Measurement of the ATLAS di-muon trigger efficiency in proton-proton collisions at 7 TeV

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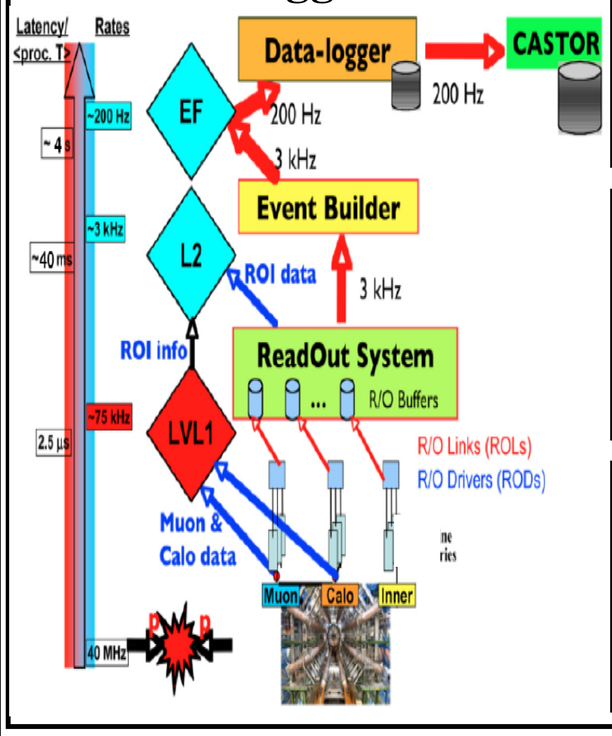
The B physics program of the ATLAS experiment includes the study of the production cross sections, the searches for rare b decays signatures which are sensitive to new physics at the TeV energy scale and the measurements of CP violation effects in B-events, such as $B_{s0} \rightarrow J/\psi\,\varphi$ and $B_d \rightarrow J/\psi\,K_s$. The key to the detection of these B signals in ATLAS is to achieve a high trigger efficiency for low-pT di-muons events, while keeping an acceptable trigger rate. Atlas developed two separates approaches for triggering on di-muons events from a resonance such as a J/ψ and Upsilon (Y). The first approach is to start from a di-muons trigger selected by the Level-1 trigger while the second is based on dedicated Level-2 algorithm. The performance of di-muons trigger has been studied using collision data at $\sqrt{s}$=7TeV. Results are compared to MonteCarlo predictions.

ATLAS Trigger

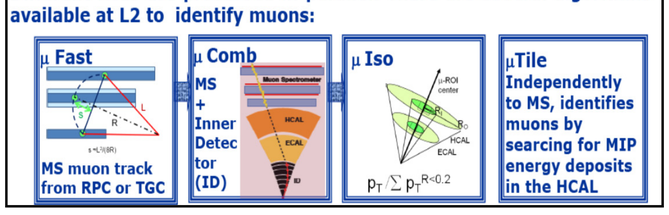


Event Filter (EF) uses the offline reconstruction algorithms adapted to the online environment.
Two main strategies are avaible at EF:

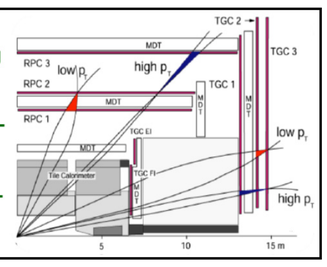
- Inside-Out (TrigMuGirl)
- Outside-In (TrigMuonEF)

Both algorithms take into account the energy lost in the calorimeter.

LVL2 accesses to the data in a RoI defined by LVL1.
Different RoIs are processed in parallel. There are several algorithms available at L2 to identify muons:



LVL1 selects muon tracks coming from the Interaction Point (IP) having a transverse momentum (p_T) above a given threshold, defined by deviation of the track wrt an infinite momentum track. Gives a first estimation of the parameters (η, ϕ, p_T) corresponding to a Region of Interest (RoI).

