The On-line monitoring of the ALICE Muon Trigger at LHC

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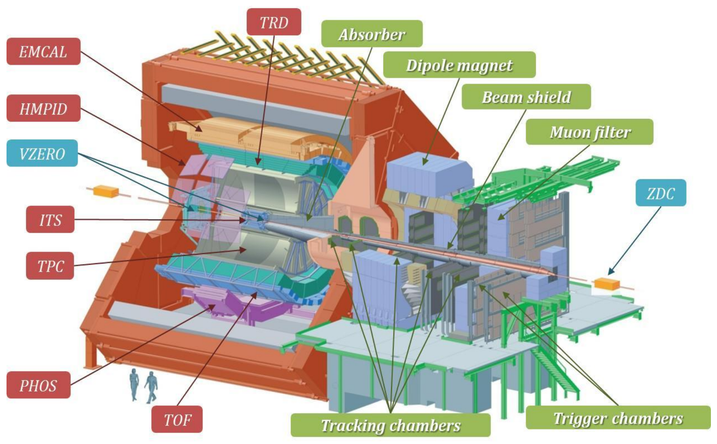
ALICE Detectors

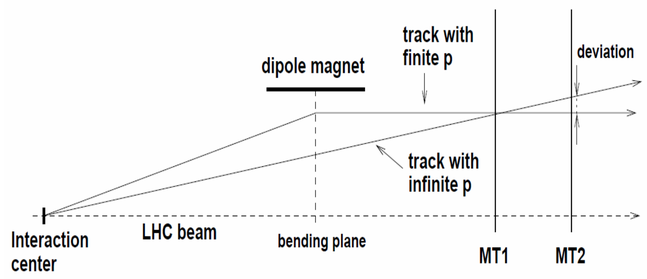
A Large **I**on **C**ollider **E**xperiment, **ALICE** [1] is dedicated to study the properties of strongly interacting matter at extreme energy densities and temperatures, the so-called **Q**uark **G**luon **P**lasma (**QGP**), produced in nucleus-nucleus collisions at the **L**arge **H**adron **C**ollider (**LHC**).



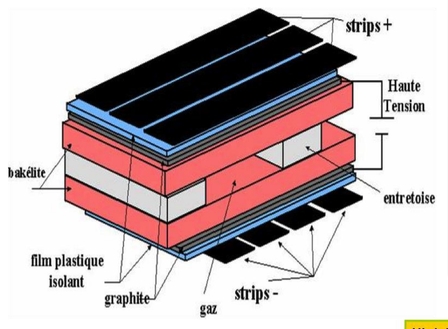
- ✓ **Central detectors ($|\eta| \leq 0.9$) identify hadrons, electrons and photons**
- ✓ **Muon spectrometer ($-4 \leq |\eta| \leq -2.5$) identifies muons**

Muon Trigger Detector

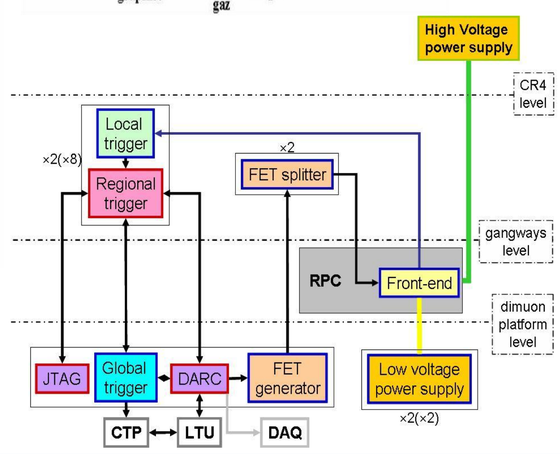
The goal of the **M**uon **TR**igger system (**MTR**) is to detect muon tracks within ~ 800 ns with respect to ALICE requirements. The trigger algorithm in the MTR Local decision electronics allows to measure the (muon) track deviation, related to the transverse momentum p_t. The muon trigger signals, above two pt cuts in parallel, are delivered to the ALICE **C**entral **T**rigger **P**rocessor (**CTP**).



