Statement on the EUDET development in 2008

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Abstract

The External Scientific Advisory Board is in charge of writing an annual statement about the Project's development and status including its role with respect to developments in the Americas and in Asia

1 Introduction

The EUDET advisory board met once in 2008 during the Annual Meeting of the EUDET project. The present statement on the development of the project is 2008 is based on our observations on the presentations that we attended at the Annual Meeting and on the content of the Annual Report.

EUDET represents an important European organizational instrument in preparations for the design and development of technologies for the ILC particle detectors. EUDET provides vital infrastructures for hardware development and communications, as well as a forum for discussions, sharing of results and propagation of information. It represents a central pillar of the European participation in the global ILC detector development activity, and a complement to the ELAN and EUROTEV activities on the ILC accelerator.

EUDET sponsored infrastructure is also enhancing global collaboration for ILC detector research. This is a very important role for EUDET, since the ILC project has been proposed as a truly international project from the beginning involving physicists from Europe, Asia, and the Americas. Examples of global collaboration involving Asian physicists on EUDET activities are their contributions to the MPGD readout plane of TPC and the scintillator electro-magnetic calorimeter. North American groups are also making important contributions, including the TPC precision endplate and calibration system and test beam facilities for calorimeter measurements.

2 JRA1 Test Beam Infrastructure

The goal is to provide a test beam with a large-bore, high-field magnet, and a high-precision, fast beam telescope. The facility is crucial for determining detector component characteristics in a realistic environment. In general progress and accomplishment are excellent. All milestones and deliverables foreseen in 2008 have been accomplished. Specifically:

Magnet: A survey of the map showed year showed that the field is homogeneous to within 3% in the region of ± 30 cm around centre, whereas larger deviations were observed in the remaining region. The transfer line for filling the liquid helium at DESY was improved by KEK and the exciting procedure was automated. PCMAG is presently loaded with the large prototype TPC and is in operation at the DESYII T24/1 test beam.

Pixel telescope: The demo pixel telescope is operational and has been regularly used in the framework of the Transnational Access.

In 2008 the validation of all components entering the charge sensing and signal processing chain integrated in the final sensor of the telescope was performed. This validation was based on two complementary prototype chips, one (called IDC) encompassing the upstream part of the chain and the other (called SDC-2) featuring its downstream part. Those chips were fabricated from late 2007 to spring 2008, and were extensively tested in the laboratory with a radioactive source and at the CERN-SPS with particle beams. While the complete architecture chain of the final sensor was validated with these prototypes, the design of the final sensor started in July 2008 and corresponds to a nine-fold replica of the validation chip. This order of

magnitude change in the sensor size and the task of connecting the column binary outputs to the fast zero suppression logic concentrated most of the design effort. The design was finally validated by numerous simulations in December 2008 and sent to the foundry for fabrication. However this production was stopped to implement a last minute change to cure some small instability shown by the simulation after the submission.

Data acquisition and evaluation software: The system has been extensively used by a large number of external users with the demo telescope. In the beginning of 2008, the EUDRB firmware has been updated for improved stability and readout/compression of two rolling frames and the TLU has been upgraded to allow software switching between LVDS, TTL and also NIM levels. The EUDAQ stability and usability has been improved and a new VME driver has been implemented. The new driver increases the readout speed from 50 Hz to around 200 Hz in zero suppressed mode and is an important step towards reading out the final sensor chip in 2009. The effort on the EUTelescope software package focused on making the software as general as possible and user-friendly in order to allow external users an easy integration of their DUT. In particular, a professional toolkit for detector alignment (MillePedeII) has been included into the framework integrating the alignment output in the existing database infrastructure and a specific correlation module has been coded in order to check the data quality at different analysis stages.

Validation of infrastructure: During 2008 the Detectors under test (DUTs) were integrated in EUDAQ level, where the DUTs use custom hardware, but integrate within the EUDAQ framework with a custom producer task, allowing very large flexibility. A second test was performed were the systems integrated at trigger level and the data synchronization is done via simple trigger/busy logic provided by the TLU and optional protection against slipping event numbers via an advanced data handshake. The use of the demo telescope in the framework of TA2 provided addition validation experience. Experiences with the DAQ, the mechanics and the periphery were directly fed back to the designers of the final telescope.

3 JRA2 Infrastructures for Tracking Detectors

Scope of JRA2 is to provide infrastructures for developing and testing new readout structures for a Time Projection Chamber (TPC) and for silicon based tracking detectors. Though some further delays have been accumulated with respect to the schedule that was revisited one year ago, the large part of the system is now in operation.