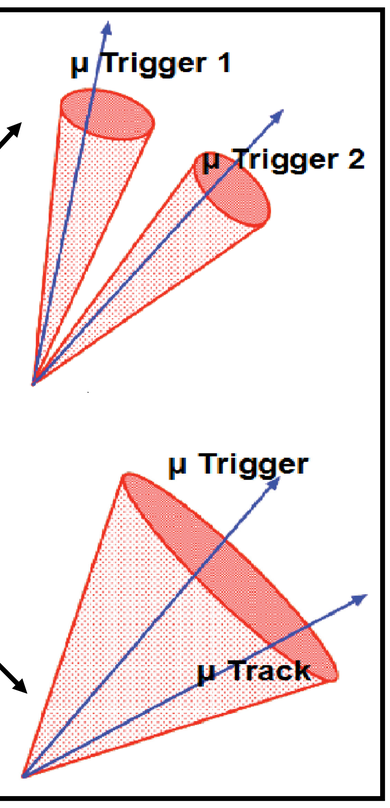


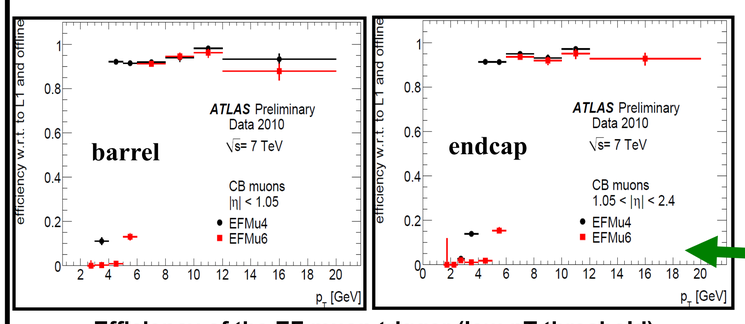
ATLAS Di-muon Trigger

Topological trigger
seeded by 2 RoI from LVL1 muon trigger

ATLAS developped two di-muon trigger algorithms which achieves high efficiency at L2 using the identification of low-pT muons coming from J /ψ decay or other resonant sources like Υ.

