EUDET: Detector R&D Towards the International Linear Collider

J. Mnich, FLC, DESY, Germany
on behalf of the EUDET Consortium

***Abstract*— EUDET is an initiative supported by the European Union to improve infrastructures for detector R&D, in particular for the International Linear Collider (ILC). The programme is focused on providing support for larger scale prototype experiments as well as on facilitating collaborative efforts. The project encompasses developments for vertex detectors, gaseous and silicon tracking, and highly granular electromagnetic and hadron calorimeters. Now at midterm the project is in full swing and some important key elements have been completed and successfully tested. This presentation will give an overview of the detector developing work and summarises the most important achievements of the different research activities.**

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***Index Terms*— EUDET, R&D infrastructure, vertex, tracking, calorimetry**

I. Introduction

Over the past years the detector R&D for the ILC has identified several candidate technologies for vertex and tracking detectors and calorimetry which meet the challenging demands for the physics at the ILC. Now the R&D efforts enter into a phase where these technologies have to be extended to larger prototype detectors to verify their feasibility and to optimise the overall detector performance. The EUDET project [1] provides with support from the European Union a framework for the development and construction of larger prototypes for ILC detector technologies. The project started in January 2006 for a duration of four years and it encompasses the design and construction of infrastructures for vertex and tracking detectors as well as electromagnetic, hadronic and forward calorimeters. Most of these infrastructures will be initially commissioned at DESY but they are designed to be movable such that they can later be exploited at other laboratories in Europe and abroad. Even though EU funding can only be allocated to European groups the project is open to world-wide collaboration. Several non-European institutes are associated and contribute to the design and construction of the infrastructures anticipating their subsequent exploitation [2].

II. Testbeam Infrastructure

The goal of this activity is to provide a test beam with a large bore high field magnet and a high precision, fast beam telescope by upgrading an existing facility in Europe. The magnetic field of the superconducting magnet has been successfully measured and the field map is now available for users. This so-called demonstrator telescope comprises a precision mechanical structure, and monolithic active pixel sensors (MimoTel) with high signal-to-noise ratio and high single point resolution. A first version of the high precision beam telescope based on silicon pixel detectors was successful commissioned and tested in particle beams at DESY and CERN in 2007 [3]. The readout hardware with high data transfer rate and synchronous operation was finalised for the analogue version of the telescope. A light-weight platform independent software completes the data acquisition system. Custom tracking software allows detailed analysis of the test beam data and was used to evaluate the telescope. A complete evaluation of the demonstrator telescope was performed using a sensor of a different technology as device under test. In summer 2008 five different groups will be using the telescope for testing their prototypes at the SPS test beam at CERN. In order to improve the resolution to the required 1 μm a high resolution pixel plane with a pixel pitch of 10μm (Mimosa18) will be added for some of these tests.

J. Mnich is with the Deutsches Elektronen-Synchrotron DESY, 22603 Hamburg, Germany. e-mail: joachim.mnich@desy.de

III. Tracking Detectors

The two main options for the main tracker of the ILC detector, Time Projection Chamber (TPC) and silicon strip detectors, are part of the EUDET programme. A large TPC fieldcage is under construction to be equipped with GEM or MicroMegas based readout structures which have demonstrated in small prototypes their potential to achieve single point space resolutions of 100 μm or below. To this aim the fieldcage will be equipped with a modular endplate to receive large surface gas amplification structures. The design of the TPC field cage has now been finalized and the device is in production. Both versions of the readout electronics, ADC and TDC based, are fully designed and in production with many elements already in hand and tested. First versions of the necessary infrastructure including software are available and partially tested. They are being improved and the full functionality can be probed as soon as the hardware is available early summer 2008.

