Muon Event Filter Monitoring and Data Quality Assessment in the ATLAS experiment

R.Crupi[1,2], M.Primavera[1], A.Ventura[1,2] (and the ATLAS Collaboration)

[1]Istituto Nazionale di Fisica Nucleare, sezione di Lecce, Italy

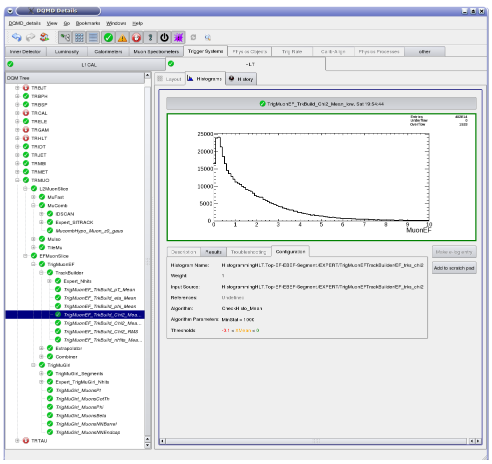
[2]Dipartimento di Fisica, Università del Salento, Italy

The three-level trigger of the ATLAS experiment at LHC is designed to be very selective while preserving the full physics potential of the experiment. The system must reduce the initial event rate of $\sim$ 1 GHz of p-p interactions at the LHC design luminosity to $\sim$ 200 Hz of events finally written to mass storage.

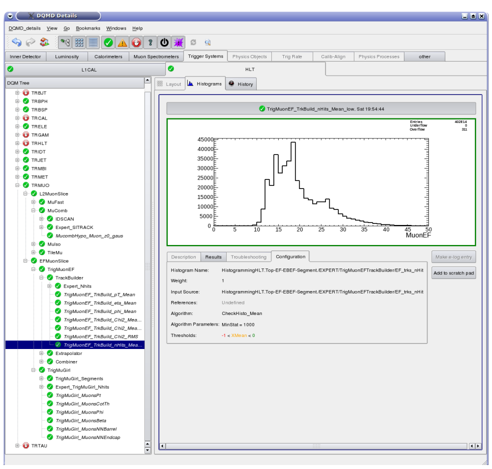
The last trigger level (Event Filter, EF) uses offline-like algorithms and has access to the full event, providing the best possible muon reconstruction/identification and finally confirming or discarding the trigger hypothesis formed at earlier levels. As it happens for all subsystems in the ATLAS detector, the quality of the data processed and collected by the trigger and Data Acquisition systems requires a reliable and efficient monitoring in order to ensure proper online operations, to reach the system expected performance and to produce a fast localization of possible problems. Complex infrastructures have been developed to continuously keep under control the quality of the taken data, both during the online processing, where a quick spotting of possible problems is required, and in the offline environment, where more sophisticated checks can be performed. The Data Quality (DQ) control system uses these infrastructures to implement two main functionalities: DQ Monitoring (DQM) and DQ Assessment (DQA). DQM relies on monitoring features like histograms and counters at different levels of data acquisition and processing. It is supposed to require an active role to the physicists on shift, which are asked to promptly react in case of problems. DQA is performed in ATLAS via a Data Quality Monitoring Framework (DQMF)[1], developed in order to interface with both online and offline services. It allows to apply automatic analysis algorithms to the monitoring features, according to suitable run configurations (e.g. "Cosmics" or "Collisions"). The analysis response produces data quality flags following a color code policy: it may generate alarms when deviations from the standard behaviour of the monitored data occur and help experts to make the final data quality assessment for a given run.

The online Event Filter DQM and DQA have been implemented within a framework common to all ATLAS trigger algorithms. Monitored data are a subset of EF variables , shown in the histograms collected at run time by the Online Histogramming Service (OHS) [2], a monitoring tool which gathers and manages the histograms produced in the current run. Few of these histograms, considered as the most relevant for a quick data quality check by the shifter crew, are displayed in the Online Histogram Presenter (OHP) service, while all other distributions are available to the shifter in the ATLAS Control Room via a Graphycal User Interface (GUI), to perform deeper checks. Examples of monitored variables for muon EF in online are: the muon track parameters (in the muon spectrometer and at the interaction point); the number of hits in the different detectors of the muon spectrometer associated to the track; the track χ^2, etc.. DQA automatic checks are then applied to these monitored distributions: e.g. mean and standard deviation values of the histograms are compared with a set of pre-configured thresholds or statistical tests (like the Kolmogorov-Smirnov test) are applied to the histograms against pre-defined reference distributions. DQ flags are finally set accordingly to the results of these checks, codified in XML language in DQMF configuration files. Two snapshots from the online DQM Display are shown in Fig. 1, reporting results of the DQ checks on muon EF Muon-Spectrometer track χ^2 (a) and total number of assigned hits (b).

