UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES

Review of Poster Sessions:

- DAQ and Data Management

- Front End Electronics

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11th. Pisa Meeting on Advanced Detectors

24-30 May 2009

Some preliminary comments

1. DAQ/Trigger sessions – considerable overlap

2. DAQ Plenary Session (Luciano Ristori)
    - Scanning/measurement of OPERA interactions
    - CDF Trigger evolution with luminosity
    - ATLAS Trigger – commissioning and physics scope
    - Use of FPGA's for fast 2D cluster reconstruction

- Choice of major trends
- CDF talk timely
- Poster session very complementary

3. Front End Electronics Plenary Session (Geoff Hall)
    - The NA62 Trigger System
    - The ALICE muon trigger
    - The CMS SLHC Upgrade calorimeter trigger
    - 3D ASIC design (pixel trackers)
    - Pushing noise and radiation hardness beyond 0.1µm
    - DEPFET arrays and source follower readout for X-ray astronomy (Asteroid)
    - DEPFET arrays for Belle2

- Key trigger developments in large multi-purpose experiments
- Key ASIC technology frontiers (analog and digital)
- Evolution of pixels on a large scale – influence on DAQ, monitoring and triggering

Comments

- Only limited contributions related to future luminosity upgrades of the ATLAS and CMS detectors
- Almost nothing about tracking triggers at SLHC
- Nevertheless, many key developments – in case of LHC, expect key issues to be power consumption, connectivity, optical links, enormous software overhead

Categories of the 16 DAQ posters

1. ATLAS/CMS/ALICE/LHCb
   - ATLAS - soft real time network alarm messages (G. Darlea)
   - CMS - Manufacture QA of CMS RPC boards (A. Korpela)
     ECAL Online commissioning software (P. Musella)
     CMS ECAL DCS and monitoring (W. Hintz)
     DQ monitoring of the CMS pixel detector (P. Merkel)
     Historic Plotting Tool for DQ monitoring (M. De Mattia)
   - ALICE - Upgrade of hardware/software for DAQ (F. Costa)
   - LHCb - Monitoring of the LHCb RICH (U. Kerzel)
2. KLOE
   - Gamma-gamma tagging system (F. Achilli)
   - DAQ for gamma-gamma physics at KLOE((L. Iafolla)
3. OTHER
   - Monitoring system of the ARGO-YBJ DAQ (S. Mastroianni)
   - OPERA Global Readout and GPS distribution (J. Marteau)
   - BELLE2 silicon readout (M. Pernicka)
   - SiLViO trigger for Lambda Hyperons at FOPI-GSI (R. Münzer)

1. Generic Development
   - Wide dynamic range DAQ for new detectors (M. Menichelli)
   - FF-Lynx: Fast links for DAQ and timing distribution (G. Magazzu)

Issues and Trends

- Data Quality Monitoring and adaption to new limits of size/complexity/history/speed
- Monitoring the DAQ network itself
- Adapting data management tools to different types of experiment
  e.g. OPERA, ARGO (size)
  e.g. SuperBelle, KLOE (readout speed)
- Fast links (improved connectivity)

Comment

- Increasing Use of FPGA'S for intelligent readout
- Intertwining of DCS and DAQ/data management requirements
- The curse of data base technology vs. being user friendly

Categories of the 17 Front-End Electronics posters

1. CMS/ALICE/LHCb/CDF
   - ALICE – Integration of Trigger and Sub-Detectors (M. Krivda)
     – The Heirarchial Trigger (H. Müller)
     – Front-End Electronics for the calorimeters (Y. Wang)
   - CMS – The Control System of the CMS Level-1 Trigger (M. Jellier)
   - TOTEM – The Modular Trigger System (M. Bagliesi)
     – The Digital readout of the CSC System (S. Minutoli)
   - LHCb – The FE Electronics of the Straw Tube Tracker (F. Jansen)
   - CDF – GigaFitter: the last SVT Upgrade at CDF (M. Bucciantonio)

