MUON DETECTOR CALIBRATION IN THE ATLAS EXPERIMENT: DATA EXTRACTION AND DISTRIBUTION

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In the Atlas experiment, fast calibration of the detector is vital to feed both prompt data reconstruction with fresh calibration constants. We present the use case of the muon detector, where a high rate of muon tracks (small data size) is needed to accomplish calibration requirements. The ideal place to get data suitable for muon detector calibration is the second level trigger, where the pre-selection of data by the first level trigger allows to select all and only the hits from isolated muon tracks and to add useful information to seed the calibration procedures. The online data collection model for calibration data is designed to minimize the use of additional resources, without affecting the behaviour of the trigger/DAQ system. Collected data are then streamed to remote Tier 2 farms dedicated to detector calibration. Measurements on the preseries of the ATLAS TDAQ infrastructure and preliminary tests on the wide area data distribution path are shown, proving the feasibility of the system.

Requirements:

Calibrations must be available after 24 hours from data taking:

→ Data for calibrations must be selected online.
→ …but no impact is required on DAQ/Trigger system

Good guess granularity : 1200 chambers * 2 Multilayers * 4 wire segments = 9600 regions
Each muon track crosses 6 regions (3 chambers * 2 Multilayers) = 1600 calibration towers

10 to 100 kμ/region
1600 towers
15 h of data taking (1 LHC fill)

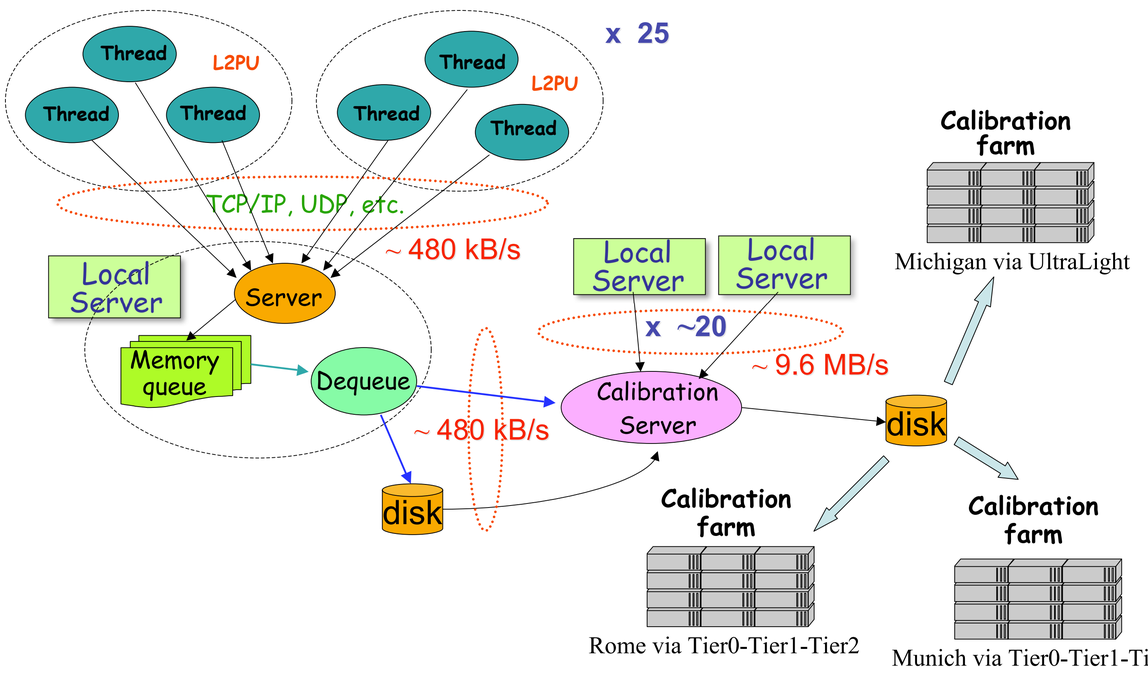
→ required rate is 300 Hz to 3 kHz

Data sources

Before the level 2 trigger (at ROD level) muon rate is 23 to 38 kHz, but there is no knowledge of the RoI. → It is not possible to select useful data.
After the 2nd level trigger granularity is full event (1.6 MB) and muon rate is too low (100-200 Hz at event builder, 40 Hz after 3rd level trigger).
At the 2nd level trigger granularity is 1 RoI (O(1 KB)) and muon rate is 23 to 38 kHz in input, O(10 kHz) in output. Additional data selection can be performed and track parameters can be added to seed calibration algorithms.

