Contribution ID: **12** Type: **Oral Contribution**

Time reconstruction in MRPC detector using deep-learning algorithms

Thursday, February 13, 2020 9:50 AM (20 minutes)

Multi-gap resistive chamber (MRPC) has been well-known for its extremely high time resolution, and therefore, it has been chosen by Jefferson Lab to constitute the Time-of-Flight system in the Solenoidal Large Intensity Device (SoLID). In this experiment, the requirement for the time resolution of MRPC detectors is around 20 ps, which far exceeds the typical time resolution (50~70 ps) that can be achieved in present large physics experiments. In this work, a very thin gap (104um) MRPC detector with 32 gaps which are arranged as 8 gaps in 4 chambers is implemented and tested with the cosmic rays. The signal waveforms of the MRPCs are readout by a waveform digitizer with a bandwidth of 1 GHz and sampling rate of 10 Gsample/s. The waveforms collected in the experiment are analyzed with three new algorithms based on neural networks and deep learning, and the time resolutions of the detector achieved with these three different algorithms are 16.8 ps, 19.7 ps and 23.62 ps respectively.
The first algorithm includes a detailed simulation of the MRPC detector used in the test. The deep neural networks are trained with the simulation waveforms, and the model generated from the training is then applied to evaluate the time resolution of the experiment. The similarities between the simulation and experiment play a vital role in this algorithm, and hence they are carefully compared and analyzed in this work. This algorithm takes the advantages of the knowledge in the simulation and achieves the best result ——16.8 ps.
In the contrast, the other two algorithms are trained with the experiment waveforms. In the cosmic ray test, four runs are conducted, each using different spacers in order to make the distance between the two MRPC detectors to be 0, 1, 2, 4 cm. The second algorithm proposed in this work uses the time interval between the two detectors of vertical events as the network label, which means the labels of different events in the same run are the same, while in the third algorithm, the labels are time intervals obtained by the traditional slewing correction. The result of the second algorithm is 19.7 ps which is slightly worse than the first but better than the third, because the cosmic rays are not perfectly perpendicular to the MRPC, making the true time interval between 2 detectors different from events to events and thus bringing uncertainties if they are considered the same. Meanwhile, since the true time interval between the detectors are unknown, utilizing the interval obtained with the slewing correction in the third algorithm can only be an approximation which depends largely on the correction. So the resolution of the third algorithm is not as good as the other two.
In general, it has been proved that an MRPC detector with a time resolution below 17 ps can be achieved and the algorithms based on neural networks and deep learning are useful in reconstructing the time of MRPC. This should be of paramount importance to the development and applications of the MRPC detectors in the future.

Primary authors: WANG, Fuyue (Tsinghua University); WANG, Yi (Tsinghua University)

Presenter: WANG, Fuyue (Tsinghua University)

Session Classification: New software approaches to data analysis