General purpose TPC development facility: After finalising the design in 2007 the field cage of the TPC has been built essentially in the first half of 2008. This involved the construction of a sophisticated mandrel, and the careful built-up of the composite structure on this mandrel. The field cage was delivered at DESY in August. It was then subjected to a vigorous testing and validation procedure, which confirmed that the basic specifications were met. After installation of the first end-plate system (micromegas) by the LC-TPC collaboration, the first tracks from cosmic rays were recorded in November. At the end of November the TPC was installed in the PCMAG facility were the experimentation started with a single micromegas panel. It is encouraging to see that the chamber is today operational, though with eight months delay with respect to the original schedule.

During 2008 the components for the 2000 channel system of the flash ADC based readout electronics have been sourced. The design and building of the complete system has commenced. The interface to the large prototype has been finalised, and the necessary mechanics to house the readout cards close to the readout modules have been designed. During 2009 the total number of channels will be increased to close to 10000 so that a large part of all seven readout modules can be instrumented. These 10000 channels represent a significant investment done by the EUDET and other LC-TPC partners in excess of the original EUDET program.

Recently front end boards for 2000 channels of the TDC based readout system have also become available. Work is now ongoing to complete the system for use in the test beam in 2009.

Silicon TPC based monitoring facility: the first step toward the ambitious goal of providing a pixelised readout of a TPC was already in 2006 with the use of the TimePix readout chip with gas detectors. A second run for the TimePix chip with no modification was delivered in June ’08 providing further chips with yield similar to the first run. During 2008 all groups have continued to test several single-chip systems in detail both with radioactive sources, cosmic rays and in test beams at ELSA in Bonn and at the CERN PS. And also to prepare multichip systems (4, 8, 64 chips) to form an endplate module for the LP-TPC infrastructure at the DESY test-beam. The parallel readout of several chips proved to be difficult. A lot of progress was achieved in parallel in the development of a software framework for the TPC.

Si-tracking facility: the various components of the Silicon Test Infrastructure are now combined together. The conduction cooling system is now built using new composite materials of low material budget and high thermal conductivity. Several modules of the forward tracker prototype are equipped with novel sensors that can be traversed by infra-red light for alignment. The new readout chips in 130nm technology have been tested extensively tested using electronic methods and mounted on hybrids that equipped the detector modules.

4 JRA3 Infrastructures for Calorimeters

Scope of JRA3 is to provide infrastructures for research and development of full-sized, scalable, electromagnetic, hadronic and very-forward calorimeter systems including their DAQ. The activity has started well, the progress in the past two years is satisfactory. It looks as if during the reporting period 2008 all important milestones have been achieved, and a large number of reports conference talks and publications have been submitted.

ECAL: In 2007 the engineering drawings have been completed both for the structure and for the slabs. The active silicon sensors have been specified, a first order has been submitted. The assembly procedure for the slab has also been defined. In 2008, all designs for the large prototype have been finished and parts to assemble a smaller “demonstrator” were ordered. The reasons for this intermediate step are to address technological challenges of the full-scale detector construction, to study large scale integration, questions of power consumption and cooling with already existing material. One of the big contributions in the ECAL project is the tungsten cover which is able to install silicon sensor and read out electronics. The structure is under production and will be tested according to schedule. The embedded electronics design

and its implementation are another big issue. The ASIC design is an optimum solution advantage to achieve such a condensed detector. The concept and real products are well tested under EUDET and will be installed further structure.

HCAL: For 2007, emphasis was put on the electromechanical design of the detector structure, on the validation of component designs with small prototypes and on the development of a single channel calibration system prototype. The activities in 2008 have focussed to the completion of the design for a mechanical absorber structure with thin gaps and minimized dead zones, and of a prototype for the integrated read-out layer and production of a multi-channel calibration system prototype. A big achievement were the structural calculations which included studies to minimize deformations. A mechanical prototype was designed, the material has been delivered, such that completion of construction is expected to be on schedule. For the active layer, the design and lay-out of a first prototype for the base unit with 144 channels has been completed, and production is underway. A combined mechanical analysis of ECAL and HCAL is also going on, thus EUDET work will have a reliable and stable detector model.

VFCAL: The effort within VFCAL was focused in 2007 on the design of the front-end electronics. The equipment for tests of the radiation hardness of sensors in a beam has been completed. Progress has been also made in the design and construction of a high precision laser position monitor system. Development of ultra-thin sensor planes using thin copper traces on flexible PCBs has been started. In 2008 the work was focused on the completion of facilities to perform sensor characteristics measurements in the laboratory and in test beams, the production and tests of prototypes of the FE and ADC ASICS and the construction of a laser position monitoring system. For these topics ‘readiness’ milestones are reached end of the year 2008, and deliverables as prototypes and reports had to be finalised.

DAQ: In 2007, work has moved to detailed design of individual components as well as purchasing, building and programming the necessary components for the system. In 2008, work on the data acquisition (DAQ) system has concentrated on the achievement of a DAQ system prototype. All components have been designed and prototypes produced which are set up in institute labs. Firmware has been written to control the hardware both to perform rudimentary tests and in preparation for future use by detectors. All of the four different prototypes have been tested and shown to work, thereby fulfilling the Milestone.

