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The DAQ System for the ARGO-YBJ experiment

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Abstract

ARGO-YBJ is a full coverage air shower detector which is reaching its final design configuration. The physical goals of the experiment require the ability to study with high efficiency the low energy showers. The Data Acquisition (DAQ) System must be able to collect data from many front-end channels and sustain a high data transfer rate (up to 10–20 mega bytes per second). In this paper, the design and performance of the DAQ system are described.
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Keywords: RPC; Data Acquisition System; Monitor system

1. The Read-out and the DAQ System

The apparatus is a full coverage layer of Resistive Plate Counters (RPCs). The signals from each RPC are picked-up with 80 read-out strips (6.7 cm wide and 62 cm long). The fast-OR signal of eight contiguous strips defines the logical pad of area $56 \times 62\,\text{cm}^2$ which is used for timing and trigger purposes [1].

The detector is divided into 6×2-chamber units, named Clusters, with modular read-out and trigger electronics housed in a Local Station [2], the entire detector consisting of 154 Clusters. Each Local Station assembles a data frame containing the addresses of the fired strips and all the timing information; this is then transferred to the Central Station at every trigger occurrence and pushed into a FIFO memory placed in the Front End Electronics (FEE) board [3].

The ARGO-YBJ DAQ modular structure allows a high speed and efficient data collection. It is built on a two-layer read-out architecture implementing an event-driven data collection by using two custom bus protocols, based on VME-bus [4,5]. In order to be scalable, the system can be split in several chains. A Motorola VME Processor MVME6100, is responsible for the complete read-out of a Level 2 chain. A schematic view of the DAQ architecture is shown in Fig. 1.

During run time, the software reads data from the second level concentrator and sends data to the farm via gigabit-ethernet. The online farm consists of a IBM blade server, organized on a crate basis. The Motorola CPU has a 100/1000 ethernet interface connected to the switch and a web interface where it is possible to manage and monitor the switch network traffic. Sub-event building is done in hardware via first and second level crates, while the farm software is in charge of performing full event building.

The online processes are distributed over a large number of nodes in the DAQ network [6]. In order to manage the program for starting and stopping the run it has been also developed a Graphical User Interface (GUI) written in Java language.

The DAQ set-up must be organized in order to have a good read-out efficiency corresponding to a dead time as low as possible. The main causes of the dead time are: the Dead Time on Transfer (DTT) and the Controller Dead Time (CDT). The logical-OR of DTT and CDT components is named Total Dead Time (TDT). While the DTT is not reducible because it depends on the data frame from the front-end, the CDT is dominated by the CPU read-out. This means that the dead time measured behaviours can be

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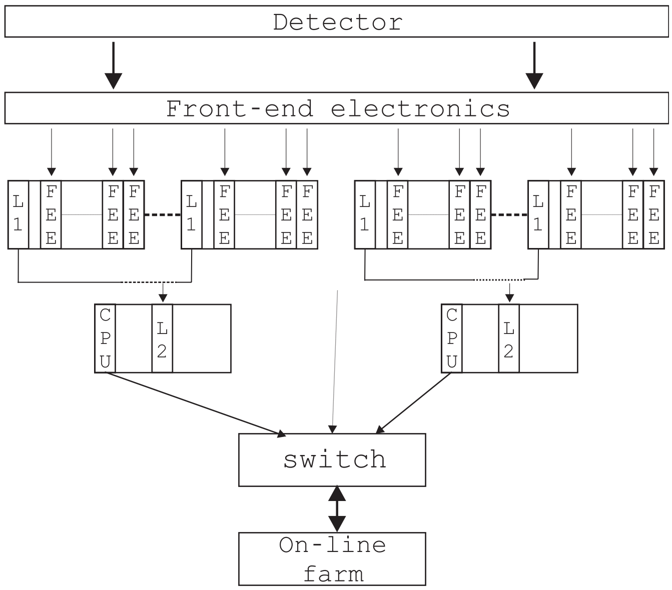

Fig. 1. The DAQ scheme. The FEE data flow to Level-1 (L1) and then to Level-2 (L2) controllers for each chain.

used to estimate and eventually optimize the overall performance.

