

Overview of MicroBooNE Readout Electronics

MicroBooNE readout electronics consists of three categories of electronics: the trigger module, PMT readout electronics, and TPC readout electronics. Both PMT and TPC readout consists of several front-end modules (FEMs) and data transmitter modules (XMIT). The FEMs records incoming ADC data with algorithm logic implemented in FPGA firmware program. One TPC FEM can readout 64 channels while PMT FEM covers 48. There are 15 TPC FEMs installed in one readout crate with an independent low voltage power supply, and there are 9 TPC readout crates to readout 8256 wire channels, the whole MicroBooNE detector. There is only one PMT readout crate as there are only 64 PMT channels (there are 2 readout channels per PMTs with different electronics gains). In each readout crate there is one XMIT module which is responsible for collecting data from all FEMs in the crate and send to the online server machines through an optical fiber cable upon receiving a readout trigger from the trigger module. The trigger module is installed in the PMT readout crate, and sends out trigger signal to all readout crates via ethernet cable. Individual readout crate carries a clock module that is synchronized with the main clock module with 128MHz oscillator crystal. Electronics modules in each crate is synchronized with this clock signal.

In each event readout, we record 8256 TPC wire signals for 4.8 ms, digitized at 2 MHz and compressed. The TPC FEMs apply Huffman compression algorithm to reduce data volume (total of > 150 MByte/s) by a factor of 5 in the presence of noise in real MicroBooNE data. The PMT FEMs, unlike TPC FEM, can apply zero-suppression algorithm using a constant-fraction-discriminator logic with configurable threshold to record signals from cosmic-ray muons. Upon neutrino beam arrival, it issues an unbiased readout window of 23.4 micro-seconds for each PMT readout channel in order to record the full details of the signal waveform. In addition, both TPC and PMT readout systems are equipped with SuperNova (SN) readout stream which is a non-triggered, continuous readout stream using a zero-suppression algorithm.