Di-muon trigger
seeded by a single LVL1 muon trigger





Efficiency of the EF muon trigger (low-pT threshold) vs Reconstructed muon pT

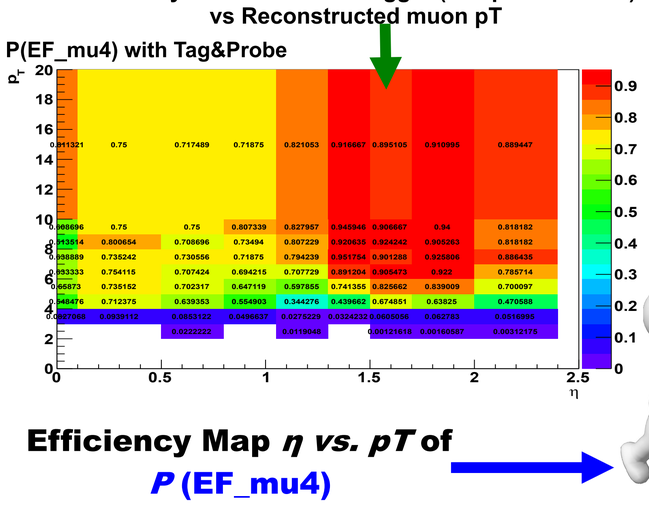
Strategy

Bayes Theorem

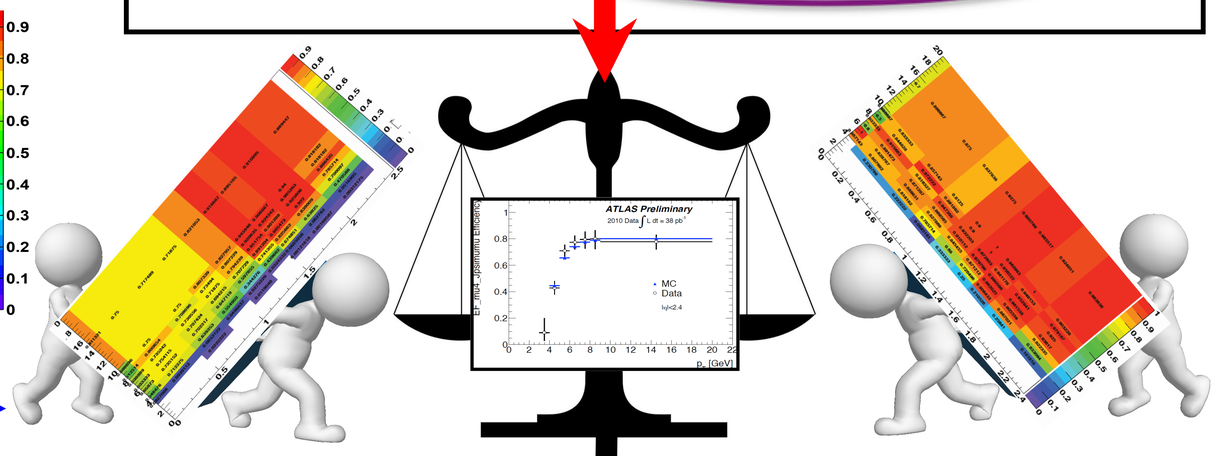
$$P(B) = \frac{P(A)\,P(B|A)}{P(A|B)}$$

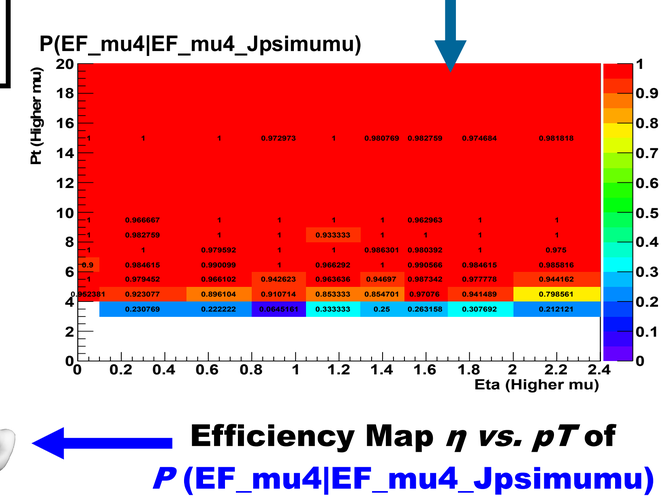
$$P(EF\_mu4\_Jpsimumu) = \frac{P(EF\_mu4)\,P(EF\_mu4\_Jpsimumu|EF\_mu4)}{P(EF\_mu4|EF\_mu4\_Jpsimumu)}$$

The probability to have a single EF_mu4 given the di-muon trigger is ≠ 1 because the non-topological EF_mu4_Jpsimumu doesn't exactly run the same algorithm of the EF_mu4.



Efficiency Map *η vs. pT* of *P* (EF_mu4)





Efficiency Map *η vs. pT* of *P* (EF_mu4|EF_mu4_Jpsimumu)

...After the calculations: Di-muons Trigger Efficiency with ∫L*dt* =38 pb^{-1} 2010 data

Efficiencies of the Di-muon Trigger and Topological Trigger
µ1 is the muon with higher pT inside the di-muon pair and µ2 is the muon with lower pT inside the di-muon pair

Data sample: Two Opposite sign fully combined muons in the J/ψ invariant mass range (2800-3340 MeV/c^2)

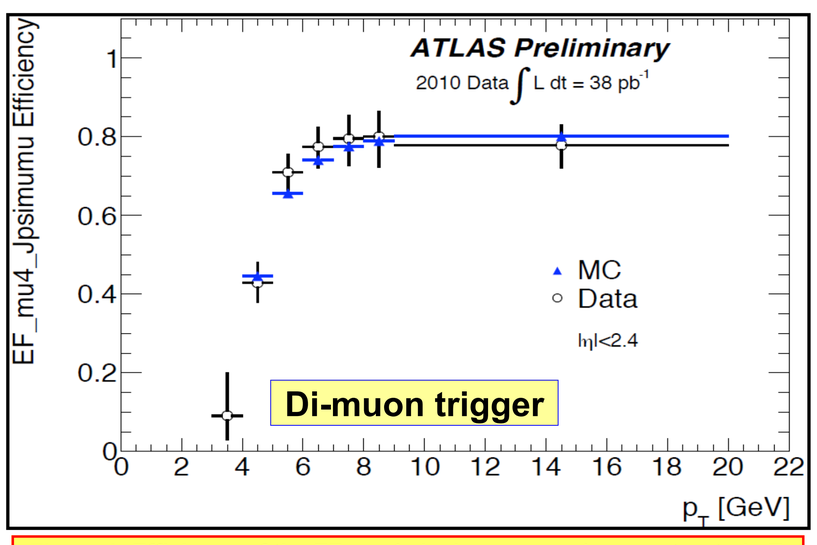


Figure 1: Efficiency of the EF_mu4_Jpsimumu vs µ1 reconstructed pT.

