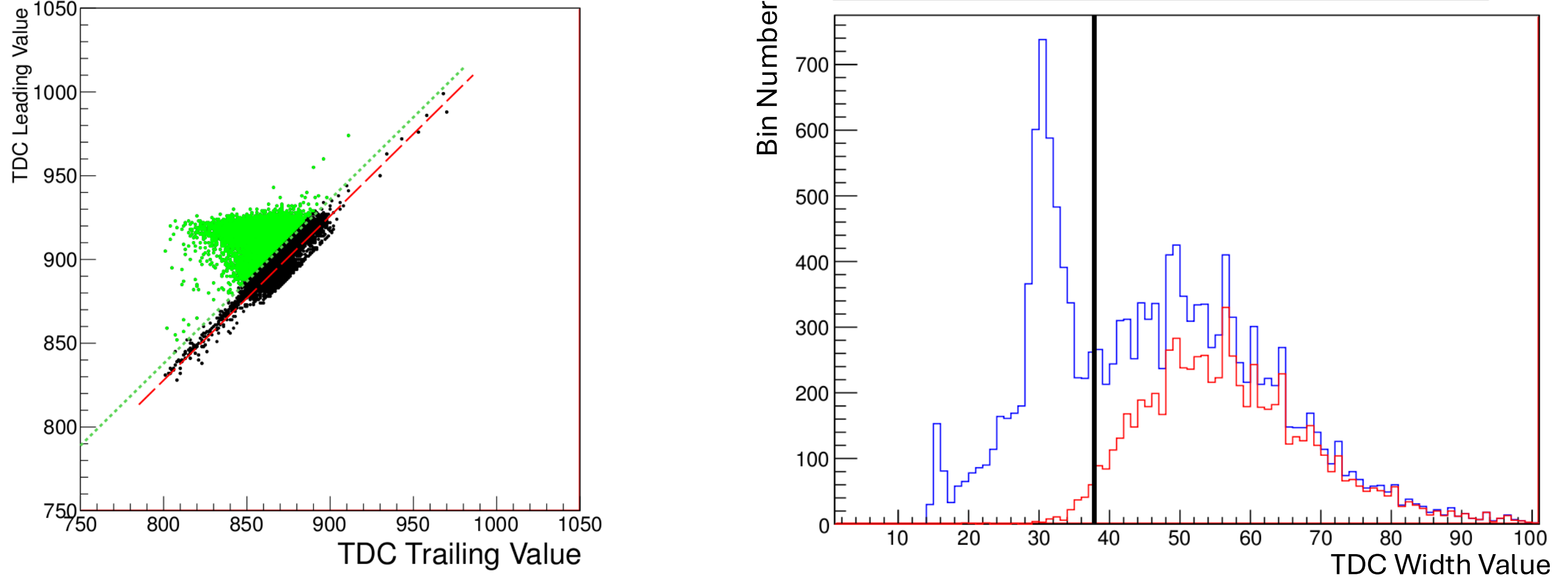
The figure to the left shows the structure of one of the maPMTs. Green wavelength fibers deliver the light signal to each pixel of the maPMT, and the charge output to each corresponding channel is located on the back of the device (gray). These PMTs are powered with high voltage.

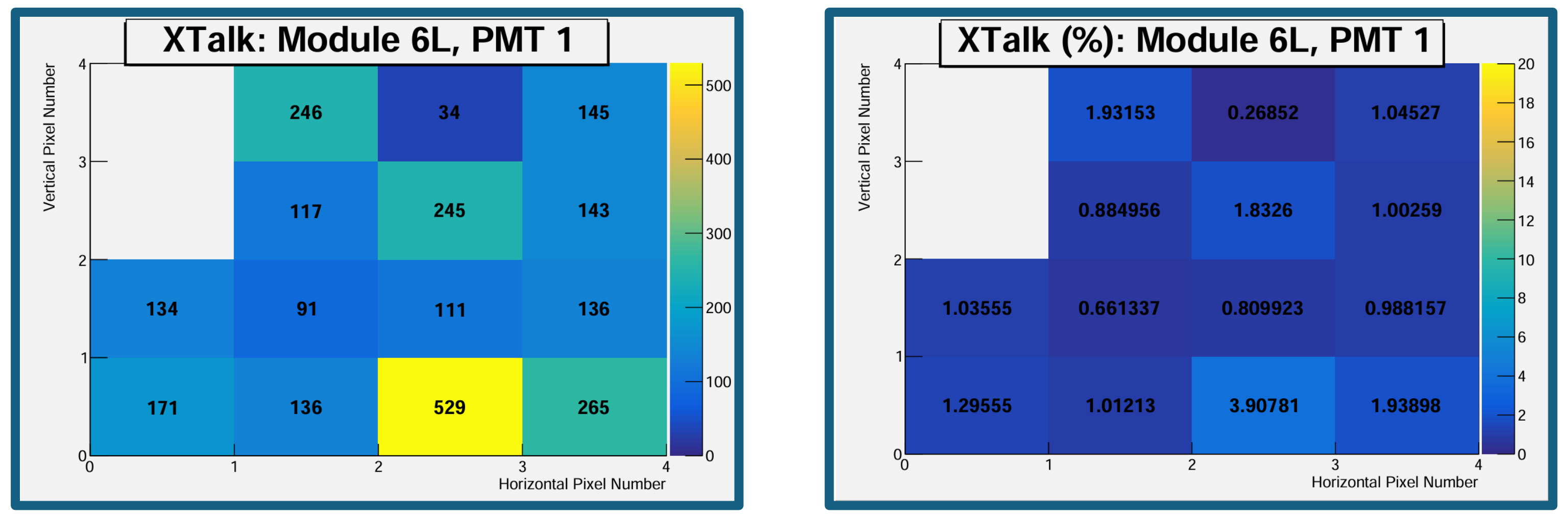
Crosstalk Methodology

A primary issue when collecting data is crosstalk between the maPMTs. A crosstalk event occurs when a signal in one channel is also registered in another channel due to capacitive coupling within the PMT. Crosstalk events are identified by their characteristically short time widths. This is analyzed with a multi-input oscilloscope (below).