- ✓ **Deviation: Track angle between the two trigger stations, with respect to the line aiming at the interaction center (Straight line: $p_t \rightarrow \infty$)**
- ✓ **The large deviation with respect to the straight line is the lower p_t track**



- ✓ **Characteristics of RPC**
  - 2mm gas gap
  - Alternative working mode
  - Streamer mode for heavy ion collisions:
    HV: 8kV
    Gas: Ar(51%)+iC_4H_{10}(7%)+$C_2H_2F_4$(41%)+SF_6(1%)
  - Avalanche mode for pp collisions:
    HV: 10kV
    Gas: iC_4H_{10}(10%)+$C_2H_2F_4$(89.7%)+SF_6(0.3%)



- ✓ **Trigger Electronics**
  - 72 Resistive Plate Chambers
  - 20992 Strips & Front-End channels
  - 242 Local trigger boards
  - 16 VME crates for Local & Regional boards
  - 1 Global trigger board
  - 2 DARC boards
  - 1 JTAG board
  - 1 Front-End Test pulse generator

Local Trigger Algorithm

Local trigger algorithm performs operations separately in the bending and non-bending plane.

- ✓ **L0-X trigger algorithm (with horizontal strips)**
  - Measure deviation in strip units (±8 strips ~ 0.5 GeV/c) for bending plane between MT1 and MT2
  - Coincidence of hits from at least 3 out of 4 MTR planes, called 34 (or 44) coincidences
- ➢ **Outputs**
  - XPos (5 bits): Position in X on MT1
  - XDev (5 bits): Deviation between MT1 and MT2 (including the sign of deviation)
- ✓ **L0-Y trigger algorithm (with vertical strips)**
  - Coincidence of hits from at least 3 out of 4 MTR planes
- ➢ **Outputs**
  - trig-Y decision (1 bit)
  - YPos: Position in Y on MT1 (4 bits)
- ✓ **LUT (Look Up Tables) [2]**
  - Provides 2 p_t cuts: Low p_t and High p_t
  - Each combination (XPos, XDev, trig-Y, YPos) has a corresponding LUT response in 2 bits
- ➢ **Outputs**
  - 2 bits of trigger decision containing the deviation direction
    00: No trigger
    01: Trigger with up direction deviation
    10: Trigger with down direction deviation
    11: Trigger with no deviation

Regional Trigger Algorithm

Regional trigger boards find (di-)muons using Local trigger information.

Global Trigger Algorithm

Global trigger board finds (di-)muon signal from Regional trigger information and sends L0 trigger signal to the CTP.

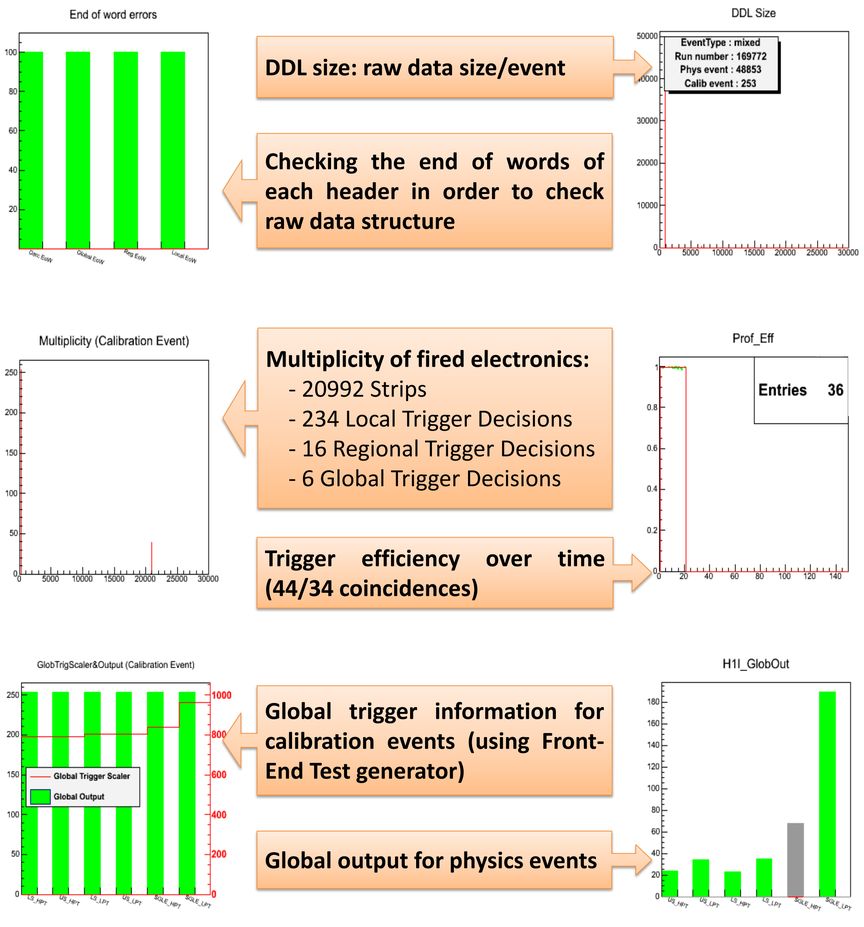
- ✓ **Deliver 6 trigger signals to CTP**
  - **SGL_LPT**/SGL_HPT: Single muon Low p_t/Single muon High p_t
  - **LS_LPT**: at least 2 muons Low p_t of like-sign
  - **LS_HPT**: at least 2 muons High p_t of like-sign
  - **US_LPT**: at least 2 muons Low p_t of unlike-sign
  - **US_HPT**: at least 2 muons High p_t of unlike-sign

