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Data acquisition in the EUDET project

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Abstract. The goal of the EUDET project is the development and construction of infrastructure to permit detector R&D for the international linear collider (ILC) with larger scale prototypes. It encompasses major detector components: the vertex detector, the tracker and the calorimeters. We describe here the status and plans of the project with emphasis on issues related to data acquisition for future test beam experiments.

Keywords. Data acquisition; tracking detectors; linear collider; EUDET project.

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1. Introduction

EUDET [1] is a project supported by the European Union in the Sixth Framework Programme structuring the European research area [2]. The project is an integrated infrastructure initiative (I3) which aims to create a coordinated European effort towards research and development for ILC detectors. The emphasis of the project is the creation and improvement of infrastructures to enable R&D on detector technologies with larger prototypes. After establishing several new technologies to match the required ILC detector performances, the construction of and experimentation with larger scale prototypes to demonstrate the feasibility of these detector concepts is the next important step towards the design of an ILC detector. Such larger detectors generally require cooperation between several institutes and EUDET is intended to provide a framework for European and also global collaboration.

The project comprises 31 European partner institutes from 12 different countries working in the field of high energy physics. In addition, 23 associated institutes will contribute to and exploit the EUDET research infrastructures. The project started in January 2006 and will run for four years providing additional funding of 7 MEuros from the European Union. In addition significant resources are committed by the participating institutes.

EUDET contributes to the development of larger prototypes of all detector components for which major R&D efforts are ongoing: vertex and tracking detectors as well as calorimeters. The project is organised in three joint research activities: test beam infrastructure, infrastructure for tracking detectors and infrastructure for calorimeters, which are subdivided into several tasks addressing different detector types and technologies. The project is complemented by networking activities, the tasks of which include support for information exchange and common analysis tools as well as a transnational access scheme through which the use of the DESY test beam and, at a later stage, the exploitation of the infrastructures by European research groups is subsidised.

With the increasing size and complexity of detector prototypes, data acquisition issues become more and more important. For some of the EUDET infrastructures the development of a DAQ system is part of the project and first conceptual ideas have been developed. Even though it is certainly too early to design the final DAQ system, it is instrumental to exchange ideas, homogenise concepts across subdetector boundaries and thus prepare the ground for an integrated concept for the ILC detector. In EUDET a coherent DAQ approach is discussed for the large prototypes involved to facilitate combined test beam experiments. Even though it was not part of the original project, discussions have started to evaluate the feasibility in light of the very different demands of the detectors. It should also be noted that efforts on coherent DAQ schemes are very welcome to advance the concept of the global detector network [3].

2. The joint research activities

2.1 *Test beam infrastructure*

This activity aims at improving the current test beam installation with a large bore magnet of up to about 1 Tesla and a low mass coil. The magnet, called PCMAG, is provided by KEK, one of the associated institutes. In addition, a high resolution beam telescope made of pixel detectors using monolithic active pixel sensors (MAPS) is under development [4]. Initially both devices will be constructed and used at the DESY test beam facility but they are transportable, as all EUDET infrastructures, and could be used later in other laboratories.

An important part of this project is the development of a DAQ system for the pixel telescope. Figure 1 shows the first design of it. This task includes the design of front-end electronics and data reduction boards. It will be complemented by a special trigger logic unit. Some parts of the design, like the connection to the readout computers, are not yet decided. The first demonstrator set-up of the telescope is scheduled to become operational by mid-2007 and the full telescope by the end of 2008.

2.2 *Infrastructure for tracking detectors*

Both options for the ILC central tracking detector, a high resolution TPC and a large low-mass tracker consisting of silicon strip detectors, are addressed in this activity. The TPC activity centres around the development and construction of a

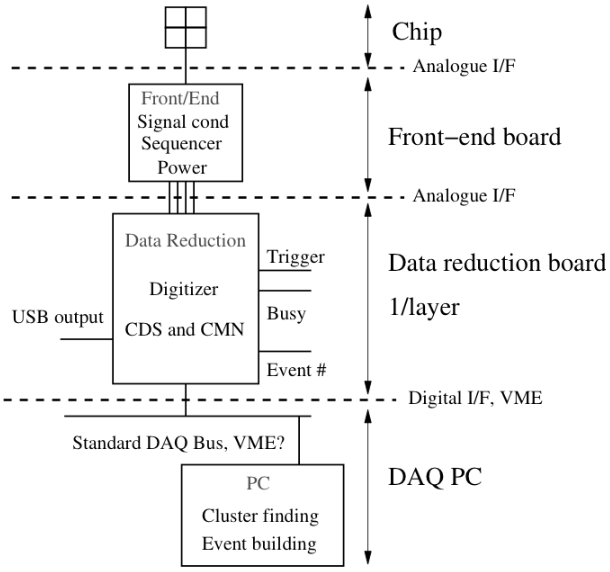

Figure 1. Design of the DAQ system for the high resolution pixel telescope.

large field cage, to be used inside PCMAG to test various options of micro-pattern gas detectors which are under study for the gas amplification at the end-plates. For the silicon tracking option, studies will concentrate on the design of a large and light mechanical structure, the cooling aspects as well as the front-end electronics development.

Together with the TPC field cage, a general purpose readout system to be used with different end-plate technologies will be provided. The design of this readout is based on existing technologies, namely the ALTRO chip developed for the ALICE experiment [5], which can provide the required high number of channels at low cost. It has also the potential to be further developed and tailored to the requirements of the ILC TPC using new high integration technologies as they become available. The TPC readout system will be complemented by an adequate DAQ system. This infrastructure is scheduled to be ready for first test beam measurements by the beginning of 2008.

2.3 *Infrastructure for calorimeters*

This part of EUDET comprises the construction of a fully equipped module of the electromagnetic calorimeter, a versatile stack for testing technologies for the hadron calorimeter as well as calibration and sensor test devices for the forward calorimeter. The development of front-end electronics and a DAQ system for the calorimeters also belong to the project.

A conceptual design of the DAQ system to be used with the electromagnetic and hadron calorimeters exists. It is flexible and can be adapted to different options of the readout electronics. Commercial products are used to ensure that the system

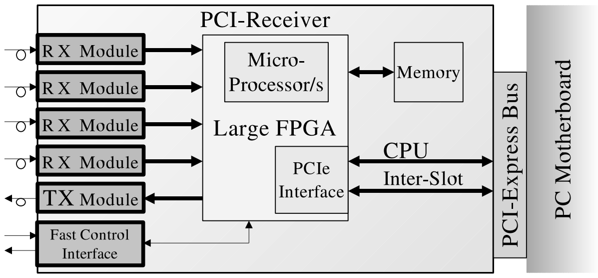

Figure 2. Off-detector receiver design for calorimeters.

is inexpensive, scalable and maintainable. Figure 2 shows the concept of the off-detector receiver card. These cards will be mounted directly on PCI buses of the DAQ computers. This concept is expected to provide a high-speed generic DAQ card available in 2009 for test beam experiments.

3. Conclusions

Within the EUDET project, infrastructures for the coming ILC detector R&D with larger prototypes will be developed and constructed in the next years. DAQ systems for the calorimeters, vertex and tracking detectors are part of the project, which will permit detailed test beam experiments in a few years. Efforts are on to investigate if the concepts for these DAQ systems can be homogenised despite partially diverging requirements on the R&D issues are to be addressed by the different detectors. Obviously, any modification and enlargement of the DAQ systems planned has to be accommodated within the time frame and the resources of EUDET. The advantages and possible benefits are, however, numerous ranging from combined test beam experiments to the valuable experience to be gained for the ILC detector.

Acknowledgments

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