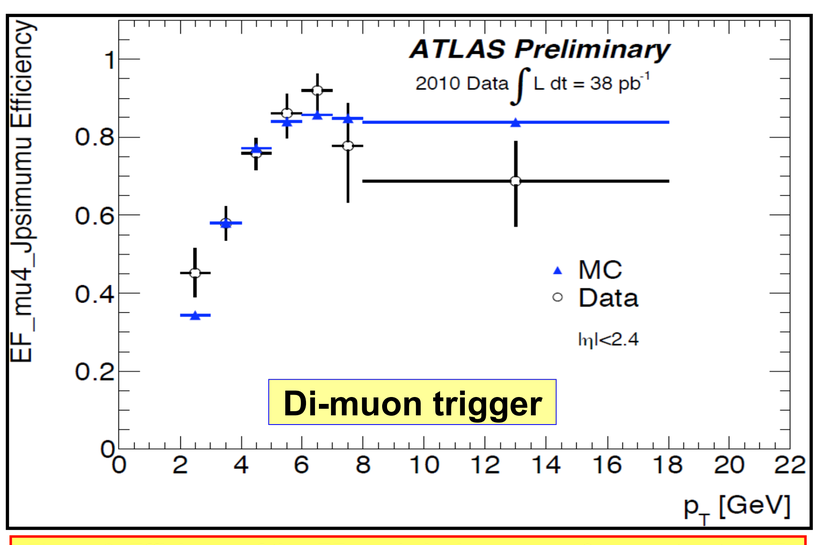


Figure 2: Efficiency of the EF_mu4_Jpsimumu vs µ2 reconstructed pT.

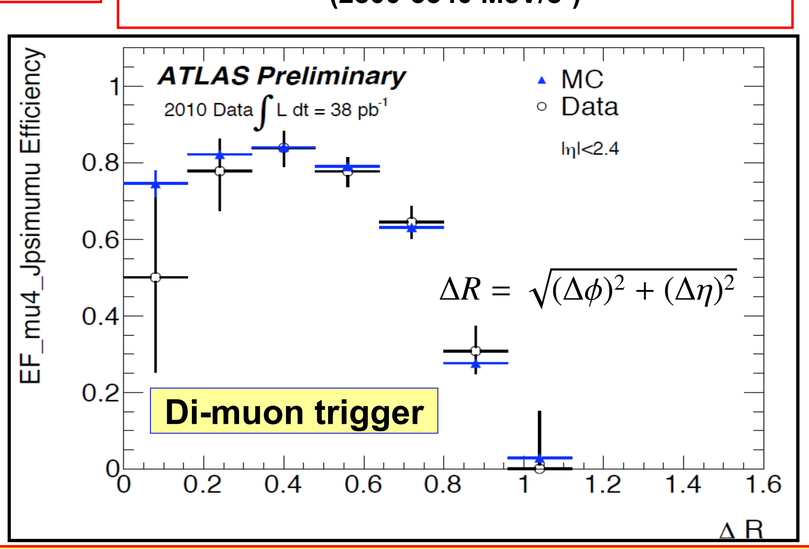


Figure 5: Efficiency of the EF_mu4_Jpsimumu vs ΔR between the two muons.

