First Operation of the HADES Data Acquisition System with Beam ◇

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In 1999 the new HADES data acquisition system was operated for the first time to read out the available HADES detectors in 2 commissioning beam times. The HADES detectors, i.e. a ring imaging cherenkov detector (RICH), four layers of mini drift chambers (MDC), an electromagnetic shower detector (PreShower) and a time of flight wall (TOF) are arranged in a sixfold axial symmetry around the beam axis [1]. The tests were performed with one sector of the whole setup fully equipped with read out electronics.

The data acquisition system uses parallel front end electronics directly at the detectors [2]. Specially developed VME readout modules allow for concentrating, preprocessing and buffering of the raw data as well as for hardware based sub event building. An ATM network with general purpose computers and a platform independent software package do the event building, filtering and taping. In the final HADES setup 73 000 channels will be read out aiming at a dead time below 10 μs. This will lead to a primary data rate of 4 GByte/s. A three stage trigger system [3] will reduce this rate roughly by a factor of 1000.

For the preparation of the 1999 beam measurements, the four detector systems were operated independently in a stand alone mode with pulser and cosmic particles and could be read out successfully. However, due to different stages reached so far in the development and integration of the readout hardware, the final design performance could not yet be reached for all detectors.

The PreShower was running with hardware controlled readout at full performance. The accepted data rate was limited by the bandwidth of the data transport (13.6 MBytes/s) and not by the dead time. The MDC readout was also fully hardware controlled, but the installed prototype boards did not yet reach the design values. The RICH readout used the final boards, but had to be run for debugging purposes in a software controlled mode with comparable high dead times. As the TOF VME sub event builder hardware was not yet available, the VME TDCs (CAEN V775, V878, and V488) were read out directly by a VME CPU (CES RIO 3062). Due to the multi event capability of the TDC modules and the high performance VME CPU (300 MHz PPC), the dead time could be kept low. The results for the four detector systems are summarized in table 1.

Detector	Channels	Dead Time (μs)	Data Rate (MByte/s)
RICH	4 608	2 000	0.08
MDC	1 100	300	1.50
PreShower	1 024	10	> 13.60
TOF	313	70	2.50

Table 1: Data rates obtained for the four readout systems of the first sector of HADES detectors.

Despite the variety of hardware and readout modes, the data acquisition could be easily switched without any changes in software from the stand alone readout to a common system of coincidence readout during beam operation. In the common data acquisition the maximum data rate was limited to 700 KByte/s due to the dead time induced by the RICH readout.

The data transport via ATM showed the designed transport rates of 14 MByte/s per connection. The traffic management features of the ATM network allowed for matching the data flow to the requirements of the different detectors (see above) and to the available tape performance (1.6 MByte/s on a DLT2000 tape drive).

The event building stage operated very reliably. The change from the test and development setup to the situation in the experiment unveiled performance bottlenecks that limited the data rate of event building to 5 MByte/s. The reason was that the EB algorithm did depend on the number of sub event builders. Meanwhile this problem could be solved. Event synchronization worked flawless, so the expected correlations between the detectors could be found. Fig.1 shows as an example the particle position in the time of flight wall and the inner drift chamber.

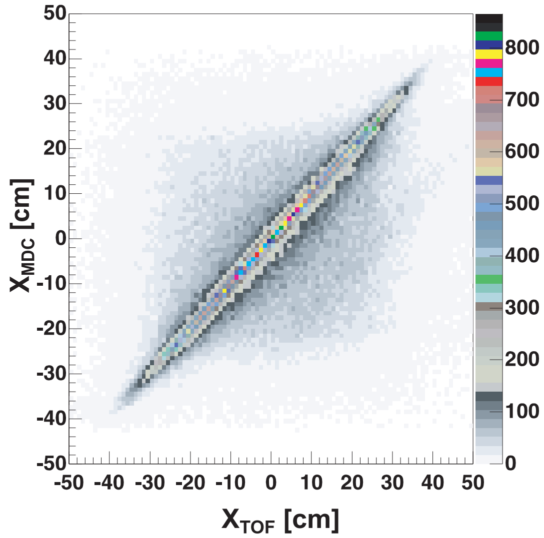

Fig. 1: Correlation of light particle positions deduced from wire numbers in one MDC versus those from left-right time differences in the TOF scintillator wall (without magnetic field). The reaction was Ar + Ti at 1.3 AGeV.

In the two runs, approximately 12 GByte were written to disk. This data is currently under analysis and addresses questions concerning detector performance by using correlations between RICH, MDC, PreShower and TOF.

Near future DAQ tests aim at full hardware control of RICH and TOF readout and at the full integration of the 2^{nd} level trigger stage.

References

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