Intensity Frontier Fellowship Summary

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1 Introduction

The Intensity Frontier Fellowship facilitated my long-term residence at Fermilab beginning in April 2015. I was able to work closely with other members of the DUNE 35t prototype simulation and reconstruction group, which significantly aided my progress on my primary focus of stopping muons in the 35t as well as other 35t-related subjects. I also had the opportunity to work directly with hardware, letting me assist in the testing of the 35t photon detector components and the LBNE calibration module.

2 Zero Suppression

Working closely with Tom Junk, I wrote a zero suppression function for the RawData package of LArSoft to be run on simulated data produced for the 35t prototype and the DUNE far detector. The zero suppression allows for a region of interest to be saved around data that is above threshold in both time and space: adjacent ADC values within a user-set number of time ticks are retained, as well as ADC values taken at the same time on a user-set number of neighboring wires on either side of the wire with the signal above threshold, as shown in Figure 1.

3 Electronic Noise

I have been in charge of overseeing DUNE's electronic noise simulation for the TPC wires. To assist Tingjun Yang's production of Monte Carlo Challenge (MCC) sets for the 35t and DUNE far detector, I conducted tests of two different models of noise generation, checking the output of the original randomized exponential spectrum noise against a white noise model borrowed from MicroBooNE.

4 Online Filter for Stopping Muons

To obtain a larger sample of stopping muons from the 35t detector, I have developed an algorithm to select stopping muon candidates based on counting the numbers of hits (reconstructed with fast hit finding that does not perform fits) inside the top center TPC (number 5) and in the rest of the 35t detector. The candidate is rejected if the event does not contain the minimum number of hits in TPC 5 and contains over the maximum allowed hits in the rest of the detector. Preliminary results on Monte Carlo indicate that the filter can have

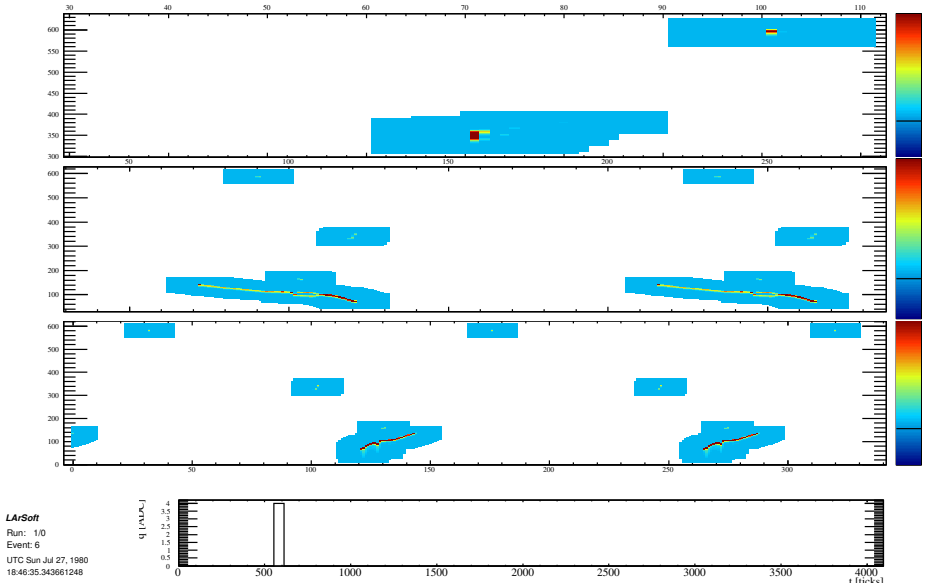

Figure 1: Zero-suppressed neutrino event in 35t geometry with regions of interest saved around values above threshold

purity of 95% with efficiency of 5.6%. The development of this algorithm benefited strongly from a procedure and preliminary code written by Tristan Blackburn, as well as the personal advisement of Tom Junk and Michelle Stancari.

5 ADC Stuck Code Mitigation

It was recently discovered that the 35t's ASICs contain a problem causing the 6 least significant bits of the TPC wire outputs to become stuck at values of all zero or all one at certain probabilities. I implemented this problem into the simulation and have developed a software mitigation method based on linear interpolation between non-stuck ADC values. This mitigation method is very promising as shown in Figure 2 and will be critical in evaluating the data to be taken by the 35t in its upcoming run. I was able to quickly address this critical issue and provide simulated samples of the problem for use in addressing it in the online zero suppression.