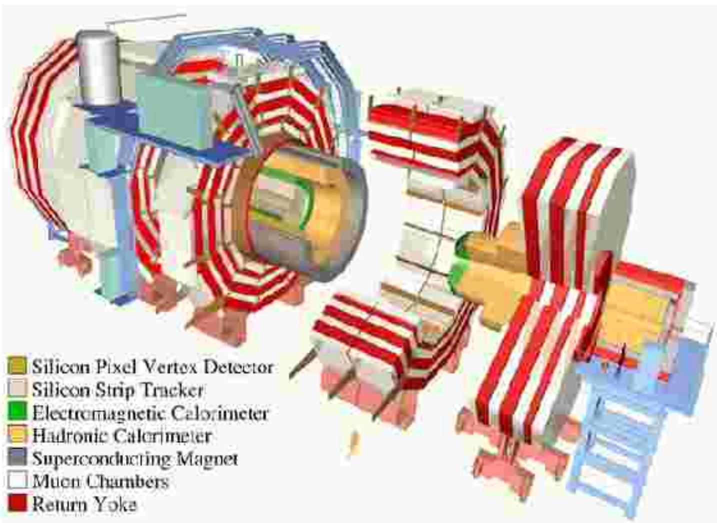
2. OTHER
   - CUORE: a programmable anti-aliasing filter (A. Giachero)
   - SIMBOL-X/IXO: a fast DEPFET readout circuit (L. Bombelli)
   - ILC: A 3D deep N-well CMOS MAPS for the vertex detector (L. Gaioni)
     (also High rate DAQ system for the SLIM5 beam test (L. Fabbri))

3. Generic Development
   - Design and performance of a compact multichannel readout for single photon detection (P. Musico)
   - CMOS Analog font-end channel for silicon photo-multipliers (F. Corsi)
   - CMOS F/E of SiPM devices aimed at TOF applications with adjustable threshold and high dynamical gain (D. Bardoni)
   - Application of the 5GS/s waveform digitising chip DRS4 (R. Dinapoli)
   - GANDALF: high resolution transient recorder (F. Herrmann)

1. Hinz (+ P. Musella)
2. Merkel
3. De Mattia

Monitoring of Large Systems – complexity – data quality

CMS Ecal DCS/monitoring – W. Hinz (ETHZ)



Issues – complexity, DCS and DAQ implications

- 75848 PbWO4 scintillating crystals + Si strip preshower
- temperature dependence of light yield
  + photo detector gain (~2.4 % per °C)
- water cooling to be controlled/monitored at 18 ± 0.05 °C

The challenge of making large system controllable

Aim – classify problematic channels with a few key tests

SEE the poster of P. Musella (LIP Lisbon) on commissioning

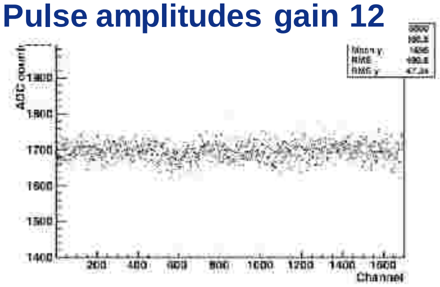
Identify 5 key (DQM) runs of all ECAL channels

1. Pedestal Run (HV on)
2. Pedestal Run (HV off)
3. Test Pulse Run
4. Laser run
5. Detector Control Run

Mean/RMS of output from these runs sufficient to ensure quality of operation and data

Intelligent history and display key issues

e.g. Test Pulse amplitudes gain 12



1 2 3 4 5

ECAL single problematic channels in time (total 75 848)