IV. Calorimeter Infrastructure

The anticipated physics at the ILC requires calorimeters with unprecedented energy resolution, in particular for jets. Particle flow algorithms based on highly granular electromagnetic

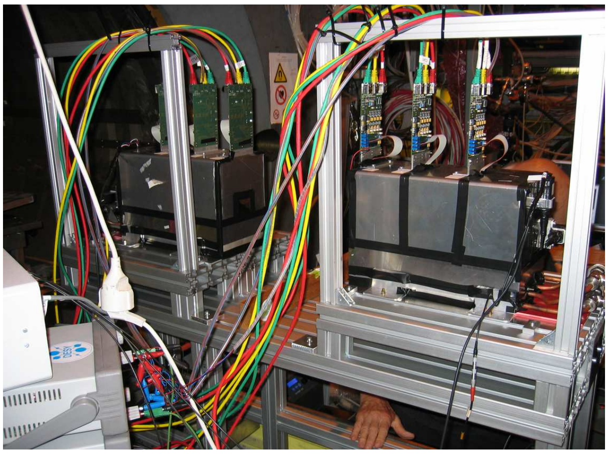

Fig. 1. Photograph of the mechanical setup installed at CERN H8 test beam.

and hadronic calorimeters are considered to be a promising candidate to achieve the goals. In EUDET scalable prototypes for these main calorimeters are developed and constructed, together with developments of silicon sensors and calibration systems [4]. Fig. 2 shows the design of the tungsten absorber structure for an electromagnetic calorimeter which will partially be constructed from EUDET funds. It will be the basis for important studies towards the ILC detector calorimeter. Among the critical design issues is the power dissipation of the readout electronics which is completely embedded in the detector. The low duty cycle of the ILC (0.5%) can be exploited to power pulse the electronics avoiding cooling systems which would deteriorate the calorimeter performance. The ECAL task has achieved the completion of the designs of the slabs and electronics such that the construction of the infrastructure can commence in 2008. A similar detector architecture with embedded electronics is foreseen for the hadron calorimeter. It includes the development of very front end readout electronics ASICs for electromagnetic and hadron calorimeters on a common platform

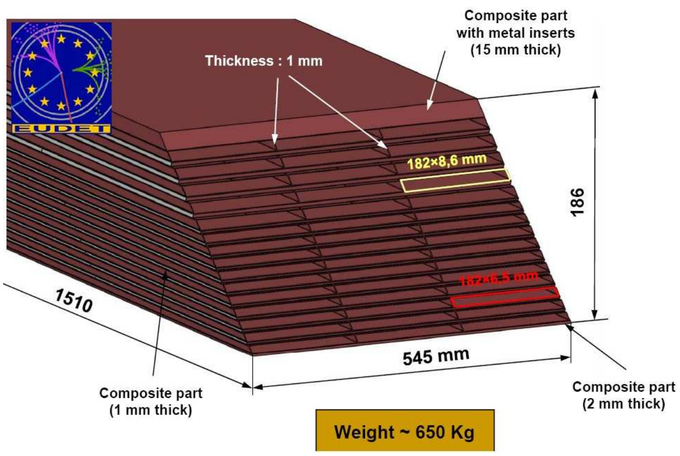

Fig. 2. Design of a scalable tungsten based absorber structure for the development of an ILC electromagnetic calorimeter

and a unified DAQ system. First prototypes of ASICs and DAQ components have been produced and successfully tested. Also the construction of the HCAL infrastructure can commence in 2008.

V. Outlook

This paper will summarise the EUDET project and discuss the significant progress achieved since its start beginning of 2006. Examples of achievements are the TimePix chip, the commissioning of the large bore magnet and the first operational version of the beam telescope. In 2008 most of the remaining EUDET infrastructures are to be completed such that they can be exploited. The presentation will focus on the latest results from test beam studies throughout summer 2008.

VI. Acknowledgement

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References

[1] www.eudet.org
[2] J. Mnich, ”EUDET: Detector R&D Towards the International Linear Collider”, EUDET-Report-2007-10, Dec. 2007
[3] A. Bulgheroni, ”First Test Beam Results from the EUDET Pixel Telescope”, EUDET-Report-2007-06, Proc. of the IEEE NSS 2007 in Honolulu, USA
[4] K. Gadow, E. Garutti, P. Göttlicher et al., ”JRA3 Hadronic Calorimeter Technical Design Report”,Eudet-Memo-2008-02