Experience with the custom-developed **ATLAS Offline Trigger Monitoring Framework** and reprocessing infrastructure

Introduction
Powerful and sensitive monitoring is vital for such a complex system as the ATLAS trigger. Any occurring processing failures, misbehaviour of selection algorithms and data defects must be discovered immediately and made known to the relevant experts. Any data not usable for physics analysis must be flagged. A complex system of data quality assessment has been developed which was used very successfully in 2011. This is based on a first processing of a subset of data a few hours after recording, complemented by further monitoring performed during the bulk data processing ~48 hours later. The offline trigger monitoring framework includes also the tools to test new trigger configurations before their online usage and a thorough analysis of those events where no trigger decision could be made during the online selection process.

Data Quality Assessment

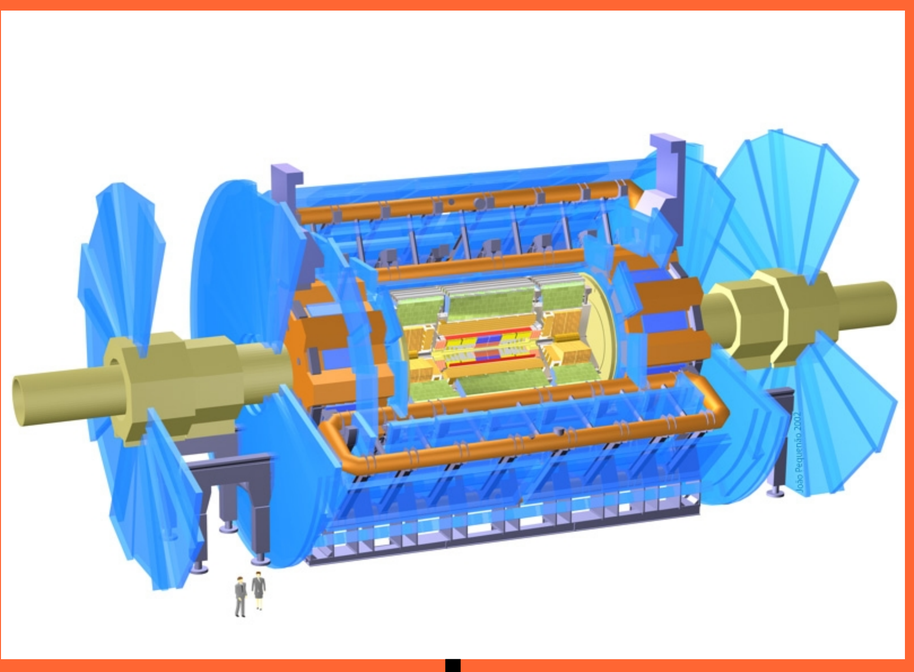
- performed with Express Stream: about 10% of the data get immediately reconstructed
- defects set for deficiencies caused by trigger algorithms, incorporated into the physics analysis

L1			HLT						
Muon	Calo	CTP	electron	photon	muon	tau	jet	b-jet	missing E_T
99.0	100	99.8	99.3	99.3	100	99.9	98.6	99.9	99.3

Luminosity weighted relative trigger quality delivery during 2011 stable beams in pp collisions at √s=7 TeV between 13 March and 31 October (in %).

Data Quality Monitoring Framework design:
- reliable: insensitive to minor changes of LHC beam conditions and trigger configuration
- efficient: identify deviations from standard behaviour with automatic checks and carefully selected distributions
- flexible: easily changeable to accommodate changes in LHC running conditions
- ease of communication: use of web interface for easy exchange of information with the help of unique URL for each DQ object

Distributions used for data quality checks:
- trigger efficiency:
quick and easy identification of inefficiencies with the help of history plots of trigger efficiency (e.g. over the last weeks). Cause of inefficiency still needs to be diagnosed
- transverse energy / momentum:
often used as threshold values for trigger chains, however threshold values depend on the luminosity
- pseudo-rapidity and azimuthal angle:
quick identification of geometry dependent trigger efficiency and possible correlation with detector defects
- invariant mass:
e.g. invariant mass peak of the J/psi meson, independent of trigger configuration and luminosity



50-60 kHz

High Level Trigger

Definitions:
- trigger chains: derive a certain trigger object (e.g. muon)
- trigger menu: stores all chains and their thresholds
- detector condition: conditions derived e.g. from calibrations
- trigger configuration:
trigger menu + detector conditions + software release

Level-2 Trigger

4-5kHz

Event Filter

300-400 Hz

Data Streams

Physics Streams: Egamma, Muons, Jets, …
Express Stream
Enhanced Bias Stream
Debug Stream
….

