Performance of the HADES Data Acquisition System ◇

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Since the first operation of the HADES data acquisition system with beam in 1999 [1] several improvements have been implemented. During further experiments with the HADES apparatus [2] the data transport and the event building were running at design performance.

The HADES setup is aimed at measuring heavy ion collisions with beam intensities of $10^8\,\mathrm{s}^{-1}$, resulting in trigger rates of up to 5×10^4 ev/s and a primary data rate of 4 GByte/s. A three stage trigger system [3] shall reduce this to a rate of 10^3 ev/s corresponding to 2 MByte/s.

The data transport in the HADES DAQ system uses a simple ATM network, consisting of one ATM switch (FORE ASX-200WG). It connects seven VMEbus CPUs (CES RIO 8062, LynxOS), that are doing the control and readout of the detector electronics, with the event builder CPU. The event builder (Pentium Multiprocessor, Linux), assembles the partial data streams into correlated events and stores them to mass storage. Each of the CPUs is equipped with an OC3 ATM adapter and can send and receive data with a maximum speed of 155 MBit/s.

In November 2000, a beam measurement at the GSI-SIS was done using the HADES setup. A ^{12}C beam was hitting a fixed ^{12}C target at energies of 1.5 AGeV. During this measurement, the first time all seven subsystems were connected and running. Due to different stages reached so far in the development and integration of the readout hardware, the dead time of the first trigger stage (LVL1) was fixed to 500 μs. This resulted in LVL1 trigger rates of approximately 1 kHz and, according to table 1, in data rates of approximately 3 MByte/s.

	Size [Byte]	
VMEbus-Crate	Sub Event	Event
RICH0	333	3 043
RICH1	304	
RICH2	335	
MDC	1057	
SHOWER	497	
TOF	407	
TRIG	78	

Table 1: Average size of sub events and events during a normal run with C + C collisions at 1.5 AGeV.

Since the second trigger stage was not used for data reduction during this experiment, the rates on the event builder were the same as the LVL1 rates. Therefore the data transport and event building stage was running at the design load.

As one can further read from table 1, the different VMEbus crates delivered a different amount of data per event. The used bandwidth of the seven ATM channels was adjusted, so that each single crate was provided with the exact share according to its sub event size, while the sum of the whole data stream was matched to the mass storage speed. Data loss due to buffer overruns could be avoided completely with this fine tuning.

During that beam time, the event builder was a 2 × 400 MHz PentiumII double processor system. Running the system with the described rates resulted in a CPU load of 2.5% per CPU. So in terms of CPU performance, there is much room for higher demands. Maximum transfer rates to tape (DLT8000, connected via LVDS-SCSI) were around 5 MByte/s. When writing to disk, the rate was limited to 2 MByte/s due to deficiencies in the then used Linux version. In the meantime this has been fixed and tests reached transfer rates to disk of well above the 15 MByte/s.

The data of this and the following beam times is under analysis. During the analysis, no side effects of the data acquisition, like event mixing, were observed. Fig. 1 shows the result of a run, in which the magnet of the spectrometer was switched on.

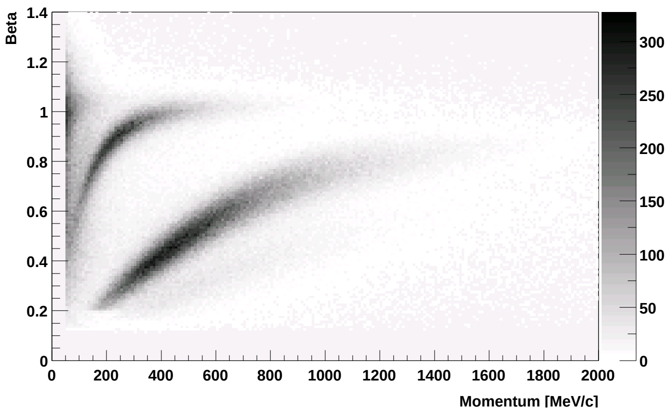

Fig. 1: Kinematic curves of the heavier (proton), lighter (pion) and lightest (electron, $\beta \approx 1$, low momentum) particles resulting from C + C collisions at 2 AGeV.

Currently, a run control for the HADES DAQ system using state machines and distributed computing is under development [4]. Provision is made for a possible increase of data rates in the HADES DAQ system. It can be accomplished by using ATM via OC12 (622 MBit/s) or OC24 (2.4 GBit/s). Scalability to arbitrary data rates is possible by using more than one event builder machine.

Since no part of the software is dependend on a special hardware, exploiting the newest and fastest technology will be possible in the future. For example, if traffic management in GigaBit Ethernet proves to be working, a change of the network technology may be an option.

References

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