6 Photon Detector Calibration

I worked with Gleb Sinev and Alan Hahn to test photon detectors before their installation in the 35t cryostat using the LBNE calibration module. I am currently working with Alexander Himmel on testing the fully installed photon detectors with the LEDs inside the cryostat connected to the calibration module. I serve as the current expert on the LBNE calibration module and have contributed to improving the software that controls it and serves a vital purpose in providing triggers to the 35t's DAQ system.

7 Conclusion

Because of the Intensity Frontier Fellowship allowing me to work full-time at Fermilab since the beginning of April 2015, I have made much more progress than I would have if I had remained working remotely in Baton Rouge. The progress of the 35t prototype and the DUNE far detector's development have significantly benefitted from my physical presence at Fermilab and close collaboration with other DUNE physicists.

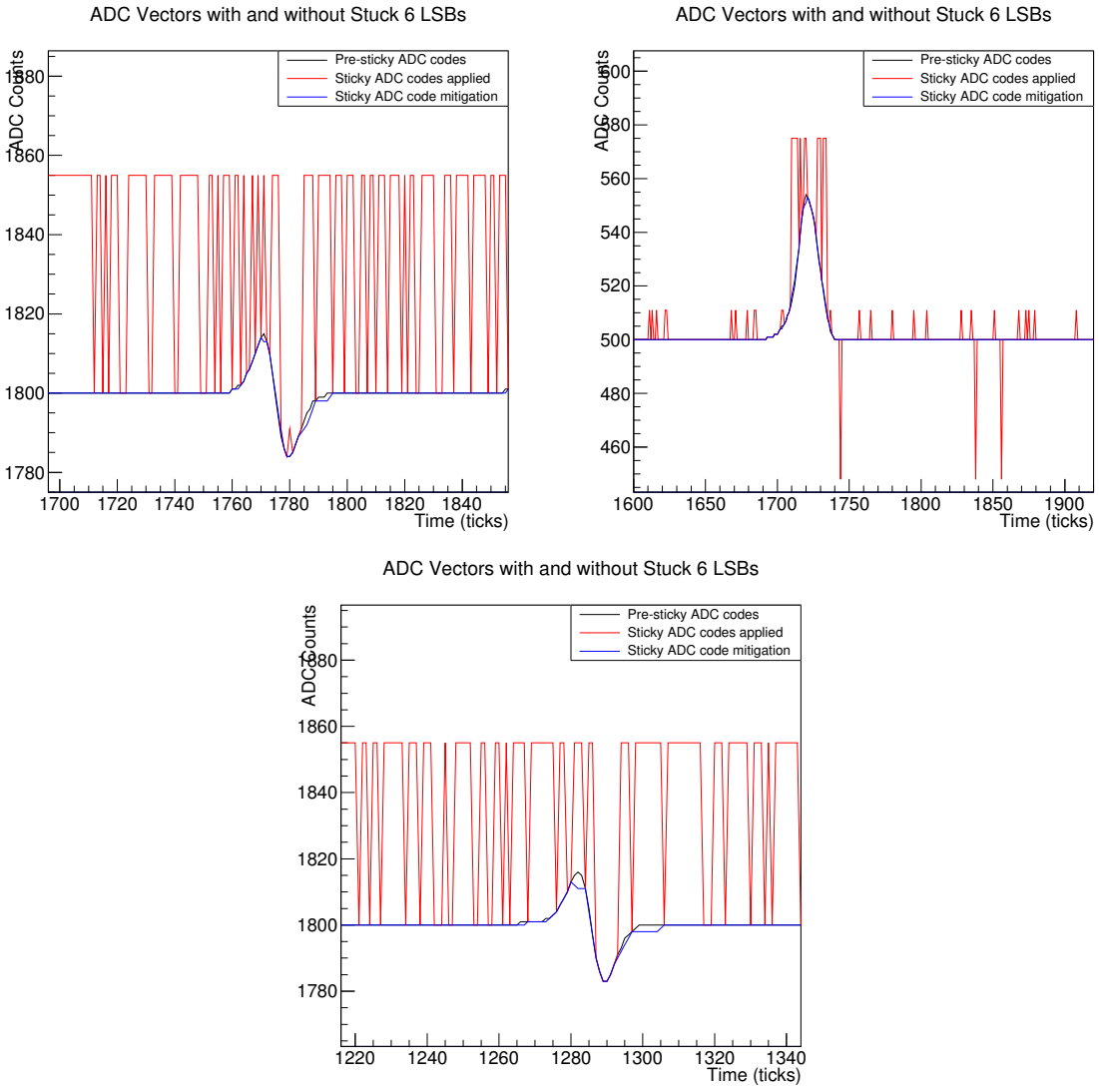

Figure 2: Simulated waveforms with ADC stuck code issue and software mitigation applied