1. Hinz
2. Merkel
3. De Mattia

Monitoring of Large Systems – complexity – data quality

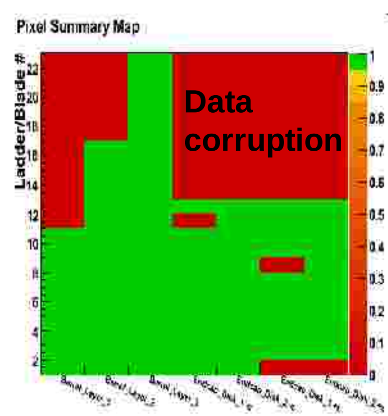
Data Quality Monitoring dor the CMS Pixel Detector – P. Merkel (Purdue)

- The CMS Pixel detector is highly granulated (1440 modules containing 66M pixels) à need for automated data quality monitoring (DQM)
- DQM system in the CMS experiment is developed within the CMS software framework
  - online: identify major problems in real time for prompt action (use subset of data, ~5Hz)
  - offline: detect reconstruction and calibration problems (full statistics, but limited granularity)
- ROOT histograms are filled for a range of quantities. They are subsequently summarized and automatically evaluated. Problems result in warnings and alarms, investigated further by Pixel experts.
- Monitor readout errors, raw charge deposition information, as well as reconstructed hits, both on and off tracks.
- Experience during global cosmic ray data taking showed ability to detect with fast turn-around (online), as well as high precision (offline), data corruption, mis-configuration and mis-calibration of the detector, as well as newly broken modules and dead or noisy pixels.

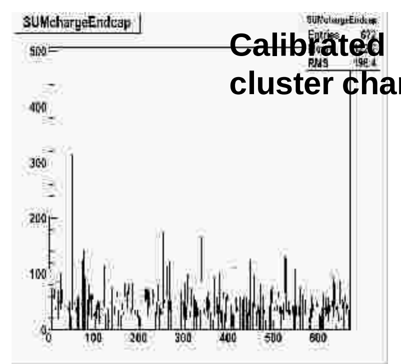
Endcaps Barrel

Interactive geometrical Maps

[mean raw charge]



Data corruption



Calibrated cluster charge

THE other KEY challenges are data certification and HISTORICAL monitoring

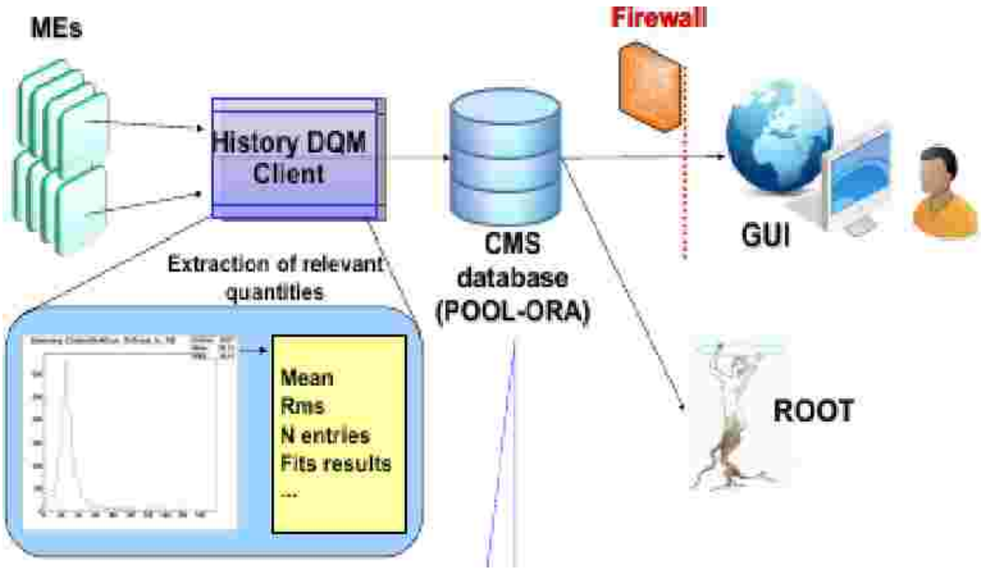
1. Hinz
2. Merkel
3. De Mattia

Monitoring of Large Systems – complexity – history

A History Plotting Tool for Data Quality Monitoring – M. De Mattia (Padova)