Monitoring software environment

Aim is to monitor data-taking status and detector status. The monitoring software environment is based on **A**utomatic **MO**nito**R**ing **E**nvironment (**AMORE**).

- ✓ **Data flow**
  - **DDL** (**D**etector **D**ata **L**ink): Data from Front-End electronics is transferred via DDL
  - **LDC** (**L**ocal **D**ata **C**oncentrator): Perform sub-event building for each sub-detector
  - **GDC** (**G**lobal **D**ata **C**ollector): Collect LDC data and perform final event building
- ✓ **Monitoring Objects**
  - Raw data structure, data size, multiplicity of fired electronics
  - Trigger efficiency
  - Global trigger outputs
  - Scaler data
- ✓ **Monitoring Versions**
  - Shifter version: Simple and easy to check
  - Expert version: Detailed check and information

Shifter Version

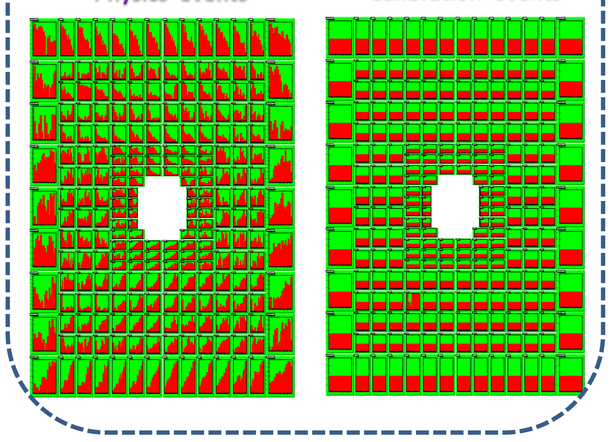


Expert Version

Strip Pattern Display

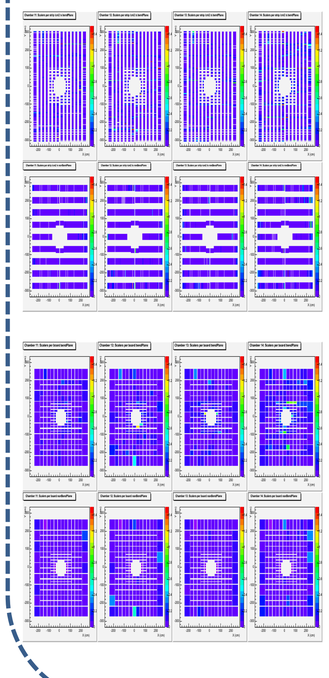
234 histograms corresponds to 234 Local boards and 16 bins corresponds to Strips and its inputs for each strip.

- Physics events
- Calibration events



Strip Scaler Information

During data taking, MTR also performs calibration process, while no collision, to measure RPC noise status in Hz.

