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Missing data reconstruction using ML techniques in the gaseous TPC PandaX-III experiment

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The PandaX-III experiment, developed to search for the Neutrinoless Double-beta decay (NLDBD), is based on a Time Projection Chamber (TPC) detector of cylindrical shape with a height of 120.0 cm, a diameter of 160.0 cm. It is filled with 10 bar gaseous Xe-136, and the readout plane is made out of 52 Micromegas modules 20 by 20 cm in size. Each Micromegas module is constructed with 64 by 64 readout channels in X and Y directions. Usually, Micromegas technology is used for tracking purposes; however, in the PandaX-III experiment, they are also used to measure deposited energy from the ionizing particles inside the gas. The rare double-beta decays of the Xe-136 nuclei generate two low-energy electrons, which produce ionization in the gas volume along their trajectories. Due to the electric field between the cathode and anode (the readout plane), electrons from the ionization process drift towards the anode and are detected by the Micromegas readout strips. Therefore, the output of the detector is represented by the total detected energy of the decay event plus XZ and YZ projections of the initial decay event track, used for background discrimination. The NLDBD search requires achieving excellent energy resolution in order to discriminate signal from backgrounds. For that, the PandaX-III experiment aims to reach a resolution better than 3% FWHM at the double beta decay peak of the Xe-136 at 2.5MeV.
However, due to the physical damage, shortcuts on the readout strips, dark current, etc., some of the readout channels could be disconnected; thus, the signal from them would be missed, giving losses on the energy measurements and the track reconstruction. In addition to that, the signal gain could be inhomogeneous on the surface of the Micromegas module, which results in a degradation of the energy reconstruction as well. To improve the quality of the measurement, data should be corrected from missing channels and inhomogeneities. That is why I am currently studying machine learning (ML) techniques to reconstruct the missing information. In my talk, I will first present the PandaX-III experiment and its problematics and then the ML studies. In particular, the usage of the Convolutional Neural Network on the event electronics signals to reconstruct event energy from incomplete and biased event data will be described, and preliminary results will be presented.

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