Having recognized the short TDC widths, a cut is performed to analytically reduce the number of crosstalk events in each PMT channel (left). A linear fit (red) filters outliers and a shift (green) finds the final value for the TDC cut. The quality of the cut is analyzed (right) on the TDC spectrum to see how well crosstalk events were cut out.





XTalk: Module 6L, PMT 1

	246	34	145
	117	245	143
134	91	111	136
171	136	529	265

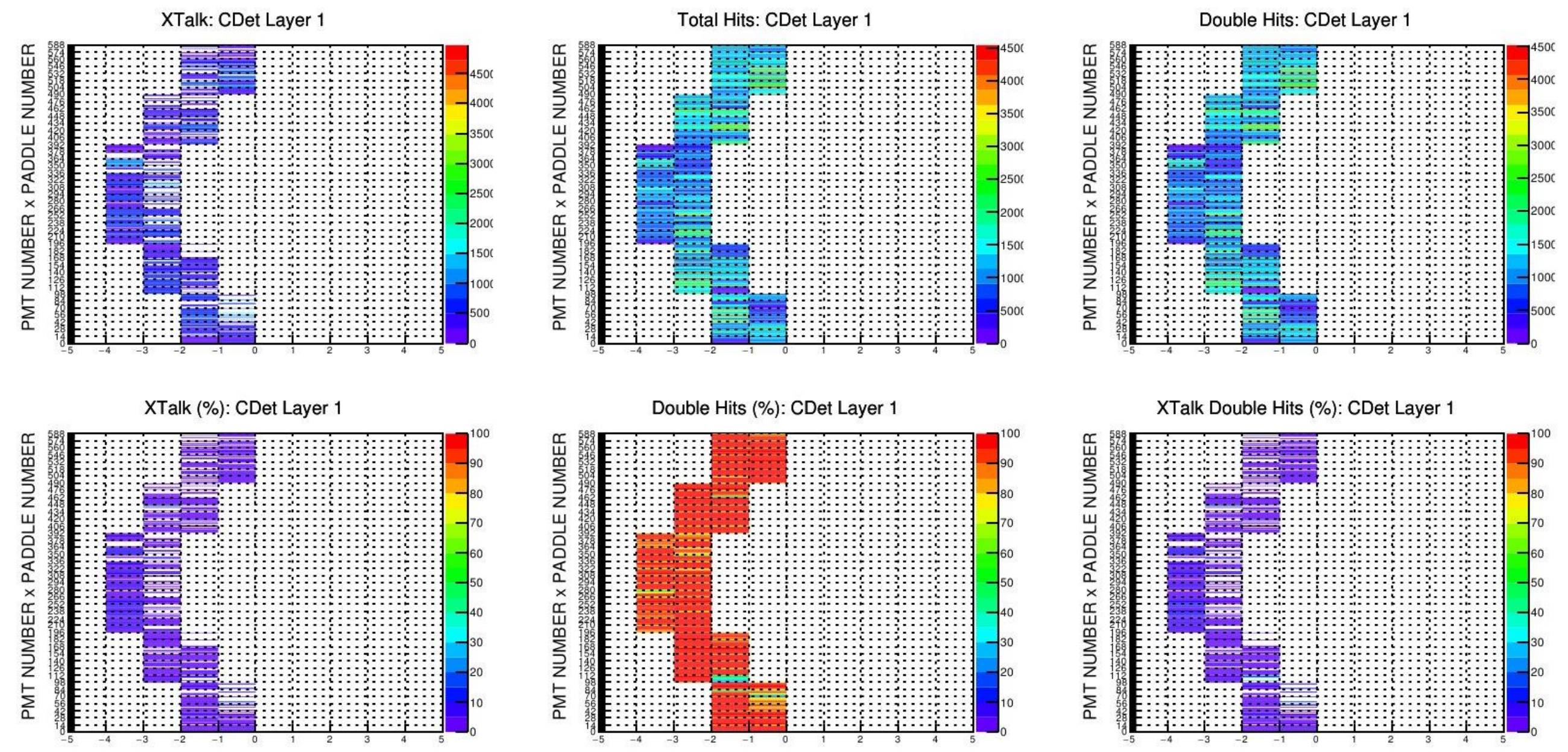
XTalk (%): Module 6L, PMT 1

	1.93153	0.26852	1.04527
	0.884956	1.8326	1.00259
1.03555	0.661337	0.809923	0.988157
1.29555	1.01213	3.90781	1.93898

Heat maps (above) are generated to analyze the effectiveness of the crosstalk suppression in each PMT pixel.

Results

Analysis was run for the first PMT on the left side of Module 6 (PMT1, M6L). On each pixel of PMT1, there are an average of 161.67 crosstalk events, with outliers of 529 hits and 34 hits. This PMT has a total hit average of 13,446.29, meaning 1.33% of events in PMT1 are crosstalk events. Crosstalk analysis concluded with the generation of a module wide data graph to use when the experiment is running in Hall A. This data graph gives useful information for all PMTs on M6L including total hits, crosstalk hits, and double pixel hits.



Conclusion and Future Work

The successful installation of CDet will support running experiments with SBS and further investigation of nucleon structure. Future work on this project includes final large-scale installation of CDet into Hall A, expanding efficiency analysis code to be detector wide, installing connectors to additional ribbon cables, and complete calibration analysis after installation.

Acknowledgements

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