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The DAQ for the EUDET pixel telescope

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Abstract

The EUDET pixel telescope [4] needs a flexible and performant data acquisition system (DAQ). Data throughput at raw data level is high and even demanding after data reduction. The integration of devices under test is provided at different levels and easy for the user. The DAQ system presented is platform independent, lightweight but scalable and outputs data as lcio streams for the ILC software framework.

*For the EUDET Collaboration

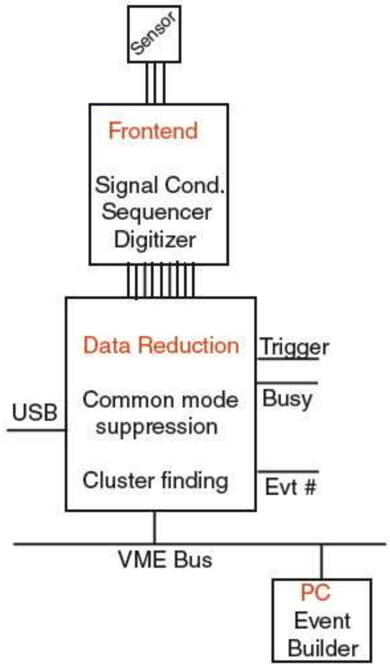

Figure 1: Data acquisition scheme of the EUDET pixel telescope.

1 Introduction

The EUDET pixel telescope consists in its current implementation of up to 6 planes of monolithic active pixel sensors of 256x256 pixels with a single point resolution of 2 to 3 μm. It provides a testbench for different pixel sensor technologies and provides seamless integration of devices under tests (DUT). While in raw data taking mode, a data size of up to 2.4 MB per event is reached. So even at low trigger rates of a few Hertz, the DAQ system must assure a data throughput of some tens of megabytes per second and higher trigger rates would be difficult to achieve. Thus, the DAQ for the pixel telescope provides a data compression at the hardware level, reducing data to about 50 kB per event.

2 DAQ overview

Figure 1 shows a sketch of the components of the data acquisition. The data from the sensors is read via frontend boards and then transferred to an intermediate readout and data reduction board (EUDRB [5]), where the data can be compressed. A MVME6100 then collects the data of different EUDRBs inside a VME64x crate. The data is then sent to the main DAQ PC via gigabit ethernet. This PC also collects the information from the trigger logic unit (TLU, see Section 4) and eventually from the device under test.