Front-end Electronics: Two first prototype readout ASICs have been fabricated: for the Digital Hadronic Calorimeter and for the electromagnetic calorimeter (ECAL). In 2007, these two ASICS have been very thoroughly characterized and were shown functional. A third Silicon Photomultiplier Integrated readout Chip has been fabricated during the summer of 2007. In 2008, the two final prototype ASICs for the three calorimeters ECAL, DHCAL and AHCAL have been fabricated. Both HaRDROC2 and SPIROC2 have been tested which fulfils the milestone. All these ASICs will continue to be carefully characterized in order to be produced in large quantity in a dedicated run mid 2009.

5 NA2 Detector R&D Network DETNET

Scope of NA2 is to provide the framework for exchange of information and facilities common to the JRAs. The activity is progressing well. The computer cluster completed and regularly

used as are the common analysis framework and the Web. During the reporting period there was only one milestone that has been achieved.

EXCHG: The Organization of the Annual meeting was correctly done with well-structured agendas posted on the indico system and with material promptly available to the participants.

WEBINFO: The web information system is fully operation and regularly maintained. It represents the central information hub for EUDET partners as well as for the outside world.

COMP: The site at UBONN is certified and in production. The site at TAU is in candidate status and essentially operational. The milestone "Full computer cluster available" has been achieved. These resources are regularly used for analysis of test beam data, for simulation of detector performance and for detector conception studies. The usage of ILC grid resources has very significantly increased over the reporting period.

ANALYS: The development of a common test-beam data analysis and simulation infrastructure is tightly integrated with the overall common ILC/LCD software effort. The functionality has been extended for tasks specific to EUDET like test beam analysis. The software tools are fully functional since a first release in July and more recently the focus of the development has been on software maintenance and the improvement of the software deployment. All three JRAs have fully adopted the common software framework and developed their specific tools (CaliceSoft, MarlinTPC and EUTelescope) within the framework. A web portal has been set up to facilitate the use of the software.

MICELEC: microelectronics technology support continued and foundry access to several deep sub-micron technologies has been provided in 2008. A series of contacts have been established with industry to define a set of new software tools, services and training for the microelectronics designers within the particle physics community. Training sessions for engineers have been organized. Microelectronics design support has also been provided to the JRAs.

VALSIM: this more specialized task of simulation of the hadronic interactions has focussed on extending the validation of physics models, improving key aspects of physics modeling, and improvements in integration testing. Many of the previous studies have been integrated in the Geant4 release 9.2. At the annual meeting, a dedicated session of GEANT4 experts and JRA3 members took place to develop a strategy to efficiently compare the huge data sample available from the Calice collaboration with the different hadronic shower models inside GEANT4.

6 Transnational Access activities

During 2008 the Transnational Access activities were regularly advertised on the EUDET web site and at several conferences to communities working on detector R&D. The web site was also refurbished taking into account suggestions from the users.

In total eight proposals were submitted to the Transnational Access activity, two for the use of the DESY test beam and six for the use of the pixel telescope. They were all of excellent scientific quality and were approved with rank A. The limited number of proposals for the DESY test beam can be explained by the fact that the DESY test beam had a long shutdown time during 2008 and we look forward to an increase in the number of proposal in 2009.

7 Conclusions

Now in the third year of life, the project is close to completion of its delivery. We congratulate the IC and the steering committee for the management of the project.

Generally speaking the project is going well. In JRA1 the magnet has been mapped has delivered a very performing prototype beam telescope and it was a pleasure to see some requests of transnational access also from non ILC related groups. There are some delays in the TPC and we look forward to delivery of the project during next year. Also JAR3 is going well and we look forward to the delivery.

The project will be extended by one year. We understand well that this does not correspond to a further delay of the milestones. We expect the delivery in 2009 as planned and we look at the 2010 as an extension of the exploitation of EUDET. We see it as a continuation of the Networking and Transnational activities, but the JRAs must deliver their deliverable in 2009, and use the large amount of the funding for this delivery.

The scope of EUDET is to build “infrastructures” for the R&D of detectors for the ILC. The relevance of these infrastructures is measured by how much are they used: i.e. the Transnational Access. In 2008 we had an important increase in TA, due to the pixel telescope, and we look forward not only to the completion of these infrastructures in time during next year, but also to their correct exploitation in 2009 and 2010. The correct exploitation of these infrastructures is important for EUDET and also for the continuation of a similar project in the future.

On the administrative side we notice that the feedback from few participating institutes is not as fast as it needs to be. We take note that the Steering committee has taken proactive actions to reduce the risk of delay in some institutions and while we were looking forward to a timely submission of the 2008 report, we learnt that this report was submitted incomplete due to delays in CNRS.