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A neural network based algorithm for MRPC time reconstruction

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Multi-gap Resistive Plate Chamber(MRPC) is a widely used timing detector of which the typical time resolution is about 50ps. This makes MRPC an optimal choice for triggering in many large physics experiments such as STAR and CBM. The prior work of improving the time resolution of MRPC has focused on altering the structure of the detector. However, the algorithm of reconstructing a more precise time has not been fully explored. Normally the signal of the detector will be discretized with the time over threshold(ToT) technique, and since the fluctuations of the charge induced by different events generate a time walk, the threshold reaching time from the digitization will be corrected with "Walk Correction". This work proposes a new time reconstruction algorithm based on the deep neural networks(NN) which gives a much better result than the walk correction. Discrete points on the signal waveform around the threshold are feed into the network, and it is trained with different network architectures to find the best prediction. Labels in the NN are the truth time when particles start losing energy in the detector. This work is based on a standalone simulation of a 5-gap MRPC detector. To get a more precise simulation of ionization energy loss in very thin gas absorbers(250um), we use the Photo Absorption Ionization (PAI) model offered by Geant4 instead of the well known Landau model. The neural network based algorithm is proved to be around 25% better than the walk correction. As MRPC detectors are going to be used in more and more high energy experiments with a higher energy frontier, the improvements of time resolution gained from the neural network in this work will be a lot more valuable.

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