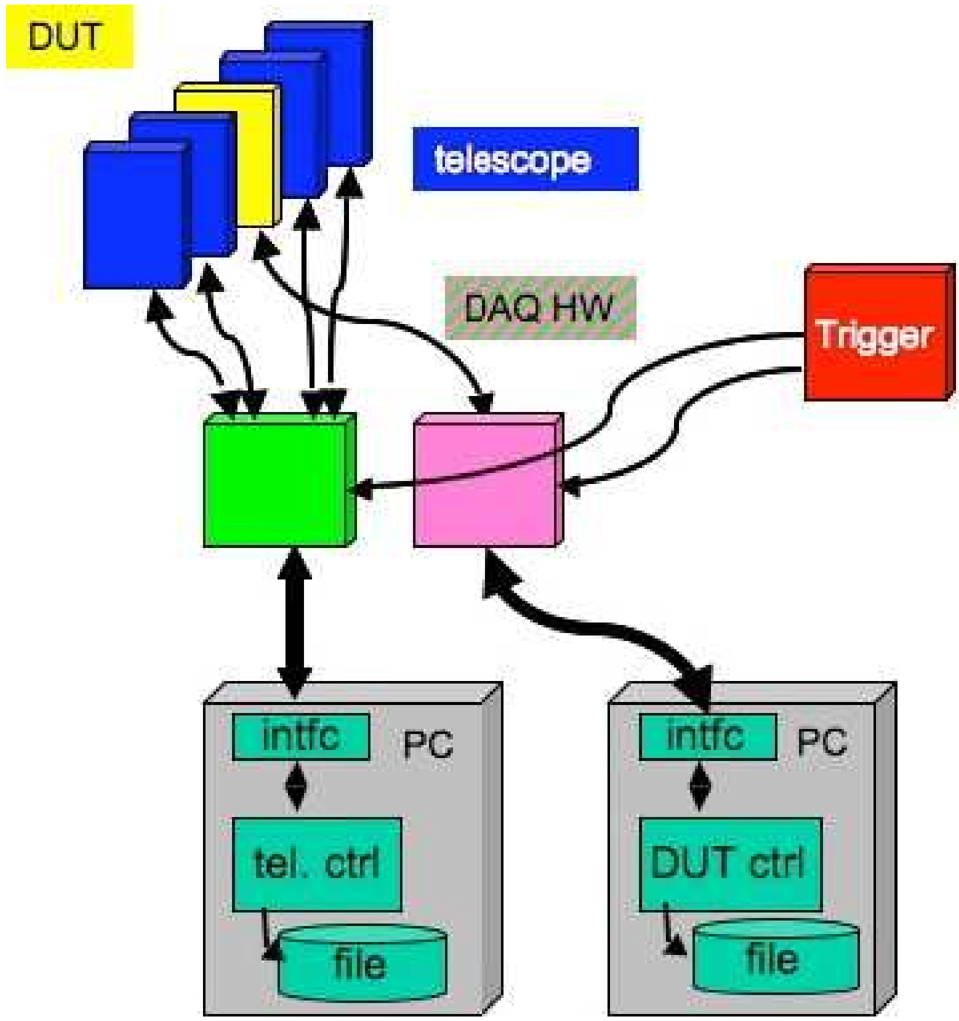

Figure 2: Integration of the DUT at trigger level.

Different scenarios for the integration of DUTs are foreseen:

- Integration at hardware level: This needs a special purpose hardware interface that should be able to read out the telescope sensors and the DUT as well. While the EUDRB implements this possibility, this approach is only feasible for very dedicated DUTs.
- Integration at software level: The DUTs will provide their own DAQ hardware, but the data will then be treated by a common DAQ software. This approach will eventually be used for some dedicated DUTs, but requests a lot of manpower from the EUDET collaboration.
- Integration at data level: Both the beam telescope and the DUT use their own dedicated hardware and software, and the data streams are combined online by inter process communication. The synchronization of events and the configuration of the different devices during start-up can be difficult in this scenario.
- Integration at trigger level (Figure 2): This will be the default scenario. Different hardware and software can be used for the beam telescope and the DUT. The synchronization of the events is done via a simple trigger, busy and reset logic provided by the TLU and the events are combined off-line. To avoid slippage of event numbers between the DUT and the beam telescope, the TLU can provide a dedicated event number, to be read out by the DUT as well, thus guaranteeing a perfect match between an event from the telescope and the DUT.

3 The EUDRB

The data reduction and readout board (EUDRB) that has been developed by INFN Ferrara/Milano is described in detail in [5]. It collects the data from the frontend boards and has the following features:

- 20 MHz readout of 4 parallel input chains,
- Altera FPGA running at up to 80 MHz,
- independent daughter boards for analog and digital input,
- SRAM memory with space for 1 million 48bit-long words for the readout of up to 3 frames in succession,
- on board zero suppression algorithm and
- a readout either by USB 2.0 or VME64x, offering maximum flexibility.

In addition, the EUDRB allows to clock out the event number from the TLU and store it in the event data.

