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Data Quality from the Detector Control System at the ATLAS Experiment

G. Aad, J. Adelman, S. Arfaoui, M. Baak, N. Boelaert, S. Burdin, J. Cook, S. D’Auria, M. D’Onofrio, J. A. Frost, C. Guyot, M. Hauschild, R. J. Hawkings, A. Hoecker, G. Iakovidis, M. Iodice, K. J. C. Leney, E. Lytken, M. Martinez-Perez, J. Masik, A. M. Nairz, P. U. E. Onyisi, S. Roe, S. Schaetzl, D. Whittington, M. G. Wilson
S. Zimmermann

1 National Technical University of Athens, HEP Group, Department of Physics, Heroon Polytechniou 9, GR 15780 Zografou, Athens, Greece
2 Institut de Física d’Altes Energies, Universitat Autònoma de Barcelona, Edifici Cn, ES - 08193 Bellaterra (Barcelona), Spain
3 Cavendish Laboratory, University of Cambridge, J J Thomson Avenue, Cambridge CB3 0HE, U.K.
4 CERN, CH - 1211 Geneva 23, Switzerland
5 University of Chicago, Enrico Fermi Institute, 5640 S. Ellis Avenue, Chicago, IL 60637, U.S.A.
6 Albert-Ludwigs-Universität, Fakultät für Mathematik und Physik, Hermann-Herder Str. 3, D - 79104 Freiburg i.Br. , Germany
7 University of Glasgow, Department of Physics and Astronomy, Glasgow G12 8QQ, U.K.
8 Indiana University, Department of Physics, Swain Hall West 117, Bloomington, IN 47405-7105, U.S.A.
9 Oliver Lodge Laboratory, University of Liverpool, P.O. Box 147, Oxford Street, Liverpool L69 3BX, U.K.
10 Lunds Universitet, Fysiska Institutionen, Box 118, SE - 221 00 Lund, Sweden
11 School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, U.K.
12 CPPM, Aix-Marseille Universite, CNRS/IN2P3, Marseille, France
13 INFN Sezione di Roma Tre, via della Vasca Navale 84, IT-00146 Roma, Italy
14 CEA, DSM/DAPNIA, Centre d’Etudes de Saclay, FR - 91191 Gif-sur-Yvette, France
15 Yale University, Department of Physics, PO Box 208121, New Haven CT, 06520-8121, U.S.A.
a Now at Lunds Universitet, Fysiska Institutionen, Box 118, SE - 221 00 Lund, Sweden
b Now at SLAC National Accelerator Laboratory, Stanford, California 94309, U.S.A.
E-mail: katharine.leney@cern.ch

Abstract. At the ATLAS experiment, the Detector Control System (DCS) is used to oversee detector conditions and supervise the running of equipment. It is essential that information from the DCS about the status of individual sub-detectors be extracted and taken into account when determining the quality of data taken and its suitability for different analyses. DCS information is written to the ATLAS conditions database and then summarised to provide a status flag for each sub-detector and displayed on the web. We discuss how this DCS information should be used, and the technicalities of making this summary.
1. Introduction
An essential part of data taking at ATLAS is monitoring the status of the hardware components, and the quality of the data taken. An important component of this is the monitoring of the Detector Control System (DCS) which supervises detector components and can provide information about conditions inside the detector. Information from the DCS should be taken into account when making a decision about whether to use a given dataset for physics analysis. After a brief overview of the Data Quality and DCS structures in sections 2 and 3, the implementation of a tool to provide an automatic summary of the status of the DCS for a given run (DCS Status Calculator) is discussed in section 4.

2. Data Quality Monitoring Framework
The ultimate goal of the Data Quality Monitoring Framework (DQMF) \[1\] is to indicate whether or not a given run is deemed suitable for use in physics analysis. The various components of the DQMF all provide status flags to signal if the checks made on a given subdetector (and thus the data taken from that detector) were satisfactory or not. The status flags are defined as follows:

- **Good** (green): Data can be used for physics analysis.
- **Caution** (yellow): Data has issues which can be solved by further reprocessing.
- **Bad** (red): Data cannot be used.
- **Undefined** (grey): Quality of data is not known.

Automatic checks from both online (while a run is taking place) and offline (up to 24 hours after a run has finished) detector monitoring are carried out and status flags for each individual subdetector are written to the offline database. A DCS status flag and detector ‘dead fraction’ (the proportion of the detector which failed one or more of the DCS requirements or was excluded from the run) are calculated offline automatically by the DCS Status Calculator and this output is also written to a folder in the offline database. These three statuses are combined with input from a data quality shifter (online) to provide a summary data quality status for each subdetector. Expert shifters (offline) from each sub-system can override this decision if necessary; otherwise this summary status is propagated through to become the final status.

