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Simulations of PMT and Track Reconstruction in Magnetic Field

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This summer, I am working on EMPHATIC (Experiment to Measure the Production of Hadrons At a Testbeam) project under Dr. Blair Jamieson supervision. EMPHATIC is a proposed experiment to measure hadron scattering and production cross sections for improved neutrino flux predictions, its aim is to provide more complete data to reduce the neutrino flux uncertainty measurements. In this project, my responsibilities are working with PMT, simulating the complete circuit consisting of PMT and Padiwa board using LTspice, and to do track reconstruction in the magnetic field. We wanted to check if the output signal from the full circuit will be big enough for the discriminator, which is an LVDS buffer on an FPGA. We simulated a circuit consisting of PMT with the components on the Padiwa board in LTspice and tested its output. The Padiwa electronics board will play a big role in this experiment as it will process and amplify the electric pulse from the PMT, so the pulse should be big enough for the discriminator. We compared the data recorded in the laboratory with the simulated output signal. The output voltage was found to be lower than the simulated one, but the experimental graph matched the simulated graph, and the signal was found to be big enough for the discriminator. For the coming EMPHATIC experiment, we are using a permanent magnet, to better identify the particle trajectories. It is necessary to ensure that the track reconstruction algorithm is in closest agreement with the real set up of the detector plates. In 2018 EMPHATIC experiment the permanent magnet was not included, so the particle trajectories were straight lines. Therefore, the Monte Carlo studies need to consider this absolute alignment of the detector plates, with feedback from the data, in order to achieve higher accuracy in momentum reconstruction of the particles. Efforts are ongoing in this perspective to understand and modify the reconstruction algorithm accordingly.

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