The offline Event Filter DQM and DQA are performed on a fast offline reconstruction of a subset of data, the so-called "express stream", including a selection of many different triggers. According to the ATLAS computing model [3], they run at CERN in two different computing centers: Tier0 (for "express" and full reconstruction) and CAF (CERN Analysis Facility, for data reprocessing and calibration), and provide the final decision on the quality of the data taken for physics analysis, allowing for setting the final DQ flags for each run. The EF monitoring, beside a set of basic histograms, mostly performs comparisons between offline reconstructed muons and EF muons, through histograms which correlate the relevant online quantities with the corresponding offline one, and computes the efficiencies of a given set of EF trigger signatures with respect to the offline muons and to the previous trigger level objects (”turn-on” curves). These histograms must be checked in the standard procedure of muon trigger DQA, thus determining the good/bad run flagging response. In Fig. 2 the offline DQM histograms of EF Muon-Spectrometer -and-Inner Detector-combined muon p_T (a), pseudorapidity η (b) and azimuthal angle ϕ (c) versus the corresponding offline reconstructed variables are shown, exhibiting a good correlation, as expected.

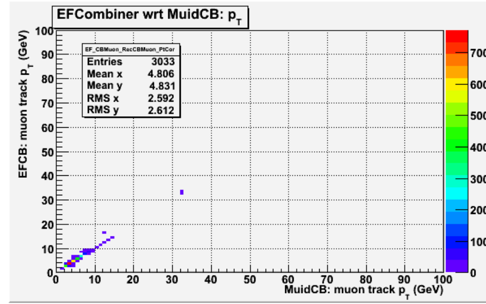


(a)

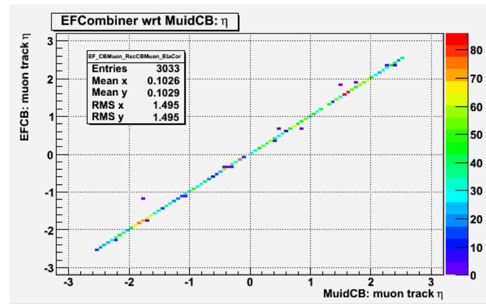


(b)

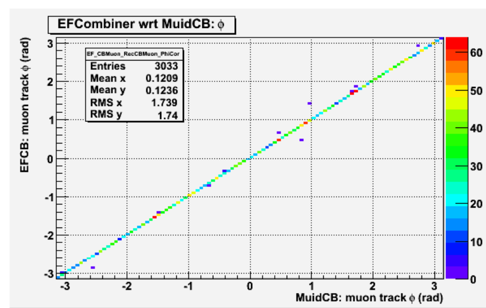
Figure 1. Snapshots from the online DQM Display showing the results of the DQ checks on muon EF Muon-Spectrometer track χ^2 (a) and total number of assigned hits (b) in a run with 7 TeV center-of-mass collisions at ATLAS.



(a)



(b)



(c)

Figure 2. Offline DQM histograms of EF Muon-Spectrometer-and-Inner-Detector-combined muon p_T (a), pseudorapidity η (b) and azimuthal angle ϕ (c) versus the corresponding offline reconstructed variables in a run with 7 TeV center-of-mass collisions at ATLAS.

REFERENCES

1. A.Corso-Radu *et al.*, “Data Quality Monitoring Framework for the ATLAS Experiment at the LHC”, IEEE Trans. on Nucl. Science, Vol.55, No.1, February 2008, 417-420.
2. A. Sidoti, Trigger Monitoring at ATLAS, ATL-COM-DAQ-2009-110, ATL-DAQ-PROC-2010-002 ,CERN, Geneva, 2010
3. D. Adams et al., The ATLAS Computing Model, ATL-COM-SOFT-2004-009, CERN-LHCC-2004-037-G-085, CERN, Geneva, 2004