Studies on implementation of pellet tracking in hadron physics experiments

A. Pyszniak a,b, H. Calén b, K. Fransson b, V. Hejny c, T. Johansson b, J. Löfgren b, Z. Rudy a, M. Wolke b, P. Wüstner c,d

a) Jagiellonian University in Krakow, Poland  b) Uppsala University, Sweden  c) Forschungszentrum Jülich, Germany  d) Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

E-mail: andrzej.pyszniak@gmail.com

Pellets and Pellet Tracking

Pellets - microscopic spheres of frozen hydrogen used as target in hadron physics experiments as WASA (Forschungszentrum Juelich, Germany) and the future PANDA experiment (GSI, Darmstadt, Germany). Diameter: ≈25 μm; generated ca. 3 m above the accelerator beam. Velocity: ≈70 m/s; velocity spread in the beam: sigma=1%. Pellet tracking system will improve the quality of analyzed data by providing information about pellet position during the interaction.

• Resolution: sigma around 0.1 mm in each direction.
• Performance: tracking information for more than 70% of hadronic events

Test Method for Rejection of Non-Pellet Events

One possibility given by the pellet tracking is to know which hadronic events occurred when there was no pellet in the beam region to be able to reject these events.

In absence of a full scale tracking system, this can be demonstrated using another system:

• One can think of a method using the instantaneous rate of interactions to determine when pellets are in the accelerator beam region.
• A study has been done at WASA!

We need a high-rate measure of instantaneous rate of interaction and a reaction to check performance of our classification method.

Elastic Triggers

Trigger - coincidence condition between different detector parts activating the data acquisition

Elastic trigger - trigger with conditions making it especially sensitive to elastic scattering events

Acceptance

Acceptance relative to the acceptance in the nominal interaction point

Elastic triggers sensitive to upstream rest-gas Test reaction sensitive to downstream rest-gas

Probability to simultaneously record elastic trigger signal and main reaction event is the highest close to nominal interaction region

Good for effective separation of pellet and non-pellet events!

Long Range Time-to-Digital Converter

Continuously records times of the elastic triggers together with times of the events collected by the main DAQ.

ID numbers of the events from the main DAQ are also stored, to identify them during the analysis.

Structures with duration ≈70 μs visible in the time spectrum of the elastic triggers. They correspond to pellets passing through the accelerator beam.

100 ms sample, Main DAQ records ≈50 events at this time, including 1 event of the test reaction

Vacuum Calculations

Vacuum calculations have been performed, taking into account the gas load and pumping conditions

Based on the calculated pressures and the pellet stream and accelerator beam overlap, the background level of the rest-gas is estimated to be 0.01%.

The fraction of hadronic events not coming from pellets is ≈25%.

This corresponds to the background level of ≈0.3%.

Most of the background events must come from other sources, e.g. bouncing pellets

Conclusions

It has been clearly shown, that it is possible to use a system external to the main experimental DAQ to distinguish between events from pellets and from non-pellet background. It has been also shown, that such rejection improves the quality of the analyzed hadronic data.

The work with the described system gave an experience with working with external system synchronized with the main DAQ but used in much longer time scale. These conditions are similar to the conditions in which the full scale pellet tracking system will be operated.

For further reading on the pellet tracking visit: