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Advanced European Infrastructures for Detectors at Accelerators

Milestone Report

Common DAQ system ready for combined beam tests

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MILESTONE REPORT

COMMON DAQ SYSTEM READY FOR COMBINED BEAM TESTS

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Abstract:

The individual components of the common data acquisition (DAQ) system have been described in previous deliverable and milestone reports. Their status is briefly summarised here as well as their use in beam tests, in particular the use of all components in tests of the analogue hadron calorimeter being developed for the International Linear Collider (ILC). All components are now in place and ready to be used in other detector R&D both for ILC developments and for other projects. Some of the planned uses are listed.

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Delivery Slip

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Executive summary

This document briefly describes the status of all components of the common data acquisition (DAQ) system as well as their current and planned use in beam tests.

In Section 1, the basic concept of the common DAQ system is described.

In Section 2, the individual components are briefly described as well as the use of all parts in beam tests.

In Section 3, the planned use of the common DAQ system is listed.

1. INTRODUCTION

The goal of workpackage 5 is to provide a suite of tools to simplify the data acquisition for common beam tests of more than one prototype detector for a future Linear Collider. This will allow multiple detectors to be more easily integrated and so allow more time for understanding technical aspscts of the detector technology and the physics performance.

The workpackage consists of several parts, split into tasks:

- Task 5.2: Interface, synchronisation and control of multiple-detector systems;
- Task 5.3: Development of central DAQ software and run control;
- Task 5.4: Development of data quality and slow control monitoring;
- Task 5.5: Event model for combined DAQ.

The individual milestones and deliverables of each of the individual tasks have been met and documented extensively in previous reports. This milestone report confirms that each is working well and are available for use by any detector group as well as demonstrating that the system as a whole (i.e. the developments in all tasks) can be used.

During the remainder of the AIDA-2020 project, the system will be deployed in as many beam tests as possible with support provided for integration. This should simplify the running for common beam tests involving many detectors acquiring data together.

2. THE COMMON DAQ SYSTEM

2.1. THE SYNCHRONISATION HARDWARE, THE TRIGGER LOGIC UNIT

The AIDA-2020 Trigger/Timing Logic Unit (TLU) is the core hardware component of the common DAQ system and distributes signals to detectors in beam tests. The TLU was originally designed within the EUDET and AIDA programmes with the EUDET pixel beam telescope in mind. The AIDA-2020 TLU has been extended to be able to synchronise different detectors with differing trigger and readout schemes, such as the CALICE calorimeters, other pixel detectors and tracking devices, as well as being able to operate at a higher particle flux. Therefore, data from different detectors corresponding to the same particle in a test beam can be combined. Detailed write-ups of the TLU have already been recently released [1,2]. A batch of TLUs have been produced and are being shipped to various detector groups for their planned beam tests.

2.2. THE CENTRAL SOFTWARE, EUDAQ2

The EUDAQ software was originally developed as part of the EUDET and AIDA programmes for the EUDET pixel beam telescope. This has since been extended and a new version, EUDAQ2, is available. The software supports detectors with different trigger schemes and different readout speeds. The EUDAQ2 software therefore enables combined beam tests of very different detectors to be performed. The software has been tested and used in several beam tests so far, as described in Section 2.5. A detailed description of EUDAQ2 is given in previous reports [3,4,5] as well as the manual available via the dedicated web-site [6]. Some enhancements are being made to the EUDAQ2 software such as providing the user with the functionality to convert the raw data to a `Root TTree` format. This will allow the user to perform analysis more quickly and easily.

2.3. THE MONITORING SOFTWARE, DQM4HEP

The monitoring software, DQM4HEP, originally developed for the semi-digital hadron calorimeter (SDHCAL) can be used for data quality monitoring (DQM) [7] and slow control monitoring [8]. The software is a generic development which has extendibility built in and so can be used to monitor data from any detector in any format. The write-up on DQM4HEP [7] outlines the general concept of the software as well providing details for its use. The software has already been successfully used by the AHCAL+beam telescope and SDHCAL+SiW-ECAL (silicon–tungsten electromagnetic calorimeter) combined beam tests.