This information is complemented by event displays which can provide 2-dimensional (Atlantis \[2\]) and 3-dimensional (VP1 \[3\]) representations of events. However, these are not used in making the final data quality decision. A summary of the ATLAS data quality monitoring framework is shown in figure 1.

3. Detector Control System (DCS)
The Detector Control System (DCS) supervises detector components and provides information about conditions inside the detector, for example temperature, state/status from the finite state machine (FSM), high voltage on a power supply etc. A full discussion of the DCS can be found in reference \[4\]. Some of the DCS quantities can affect the quality of data taken, and should therefore be monitored for use in the final data quality decision for data. Different quantities are useful for different subdetectors and the DCS Status Calculator has been designed to accommodate this.

All DCS information from the detector is written to the ATLAS online database (PVSS Oracle Archive). Every 15 minutes a process is run to copy a subset of this data to the offline database (via the COOL API \[5\]). Once the information is available from COOL, the DCS Status Calculator can be run, to summarise the DCS status. A schematic of the flow of DCS information is shown in figure 2.
4. DCS Status Calculator for Data Quality

The DCS Status Calculator summarises information from COOL folders to make a decision about the suitability of data for reprocessing. The number of luminosity blocks and the start and end times for a given run (UTC timestamps) are obtained from the database. This step is necessary because DCS information is indexed by timestamp, rather than run/luminosity block. Following this, DCS information for each detector channel and also (if requested) the detector configuration is collected. Any number of DCS inputs can be considered. A 5-bit bit-set is constructed for each channel, with information about whether or not it was excluded from the run, and a status representing the combined DCS inputs. Finally, all the channels are considered together to provide a detector dead fraction, and based on this, a status flag. This process is depicted in figure 3.

The framework for running the DCS Status Calculator automatically and a library of standard functions (e.g. converting run number to timestamp, reading information from the database, comparing different inputs etc) is provided by the ATLAS Data Quality group, but the subdetector groups are responsible for configuring the tool for their own system. There are two elements to the configuration. Firstly, an XML file containing database connection information, paths to folders, variable names, and criteria for that variable being good/caution and for the detector to be good/caution/bad. The subdetector groups are also responsible for maintaining a second file, from which library functions are called. Any subdetector specific functions (e.g. to look at detector configuration) are defined here too. The structure of the package is shown in figure 4.
Figure 3. The DCS Status Calculator process: Once a run number is entered, the corresponding timestamps are obtained. Then DCS information for each subdetector channel is collected and compared with the detector configuration (if requested). Finally, these inputs are all combined and a detector ‘dead fraction’ and status are written to the database.

Figure 4. Structure of the DCS Status Calculator, showing the different components of the tool and where the responsibility for each lies.

4.1 Automatic Running
Run numbers are obtained from an RSS feed [6]. This is both updated and polled every 10 minutes and returns an XML file with information about any runs which have started or are ongoing since the last update. This file is then parsed to obtain the relevant information and the run numbers are collected. Once an hour the DCS Status Calculator runs over this list of run numbers. Precautions are taken to ensure that runs have finished and that sufficient time for all information to be written to COOL has elapsed.
4.2. Viewing Output

The status flags output by the DCS Status Calculator can be easily viewed using a standard ATLAS tools, including a web-based database browser. An example of the database browser is shown in figure 5. This tool is widely used within the data quality group to browse database entries from all data quality inputs (online and offline automatic checks and shifter inputs), as well as the DCS results.

![Figure 5. Data quality results can be viewed online using a database browser.](image-url)

5. Summary and conclusion

A framework for summarising DCS information on a per run and per subdetector basis has been implemented and has been running successfully since September 2008. It is now used by the entire ATLAS inner detector (pixel detector, Semi-Conductor Tracker (SCT) and Transition Radiation Tracker (TRT)), electromagnetic (Liquid Argon) calorimeter and two out of the four muon sub-systems (Monitored Drift Tubes (MDT) and Resistive Plate Chambers (RPC)). Details on all ATLAS sub-detector systems can be found in reference [7]. The remaining ATLAS subdetectors are expected to join by the time data taking starts in Autumn 2009. The summaries provided by the DCS Status Calculator contribute to the final data quality status flag to indicate a run’s suitability for physics analysis.

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