Development, Implementation and Performance Report of Dimuon High Level Trigger of ALICE

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Motivation

The asymptotic freedom property of QCD suggests that the strongly interacting matter at sufficient high temperature and/or density is described in terms of quark and gluon degrees of freedom or Quark Gluon Plasma (QGP) phase. A Large Collider Experiment (ALICE) of CERN will study this deconfined phase at LHC energies through different observables. One such probe is the suppression (or enhancement as observed in RHIC) of heavy quarkonium states (J/ψ, J/ψ', Υ, Υ', Υ'') in heavy ion (*Pb*-*Pb* at LHC) collisions [1–3]. The Muon Spectrometer of ALICE is designed to measure these quarkonium bound states through their muonic decay channels

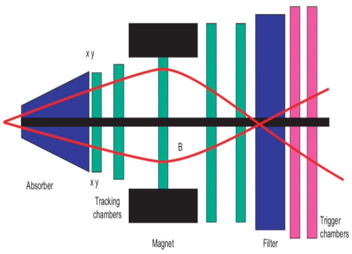

FIG. 1: The Dimuon Spectrometer of ALICE

within $2.5 \leq \eta \leq 4.0$. The Spectrometer is composed of, five Tracking stations (Cathode Pad Chambers), two Trigger stations (Resistive Plate Chambers), a Front Absorber of 10 interaction length, a warm dipole magnet of 3 Tm field integral and 1.2 metre thick Muon Filter [Fig. 1]. A typical data rate of 1 kHz is expected for the highest luminosity central *Pb*-*Pb* collisions in the spectrometer.

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Description of the problem

While passing through the detectors, the charged particles produce hits in the tracking and trigger detectors. Since the trigger detectors are build with Resistive Plate Chambers, these issue a fast trigger (L0 trigger) when collinear hits pointing towards origin are found. This direction is used to collect the path-marks of the track in the tracking detectors to improve the momentum estimation. If two oppositely charged particles are identified, they are combined to produce the dimuon invariant mass spectrum. But this spectrum suffers from large background of low momentum muons from pions and kaons, which are not stopped by Muon Absorber. Therefore, a threshold cut on the transverse momen-

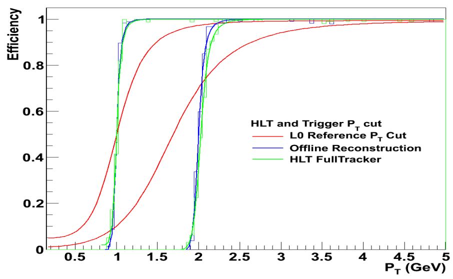


FIG. 2: The p_{T}-cut efficiency L0, dHLT and offline decision at 1 GeV/c and 2 GeV/c.

tum (p_{T}) is applied by the Muon Trigger stations to remove contaminating muons from mass spectrum. It has been found from the simulation studies that a p_{T}-cut of 1 GeV/c (2 GeV/c) cleans the invariant mass spectrum for J/ψ (Υ) family. However, the p_{T}-cut efficiency plot in Fig. 2 shows that several low p_{T} events are passed by L0 trigger, which contaminate the mass spectrum. The origin of this inefficiency of L0 decision is due to the incorrect p_T estimation of the tracks based on partial tracking in Trigger station. This can be improved when the full tracking is performed during the Offline physics analysis, but the detail Offline analysis can not be applied for fast analysis at 1 kHz trigger rate. For instance, the Offline reconstruction needs few seconds to analyse a central *Pb*-*Pb* event, whereas it has to be completed within 1 millisecond [1/(1 kHz)] for online application. Therefore, a new fast algorithm has been developed during the course of this thesis, which provides a better evaluation of track momentum at 1 kHz trigger rate. Hence, an improved trigger decision (High Level Trigger [HLT]) is generated that closely corresponds to the Offline analysis (see Fig. 2). The online analysis should have three important properties :

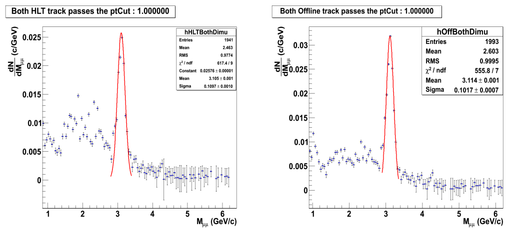
Fast : Processing of data stream at 1 kHz, a failure will lead to back pressure to the data taking in other detectors of ALICE.

Robust : Analysis scheme has to be fully tested for memory leakage, logical flaw and full proof against any sort of corrupted rawdata.

Quality : The quality of results has to be as close as possible to the Offline analysis.

Results

An efficient hit reconstruction based on fast center of gravity method and track finding algorithm based on Cellular Automata and Kalman Filtering has been developed and implemented in the HLT PC cluster as a part of this thesis work. The performance and quality of this real-time processing with simulated data matches the above criteria and have been reported in Ref. [4–6]. At present, it is a part of the ALICE HLT framework and actively participating the global data taking of *p*-*p* collisions at 7 TeV energy. As a final validation, a set of data files from *p*-*p* collisions at 7 TeV have been analysed by the online algorithms (see Fig. 3). It is observed from the figure that the analysis by online algorithm closely matches with the Offline reconstruction.



(a)Effect of HLT trigger decision on mass spectrum for p_T-cut of 1.0 GeV/c

(b)Effect of Offline decision on mass spectrum for p_T-cut of 1.0 GeV/c

FIG. 3: The analysis results of J/ψ observed in *p*-*p* data set of 7 TeV.

The present thesis work covers the different steps of development, implementation and final the validation of these online algorithms with GRID data. This thesis also reports the recent data analysis of the *p*-*p* collisions at LHC.

References

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