Study of muon isolation at L1 using calorimeter information

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on behalf of FNAL/LPC upgrade team

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Use calorimeter isolation to Level-1 muon

Steps to approximately simulate muon isolation at L1:

- Step1: Read L-1 muon and L-1 UCT15 jets in the event

- Step 2: Compute deltaR of each L1 muon with respect to the nearest UCT15 jet
  - one can also apply pileup subtraction to UCT jets, but we haven't done this in the present study

- Step3: If there is no overlap in $\Delta R=0.3$ then the muon is considered isolated. If there is an overlap compute jet p_T/ muon p_T after removing the muon footprint. If this ratio < 0.5 then assume that the muon is isolated.
  - all these parameters will be optimized, for now we simply picked some sensible value

Samples used to compute efficiency & L1 rate

Efficiency sample

- Z→μμ in data in runs 2012 C (HCP: 7/fb)
  - **Muon p_T > 20 GeV, $|\eta|$ <2.4**

- Require good quality criteria
  - **Reconstructed as a Global and Tracker Muon**
  - **≥10 tracker hits, ≥1 pixel hits (Tracker track)**
  - **≥2 muon hits of the Global track**
  - **χ2/ndf < 10 global fit**

Rate sample

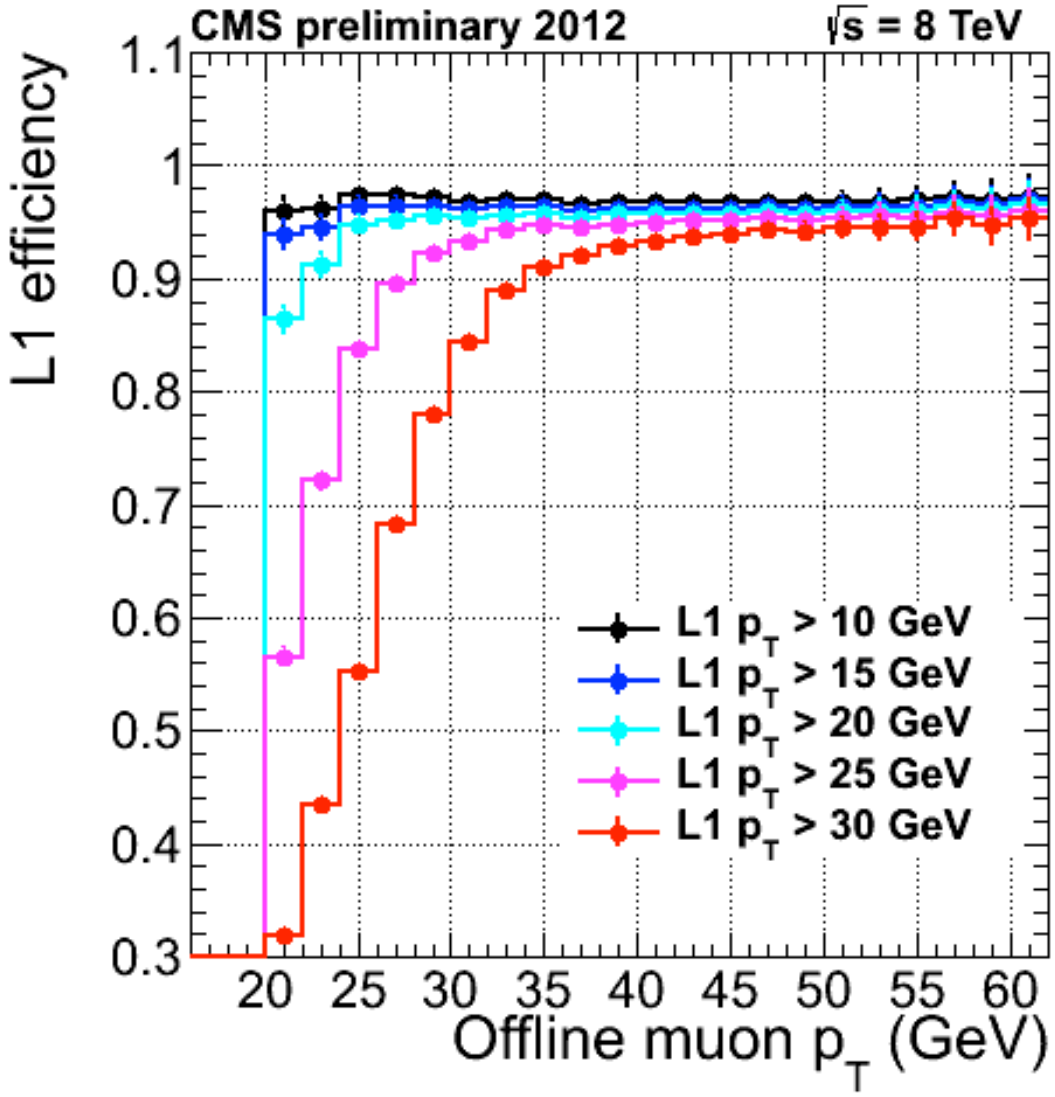
- ZeroBias3 (run: 198609)
  - **High pileup run (~66 pileup)**