2.4. THE EVENT DATA MODEL

The event data model has been defined in detail in previous reports [9,10]. The model is based on the eudaq::Event class in EUDAQ2. Data is kept in EUDAQ2 as raw quantities as well as allowing the (optional) conversion to LCIO [11] objects, particularly useful for prototype detectors planned for the ILC. The event data model has been used within DQM4HEP to monitor data quality during an AHCAL combined beam test, thereby verifying the approach and the common nature of an event in both the major software programmes, EUDAQ2 and DQM4HEP.

2.5. USE IN BEAM TESTS

The use of the individual components has been outlined in the previous sub-sections, above. This demonstrates that all individual components are publicly released, in use and available for use by other systems. Several ILC detector developments have taken advantage of these tools, but also other systems have used them. The TLU is used extensively in test-beam facilities at CERN and DESY and will continue to do so thereby serving the needs of many detectors beyond ILC R&D. The

EUDAQ2 software has been used in tests of tracker modules for the ATLAS upgrade [3]. Of particular note are the beam tests done for the ILC AHCAL which has used all of the above components and therefore demonstrates that the full system is ready for use.

3. PLANNED USE OF COMMON DAQ SYSTEM

The use of the various parts of the common DAQ system and the system as a whole is planned for the following ILC-related detector beam tests:

- The AHCAL will continue to use EUDAQ2 as their central DAQ system, along with DQM4HEP as the monitoring software and a TLU for synchronisation purposes. This will also be in tests with the CMS high-granularity calorimeter (HGCAL) planned for the LHC upgrade.
- The time projection chamber (TPC), being developed for the ILC, will use an external silicon tracker in order to provide an external position measurement. This combined beam test will use EUDAQ2 as well as DQM4HEP for monitoring and the TLU for synchronisation.
- The common DAQ system is being considered for use by other ILC calorimeter prototype detectors.

All components are freely available and can be used by any detectors under development for the ILC and beyond.

4. REFERENCES

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[4] M. Wing et al., “EUDAQ interfaces to other DAQs available”, AIDA-2020 Milestone report, AIDA-2020-MS46.

[5] M. Wing and Y. Liu, “Development of run control ready”, AIDA-2020 Milestone report, AIDA-2020-MS62.

[6] http://eudaq.github.io

[7] R. Ete, T. Coates and A. Pingault, “Data quality monitoring tools ready”, AIDA-2020 Milestone report, AIDA-2020-MS67.

[8] J. Kvasnicka, “Slow control system ready”, AIDA-2020 Milestone report, AIDA-2020-MS68.

[9] A. Irles, “Online data model available”, AIDA-2020 Deliverable report, AIDA-2020-D5.5.

[10] A. Irles, “Online event data model available”, AIDA-2020 Milestone report, AIDA-2020-MS47.

[11] LCIO (Linear Collider Input/Output) event model for linear colliders, http://lcio.desy.de

ANNEX: GLOSSARY

Acronym	Definition
AHCAL	Analogue hadronic calorimeter for the ILC
ATLAS	A toroidal LHC apparatus collaboration at the LHC
CMS	Compact muon solenoid collaboration at the LHC
DAQ	Data acquisition
DQM	Data quality monitoring
DQM4HEP	Data quality monitoring for high energy physics software
EUDAQ2	Central data acquisition software for beam tests
EUDET	European project on detector R&D towards the International Linear Collider
HGCAL	High-granularity calorimeter
ILC	International Linear Collider
LCIO	Linear collider input/output framework
LHC	Large Hadron Collider
SDHCAL	Semi digital hadron calorimeter for the ILC
SiW-ECAL	Silicon–tungsten electromagnetic calorimeter for the ILC
TLU	Trigger logic unit; synchronisation hardware for beam tests
TPC	Time projection chamber; tracking detector for the ILC