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Studies on implementation of pellet tracking in hadron physics experiments

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Collaboration

Abstract content

Pellets are microscopic spheres of frozen hydrogen (approx. 25 micrometers in diameter), used as the target in hadron physics experiments such as WASA (Forschungszentrum Juelich, Germany) and the future PANDA experiment (GSI, Darmstadt, Germany). Because the space between the pellet generator and the interaction region is occupied by the particle detector system, pellets are produced approx. 2-3 m above the interaction region and travel towards it inside thin pipes. Because of the non uniform velocity of pellets in the stream, their time distribution is stochastic with the average distance between pellets of the order of a few millimeters. The average pellet velocity is approx. 70 m/s which means, that the generated pellet needs approx. 30 microseconds to reach the accelerator beam region and traverses it during approx. 70 microseconds. The aim of the pellet tracking system is to optically detect pellets, measuring their positions and times at a few measurement levels installed in two sections located below the pellet generator and above the pellet dump. The measured information will be used to reconstruct pellet tracks and consequently, to be able to know their position at a time of hadronic interaction. The tracking system will operate in synchronization with the main experimental DAQ, but at the same time it will operate in much longer time scale than the main DAQ. One of the advantages given by the pellet tracking is suppression of events not coming from pellets, but from a background - from the rest-gas (a product of pellet evaporation remaining in the scattering chamber) or from other non-pellet sources. This functionality may be demonstrated using another system. Such a system can be operated at the moment, before the prototypes of the full scale pellet tracking are built and used in accelerator facilities. This kind of study has been performed with the use of WASA detector. It is known from previous studies that pellets are present in the beam region only for some fraction of time. The events from rest-gas happen all the time. However, it is more probable that when a pellet is in the beam region, the recorded event originated in the pellet. Bearing this in mind, one can exploit an alternative method of checking when pellets are in the beam region, based on the integrated event rate of interactions and the knowledge that when a pellet passes through the beam, there are more interactions. The described method makes use of so called Long Range TDC - a device continuously recording times of input signals. In our case these signals are WASA elastic triggers - coincidence conditions between different detector parts activating the data acquisition and designed to be especially sensitive to elastic scattering events. Usage of these triggers in the study has been also proven to favor events occurring close to the nominal interaction point, providing even better separation between “good” events and non-pellet background. The study proved, that it is possible to distinguish between the events originating in pellets and the non-pellet background. Moreover, because of many technical similarities to the full scale pellet tracking system, the described method gives an experience in working with such system. This includes the hardware part of the project, as well as the further data processing and using the obtained information in the analysis of hadronic reactions.

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