- **The size and complexity of the CMS detector makes Data Quality Monitoring (DQM) challenging**
- **A CMS tool allows to monitor the detector performance time: the so called History DQM**

History DQM workflow scheme:



- Extracts from the DQM histograms summary informations stored in a database
- Allows their visualization in trend charts
- Useful tool to asses the data quality

Poster content outline:

- We describe the architecture and implementation of the History DQM tool
- We report preliminary experience from the Cosmic Data taking of CMS in Autumn of 2008

Other LHC experiments have developed equivalent monitoring frameworks

See also LHCb poster (Kurzal) for RICH monitoring and calibration

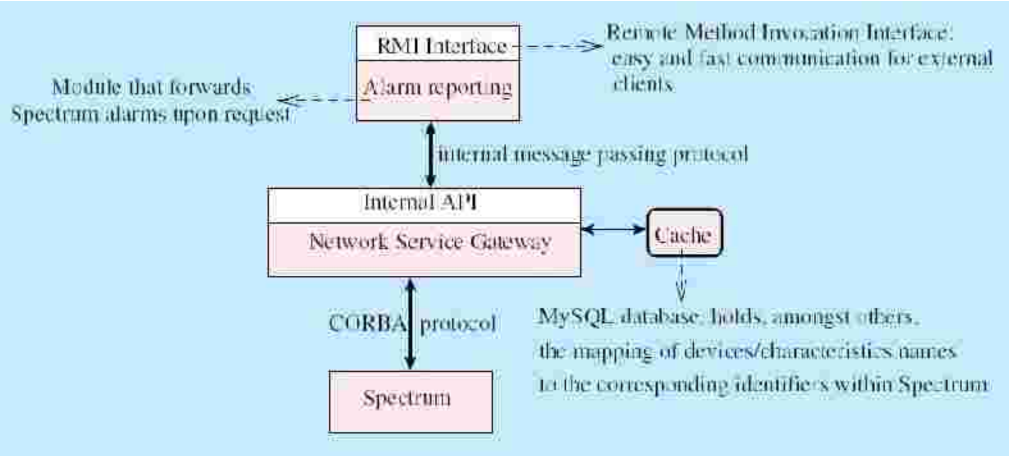
Expect evolution with real data

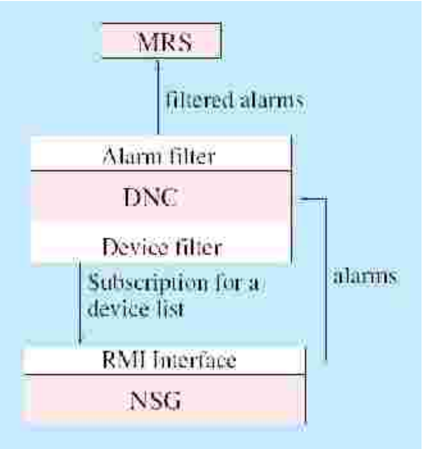
Monitoring and operation of extended networks

Lavinia Darlea (CERN) – Monitoring the ATLAS TDAQ network

- Proven to be very difficult task: dimensions and complexity.
- Commercial tools (e.g. Spectrum) inadequate
- NSG is new product connecting to Spectrum thru RMI interface
- DNC is new product injecting network alarms directly into TDAQ
  OUTPUT used for actions in case of network failure
  CURRENTLY used for confirmation, rather than diagnosis (because of polling delays in SPECTRUM