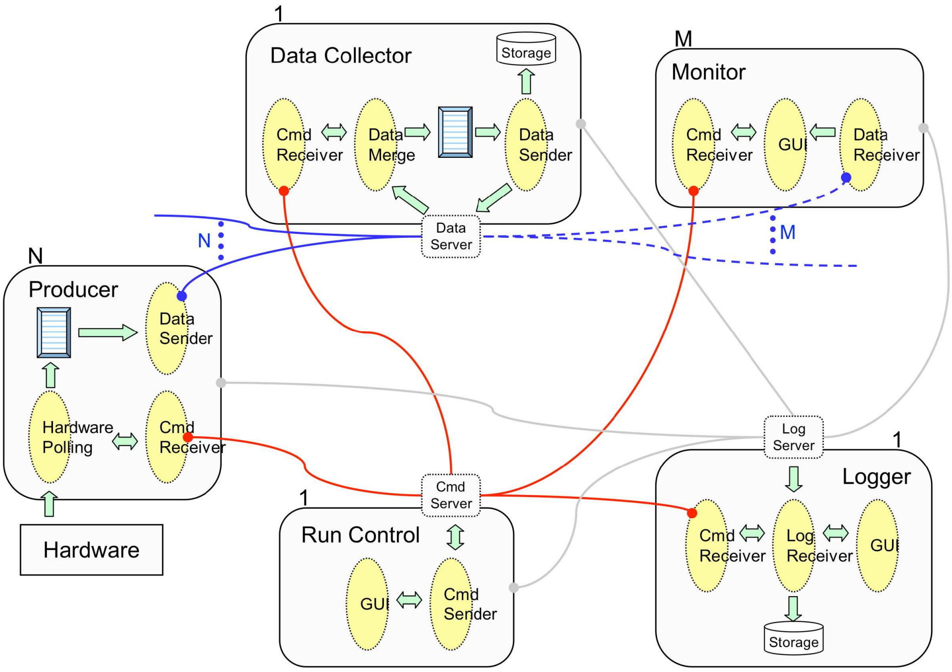

Figure 3: Interprocess communication of the DAQ software framework

4 The trigger logic unit (TLU)

For the data integration at trigger level, the University of Bristol has develloped a dedicated trigger logic unit for EUDET [6]. It is based around an off-the-shelf FPGA board. It has LVDS and/or TTL interfaces to the beam-telescope readout and any DUTs, PMT signal and/or NIM level signal interfaces to the beam-trigger and a USB interface to the DAQ. The data handshake between TLU and the DUT can be done in a simplified trigger/busy/reset mode or in a more sophisticated trigger data handshake, where the event number is clocked out by the DUT. The TLU is controlled and configured via an USB interface. Over the USB, additional information like the event timestamp and internal scalers is available.

5 The data acquisition software framework

The software framework for the data acquisition is constructed around a global run control and interprocess communication using sockets. A sketch of the different processes is shown in Figure 3. Producer tasks connect to the hardware of the beam telescope, to the TLU and eventually to a DUT in case of its full integration at software level. Data is sent from the producers to a central data collector and can be monitored by different processes. Control messages and status informations are sent to the logger process.
The software framework has been written platform independent. In the current, the

beam-telescope producer runs on a Power-PC VME CPU under Linux, the TLU producer on a PC with Linux and the main run control, monitoring and logging under MacOSX. Windows systems are currently not used but supported using cygwin. Incoming data is stored on a 2 TB RAID 10 disk array and transferred to the GRID for conversion to lcio format and data analysis using the ILC software framework.

6 Summary

A competitive DAQ system has been developed for the EUDET beam-telescope. Ease-of-use and platform independence for users of the telescope has been a main issue. The DAQ has been used successfully in testbeams at DESY and CERN in summer 2007 and will be further improved for upcoming tests. A full data chain from the readout of the pixel sensors up to the storage on the GRID has been established.

References

[1] Slides:
`http://ilcagenda.linearcollider.org/contributionDisplay.py?contribId=358&sessionId=83&confId=1296`

[2] `http://www.eudet.org`

[3] `http://europa.eu.int/comm/research/fp6`

[4] D. Haas, *A pixelated telescope for the E.U. detector R&D*, in these proceedings.

[5] C. Bozzi, *The data reduction board of the EUDET pixel telescope)*, in these proceedings.

[6] Eudet-Memo-2007-02: D. Cussans, *Description of the JRA1 Trigger Logic Unit*, see `http://www.eudet.org`