FOPI Trigger: Improving Statistics on Strange Particles

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Introduction. FOPI experiments produce low statistics with respect to certain strange particles, especially negatively charged kaons [1]. The reasons are their rareness and the slow data read-out even with the updated FADC scanning system [2]. Thus, a trigger system is required to ensure that only events containing these particles are read by the FADC scanners [3]. We have investigated, how our trigger algorithm [4] can increase strange particle yield and how this affects hardware [5] requirements.

Trigger Concept. The trigger will be integrated into the experiment as follows: the central drift chamber's (CDC) sense wires signal is passed to the trigger via a discriminator, circumventing the FADCs. The trigger algorithm extracts the particles' track information, and together with the time-of-flight data determines the particles' species. If an anti-kaon is found the FADC scanners get a "start read-out" signal. If not, read-out time is saved.

Performance. The first version of the trigger algorithm [4] was designed to classify – under optimal conditions – every particle contained in the CDC data. While this is the best way to analyze a single event, the procedure does not significantly increase the number of kaons that can be recorded during an experiment of fixed duration.

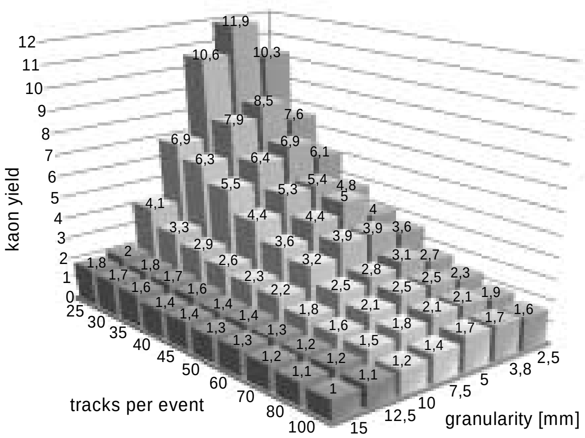

Fig. 1: kaon yield vs. granularity and occupancy.

Ghost Tracks. A simulation was elaborated that produces the number of kaons that can be found in a given period of time rather than the percentage of particle tracks that can be classified accurately. The result is that the number of detected kaons highly depends on the number of "ghost tracks" and only secondarily on the percentage of accurately classified particles. The number of ghost tracks in turn basically depends on the occupancy in the detector image, i.e. the number of particle tracks contained in the sense wires' signals. Ghost tracks emerge from sets of hits that incidentally form a track. Their number is significantly increased by the fact that – induced by the CDC design – 50 percent of the detector's signal lead to mirrored hits. To focus on suppressing ghost tracks turned out to be the proper strategy for increasing the yield of a certain particle species. Other parameters, like granularity of search patterns or filter operators, were used to fine-tune algorithm performance. Another interesting result is that kaon yield does not significantly depend on the algorithm's execution time.

Kaon Yield. Compared to kaon yield without a trigger our simulation suggests that the algorithm can increase the number of kaons by a factor of ~3 with approximately 50 particle tracks per event, and a factor of ~6 to 8, if only ~30 particle tracks occupy the detectors' data. Fig. 1 shows the dependence of the yield as a function of occupancy (number of tracks) and granularity (resolution of predefined tracks or number of search patterns).

Hardware Requirements. Hardware consumption of the FOPI trigger algorithm primarily depends on the granularity, i.e. how many predefined patterns have to be compared with the hits on the CDC wires (the detector image). A second important parameter is the occupancy and the size of the hit space, i.e. the number of tracks, detector pixels per track and thus of active pixels in the CDC. The latter determines the algorithm's execution speed. Fig. 2 shows hardware consumption as a function of granularity, occupancy, and kaon yield.

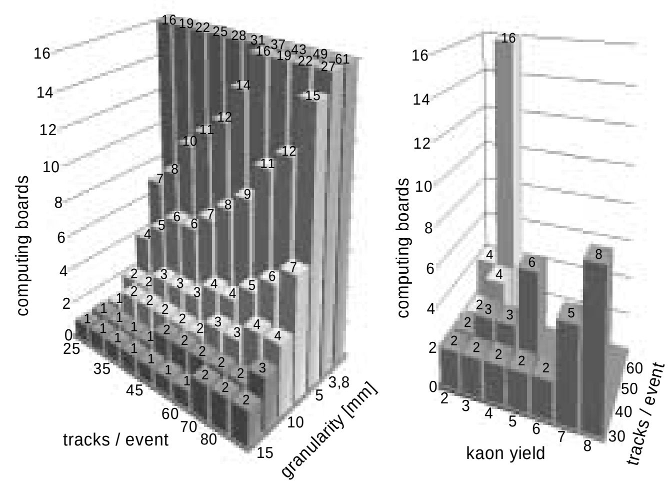

Fig. 2: hardware consumption vs. granularity, occupancy, and kaon yield.

Outlook. The physical interface between Atlantis and the CDC still has to be developed, the next step is the coding of time critical and computing intensive parts of the algorithm into a hardware description language (CHDL [6] or VHDL) and to test the result on the Atlantis [5] hardware.

References

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