2. Test results

A portion of the final version of the DAQ System was assembled in order to integrate and test all the components under real conditions. The expected trigger rate for the final carpet should not exceed 10 kHz, with an average event size of ~1 kbyte [7]. The Front-end readout electronic was connected to the 2-chain DAQ System. The above conditions were chosen in order to reproduce the real experimental setup. In a 1-chain set-up, the measurements have been done by increasing the trigger rate up to saturation of the bandwidth, with an ~1 kbyte average frame.

In order to keep the TDT as low as possible, it is essential to reduce the CDT. As can be seen in Fig. 2, up to ~20 kHz the dominant component is DTT. With these measurements we can demonstrate that the DAQ read-out does not introduce a further dead time.

In case of a detector upgrade the DAQ System can be split in multiple chains and the blade server acts as an event builder. Distributing the total amount of data on the two chains, the bandwidth and dynamic range can be doubled as shown in Fig. 3.

3. Conclusions

The new ARGO-YBJ DAQ system has been tested showing to be stable and efficient. It will be deployed on the complete detector by the Autumn of 2006.

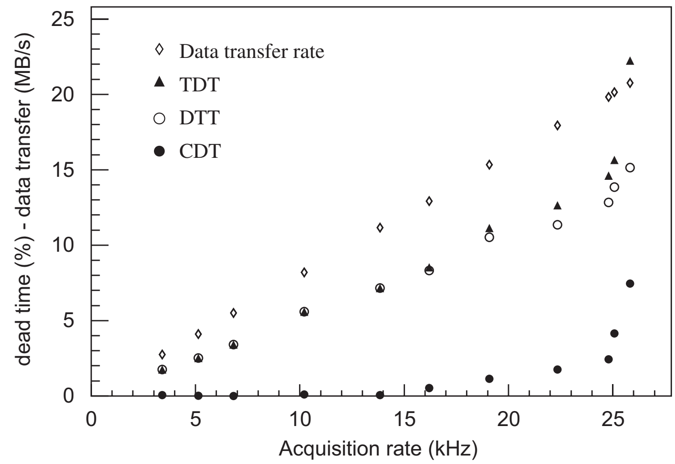

Fig. 2. 1-chain performance measurements. The data transfer can reach a maximum of ~20 MB/s.

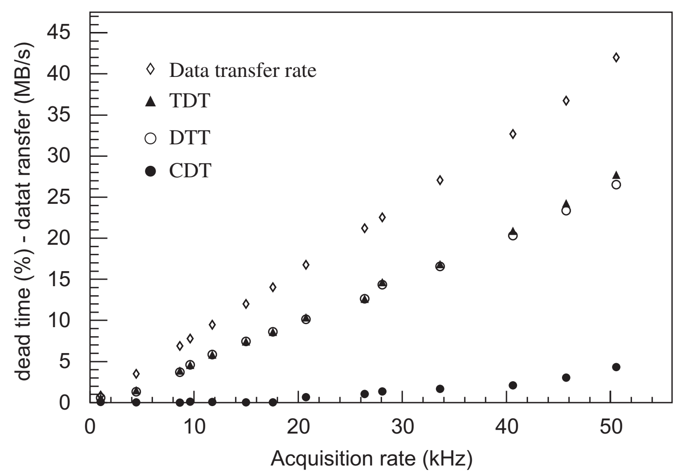

Fig. 3. 2-chain performance measurements. The data transfer can reach a maximum of ~40 MB/s.

References

[1] Z. Cao, Status of the ARGO-YBJ experiment, Proceedings of the 29th ICRC Pune, India, 2005.
[2] Assiro, et al., Nucl. Instr. and Meth. A 518 (2004) 549.
[3] A. Aloisio, et al., The ARGO-YBJ Level-1 DAQ System, Proceedings of the 27th ICRC, vol. 7, Hamburg, Germany 2001, p. 2887.
[4] A. Aloisio, et al., Level-1 DAQ for the KLOE Experiment, Proceedings of the International Conference on CHEP, vol. 371, World Scientific, Singapore, 1995.
[5] A. Aloisio, et al., A VME Crate Interconnect architecture for event-driven DAQ Systems. Proceedings of the IEEE Conference on RT France, 1997.
[6] A. Aloisio, et al., Nucl. Instr. and Meth. A 516 (2004) 288.
[7] A. Aloisio, et al., IEEE Trans. Nucl. Sci. NS-51 (4) (2004) 1835.