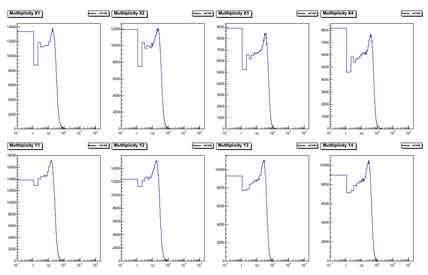


- Hz/Strip
- Hz/Local board
- Hz/RPC

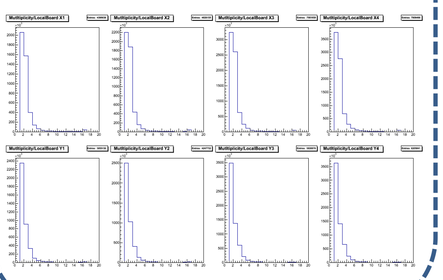
→ **Noise level check**

Hit Multiplicity

- Total Local boards/station for X & Y strips

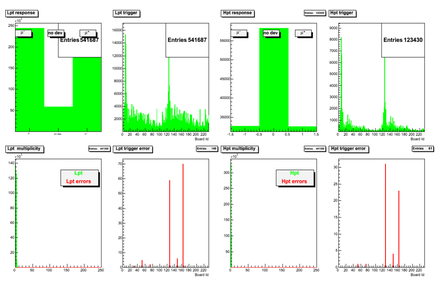


- Local board for X & Y strips

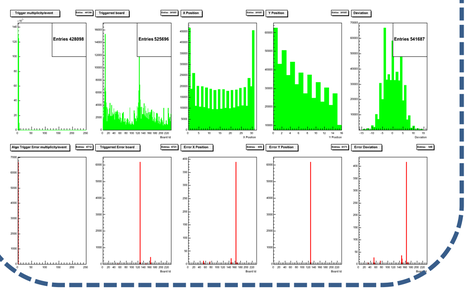


Local Trigger Algorithm Test

- (top plots) LPT/HPT response per board and corresponding multiplicity
- (bottom plots) Errors

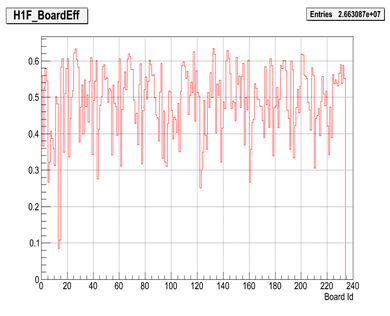


- (top plots) Trigger multiplicity, triggered board, X position, Y position and deviation
- (bottom plots) Errors

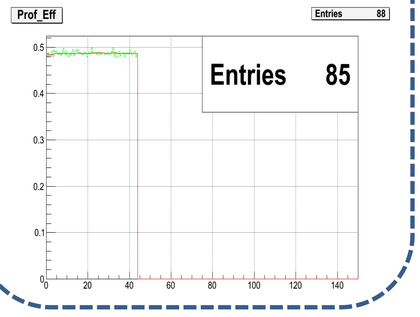


Trigger Efficiency

- Ratio 44/34 vs. Local board

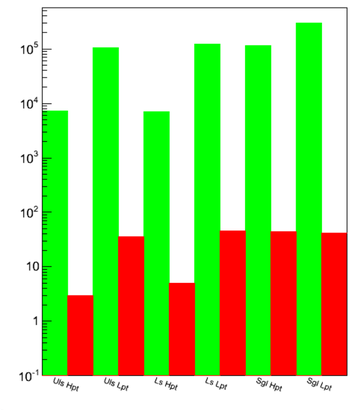


- Ratio 44/34 vs. Time



Global Trigger Test

Global trigger board is the top level decision unit of the ALICE Muon Trigger. The Global trigger algorithm response is readout in the data and compared to the calculated one.



References

[1] ALICE Collaboration, JINST 3 (2008) S08002
[2] G.A.Schuler and R.Vogt, Phys. Lett. B387, 181 (1996). [hep-ph/9606410]

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Frascati, Italy, 5-10 Feb 2012