Trigger Reprocessings

The trigger selection can be run offline to validate changes in the High Level Trigger, namely:
- software changes in the release (e.g. bug fixes)
- major changes of the trigger menu (e.g. new chains or thresholds)
- conditions change:
improved alignment or calibration
- small changes: assessed by a nightly test on a single computing node with memory usage test and count of the number of events accepted
- bigger changes: trigger reprocessings
- run with distributed computing framework called PANDA: http://panda.cern.ch
- for assessment use a similar framework to that used for data quality assessment
- reprocessing signed-off by experts before release (or other changes) are deployed online

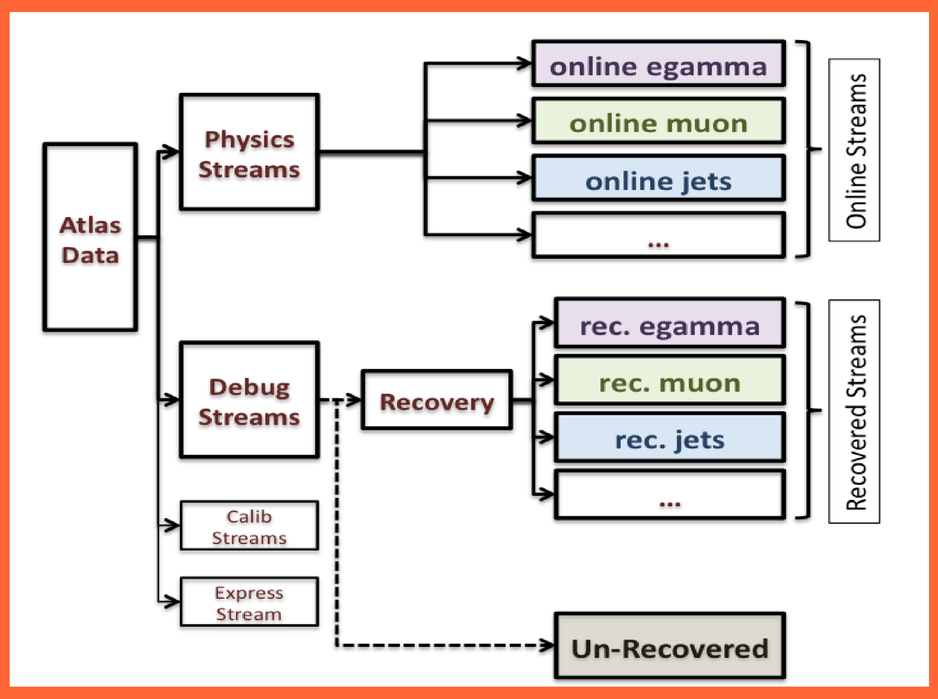
Enhanced Bias Stream
- special dataset collected with a very loose trigger
- contains events normally rejected by the trigger (trigger accepts 1 in 200 events)
- about 1 Million events
→ deviations from expected behaviour visible
- new dataset needs to be collected when LHC conditions change significantly

used for:
- trigger reprocessings
- trigger rate predictions

Debug Stream Treatment

Definition:
Events for which the trigger could not make a decision end up in the Debug Stream. In the order of one event in a million events accepted by the trigger are debug stream events.

Reason:
There are several possibilities why the trigger cannot make a decision within a given time:
- misconfigurations of the trigger: do not happen often, however can send a lot of events into the debug stream for a given time
- timeouts at L2 or EF (~ 15% of all debug stream events)
- errors in either L2 or EF (~ 25% of all debug stream events)
- others



Treatment:
- rerunning the trigger algorithms without any time limits
→ recovery of the events, 0.1% of debug stream events remain unrecovered
- analysis of the characteristics:
  - type of failure (timeout, error, misconfiguration)
  - time of occurrence
  - failure in which part of the trigger execution
  - etc.

→ correlated to issues on detector / data acquisition level
→ issues with the trigger algorithms are communicated to the developers
- recovered events are streamed like events obtained online
→ physics groups deal with integration of debug stream events

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