TRAFFIC is high and this monitoring is part of continuing development





1. Darlea
2. Mastroianni
3. Marteau

Monitoring and operation of extended networks

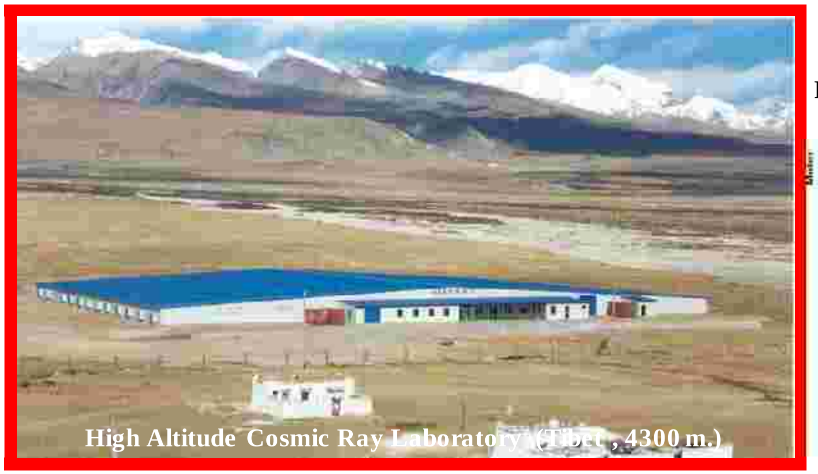
Monitoring of the ARGO-YBJ DAQ – S. Mastroianni (Napoli)

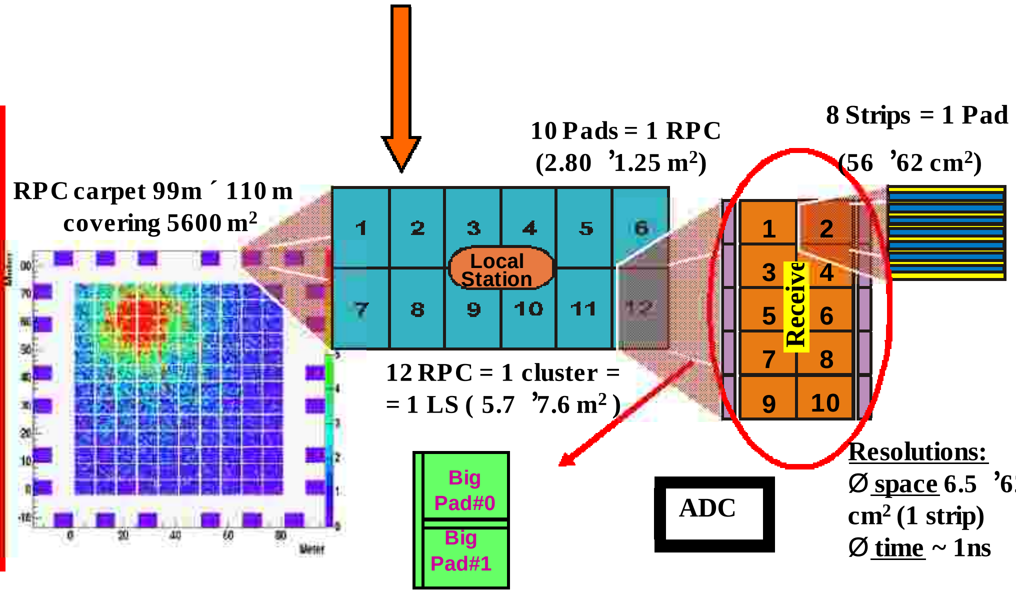
- Stable data taking since Nov. 2007
- Low Multiplicity trigger with 20 fired pads on central carpet

à Trigger rate ~ 4 kHz

•Aims: cosmic-ray physics (above ~1 TeV)
VHE ?-astronomy (above ~300 GeV)