Proposed system

The 2nd level trigger algorithms run in a farm of 500 processors, divided in 20 racks. 25 nodes in a rack are booted from a local disk/file server. Each node runs 3 level 2 Processing Units. Data prepared in level 2 PU is sent to a collector in the local file server, then sent to a global collector and written to disk. Data can then be sent to remote calibration farms (Tier 2 in the LHC computing model) for processing.
In order to fulfill the requirements, the latency added to the muon 2nd level trigger must be negligible with respect to the processing time (O(10 ms)), the load on local servers must be negligible and data distribution channels to the remote farms on the WAN must sustain the data rate.



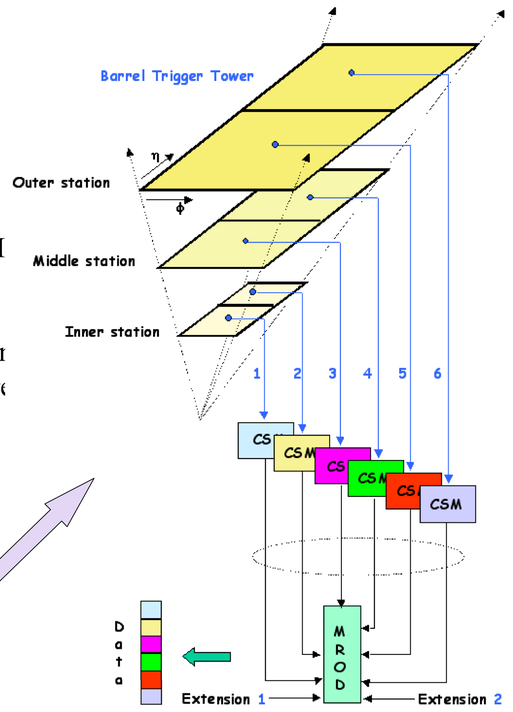
Data extraction procedure has been tested on the ATLAS preseries. Emulated L2PU produce data packets (1 kB/event) and send them to the local rack server. The local server packs data in 64 kB packets and sends them to a calibration server. The calibration server behaviour has been tested emulating 20 local servers sending data to it.
Three servers have been tested: one based on TCP and written in C++, one based on the ATLAS online monitoring protocol (CORBA-based), one based on TCP and written in Python (allowing web-based monitoring).
In all cases, CPU usage both in the 2nd level nodes and in the local server do not affect the functionality of the system.

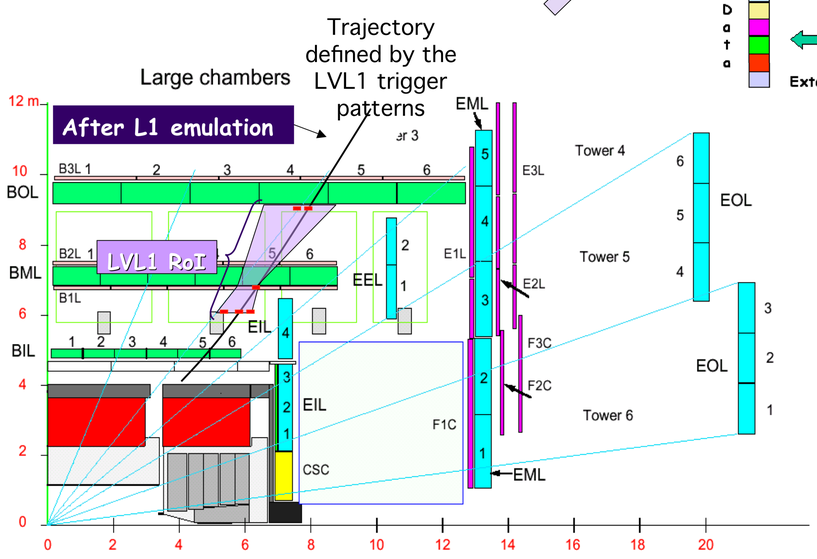
	TCP (C++)	TCP (Python)	Monitor
Client	< 1%	< 1%	< 1%
Local server	1%	6%	2%
Final server	4%	14%	6%