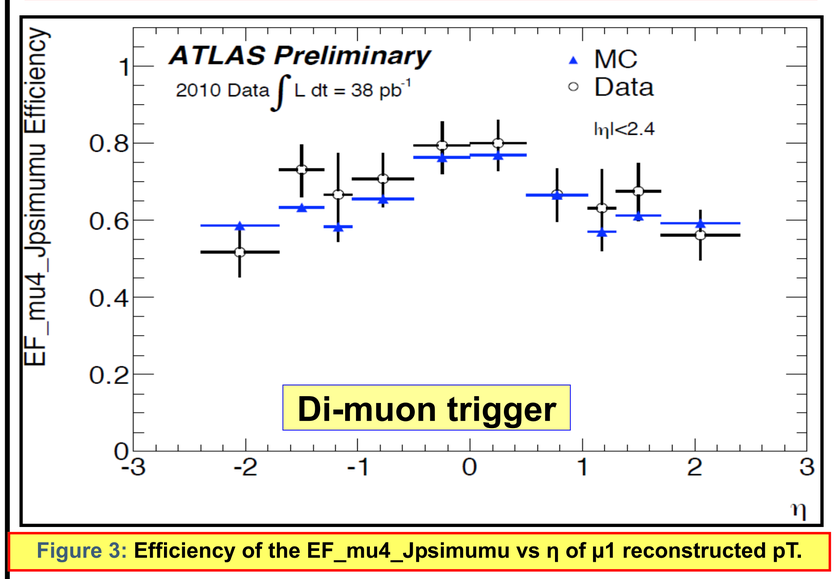


Figure 3: Efficiency of the EF_mu4_Jpsimumu vs η of µ1 reconstructed pT.

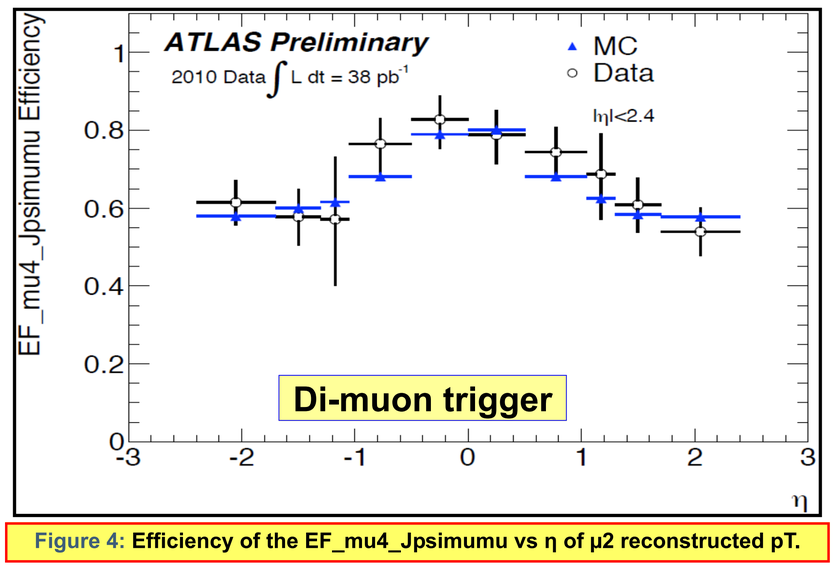


Figure 4: Efficiency of the EF_mu4_Jpsimumu vs η of µ2 reconstructed pT.

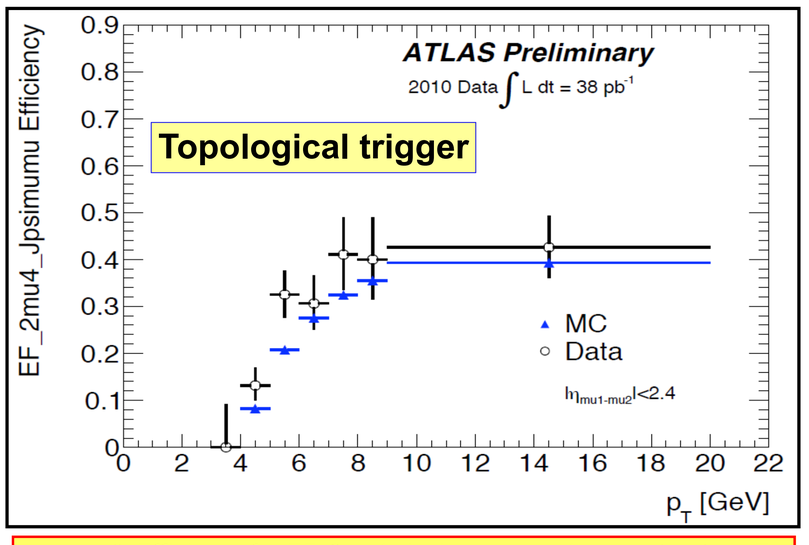


Figure 6: Efficiency for EF_2mu4_Jpsimumu vs µ1 reconstructed pT.