Large channel number
High data transfer peak
Very large dynamics





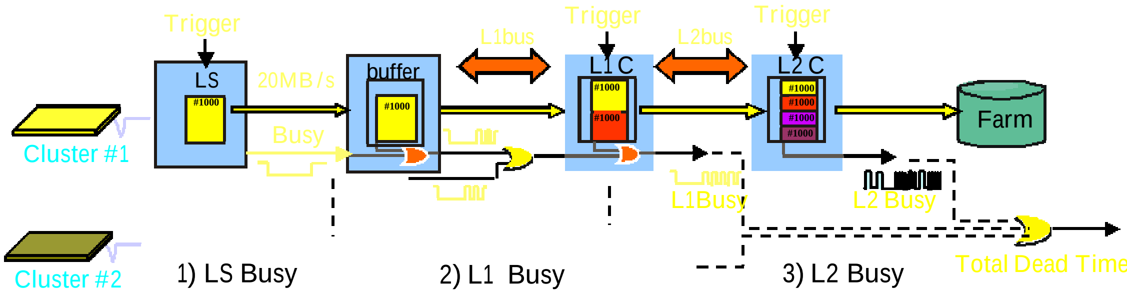
Øto distribute timing-critical signals
Øto realize a hardware real-time control without software penalities:

à to monitor the dead time at each DAQ levels
à to optimize the data acquisition
à to troubleshoot the system in case of an error
à to check the event number synchronization

1. Darlea
2. Mastroianni
3. Marteau

Monitoring and operation of extended networks

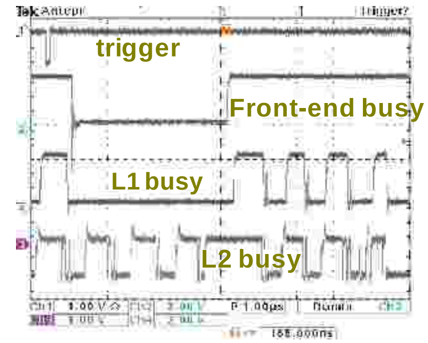
Data shifted from the LS propagating through every FIFO element until they reach the L2 controller



- On transfer

- LS busy
- Data buffer's ORed Busy
- Fifo on board

- Fifo on board



The fifo status depends upon the difference of the flow between the writing and reading!

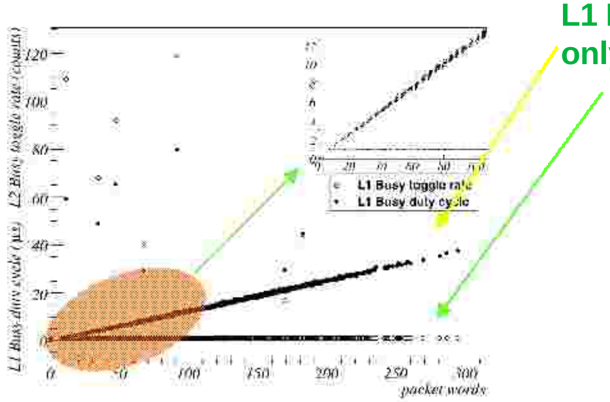
The Monitoring System

It works like a logic-analyzer continuously measuring all the Busy duty cycle and frequency for each trigger and writing the results in a FIFO

- ü study of the trend of Busy sources trigger by trigger
- ü study the DAQ data fow in order optimize the overall performance
- ü trigger on a complex Busy pattern by setting a reference range

Test results

A data frame generator with average size of 70 words, feeds 4 buffer channels @ 4kHz in order to reproduce the real experimental setup.



L1 Busy duty cycle is linear behaviour only one time for each trigger

1. Darlea
2. Mastroianni
3. Marteau

Monitoring and operation of extended networks

OPERA – Smart Ethernet with GPS synchronisation – J. Marteau (Lyon)

- Each detector element is a 1 Gb/s ethernet node
- Standard mezzanine embeds FPGA, FIFO, μ-processor with CORBA protocol
- FPGA programmed to each sub-detector
- Individual nodes run a 100 MHz clock generated via 20 MHz synchronization clock locked to GPS
- Commands encoded (e.g. delay etc.)

Full distributed network architecture (OPERA 1200 sensors)

R&D for future – full distributed architecture

- Reduce market dependency
- ACTA gigabit standard
- New synchronization scheme