MDT calibration

The precision chambers of the ATLAS Muon Spectrometer are built with the *Monitored Drift Tube (MDT)* technology. The requirement of high accuracy and low sistematic error can only be accomplished if the calibrations are known with an accuracy of some μm. The relation between the drift path and the measured time (the so called *r-t relation*) depends on many parameters (T, hit rate, gas composition, thresholds,...) varying with time. It has to be measured from the data without the use of an external detector, using the *autocalibration* technique. It relies on an iterative procedure applied to the same data sample, starting from a preliminary set of constants.
The required precision requires a large amount of non-parallel tracks crossing a region, called *calibration region*, i.e. the region of the MDT chamber sharing the same r-t relation.

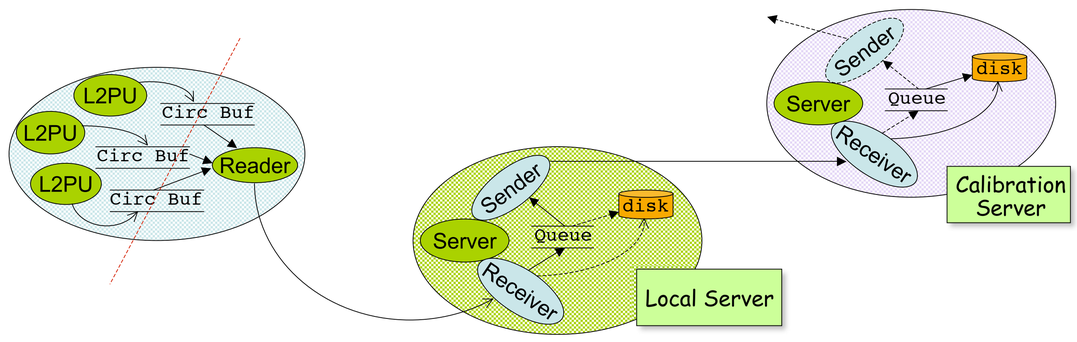
The readout in the muon barrel is organized in trigger towers. Data from each MDT chamber is collected by a Chamber Service Module (CSM). A ReadOut Driver (ROD) collects data from CSM in a trigger tower.
The level 1 trigger identifies the trigger towers corresponding to a candidate muon track (a Regior of Interest); only data from a Region of Interest are sent to the second level trigger farm. In this way, only interesting data are sent to the second level trigger.



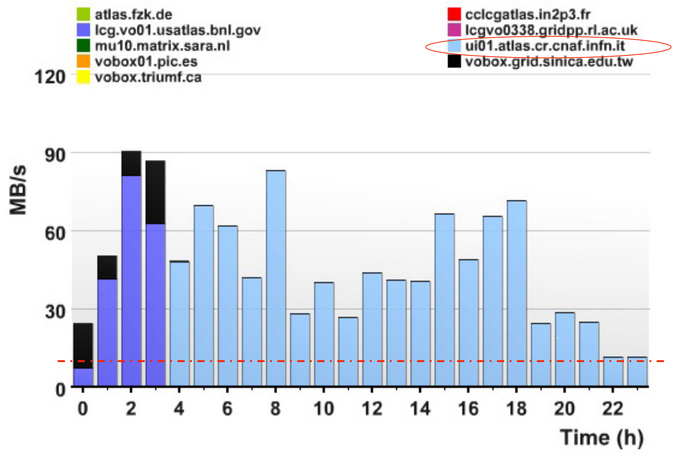


Critical issues

1) Additional trigger latency must be negligible with respect to the total one (O (10 ms)).
2) Usage of local server resources must not interfere with server's operation (it is a disk server for all the local rack). Networking is not a problem since traffic is negligible.
3) Usage of calibration server resources.
4) Data transfer on WAN.



Software structure: the PU are separated from the reader by a buffer.
Level 2 latency is only related to data preparation (O(200 μsec)).



Preliminary test of data transfer between Tier 0 and Tier 1 (CNAF) during SC3.
Without QoS, transfer rate is always above the required one.

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