Caveats

- Assumed regional L1 muon reconstruction as in current data
  - We know that planned improvements in DTTF & CSC TF will improve muon performance somewhat, so the gain in rate shown on previous slides may be optimistic
  - Need help to approximately emulate muon chamber improvements, so that we can get a realistic estimate of likely improvements from Calo isolation

- All efficiencies have been computed using simplified assumptions. A more rigorous computation using Tag & Probe technique is underway. So the values will change somewhat (within a range of several percent).

L1 turn-on curve for iso mu as a function of p_T

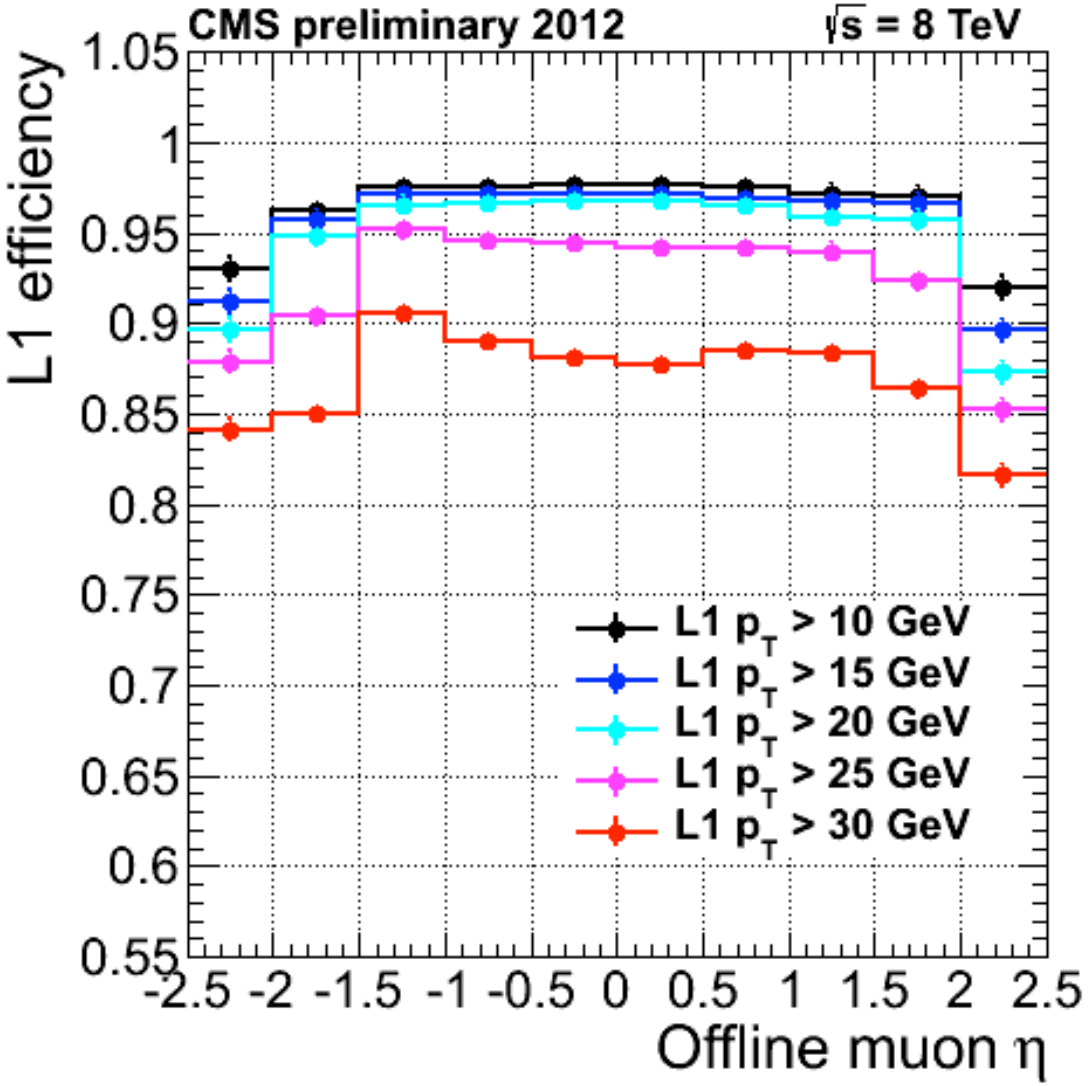


Denominator: Offline isolated muon (PF relative combined isolation < 0.2) which are matched in ΔR<0.3 to a level-1 isolated muon

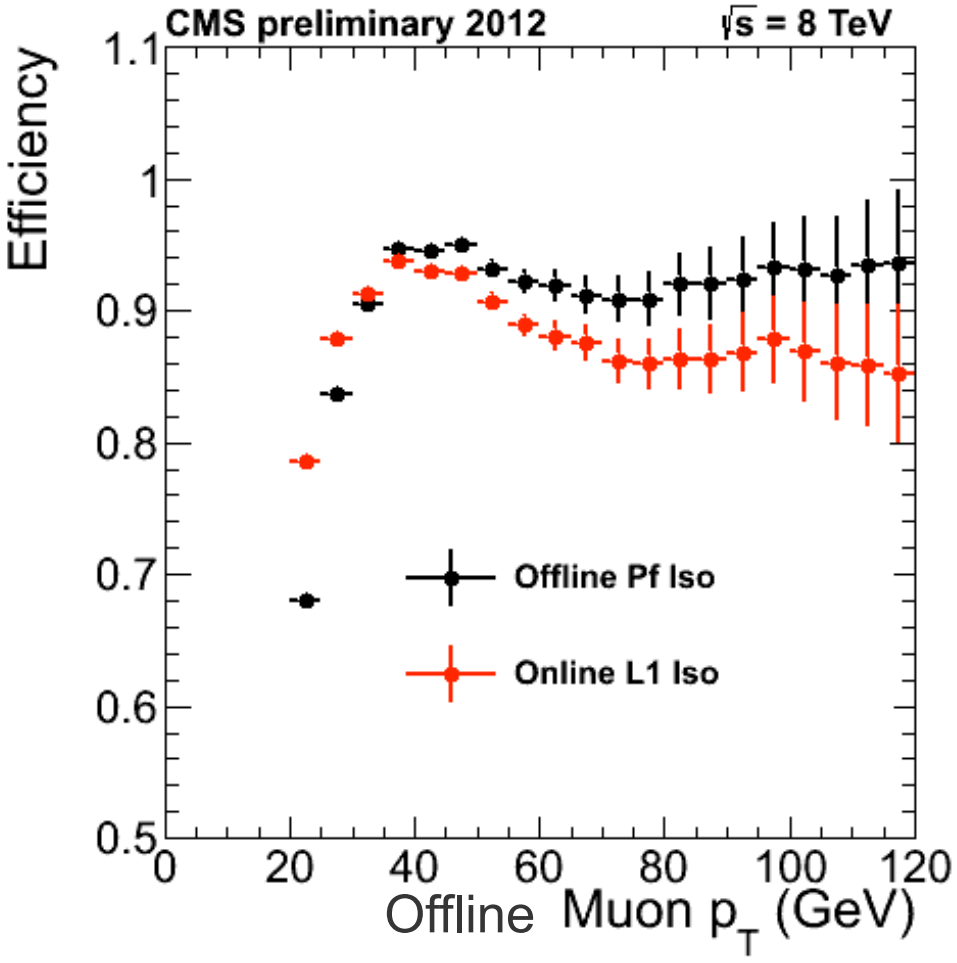
Numerator: Same as denominator but also passing a given L1 p_T threshold.

A new L1IsoMu20 (25) may work fine for HLTIsoMu25 (30).

L1 turn-on curve for iso mu as a function of η



L1 Muon efficiency as a function of p_T



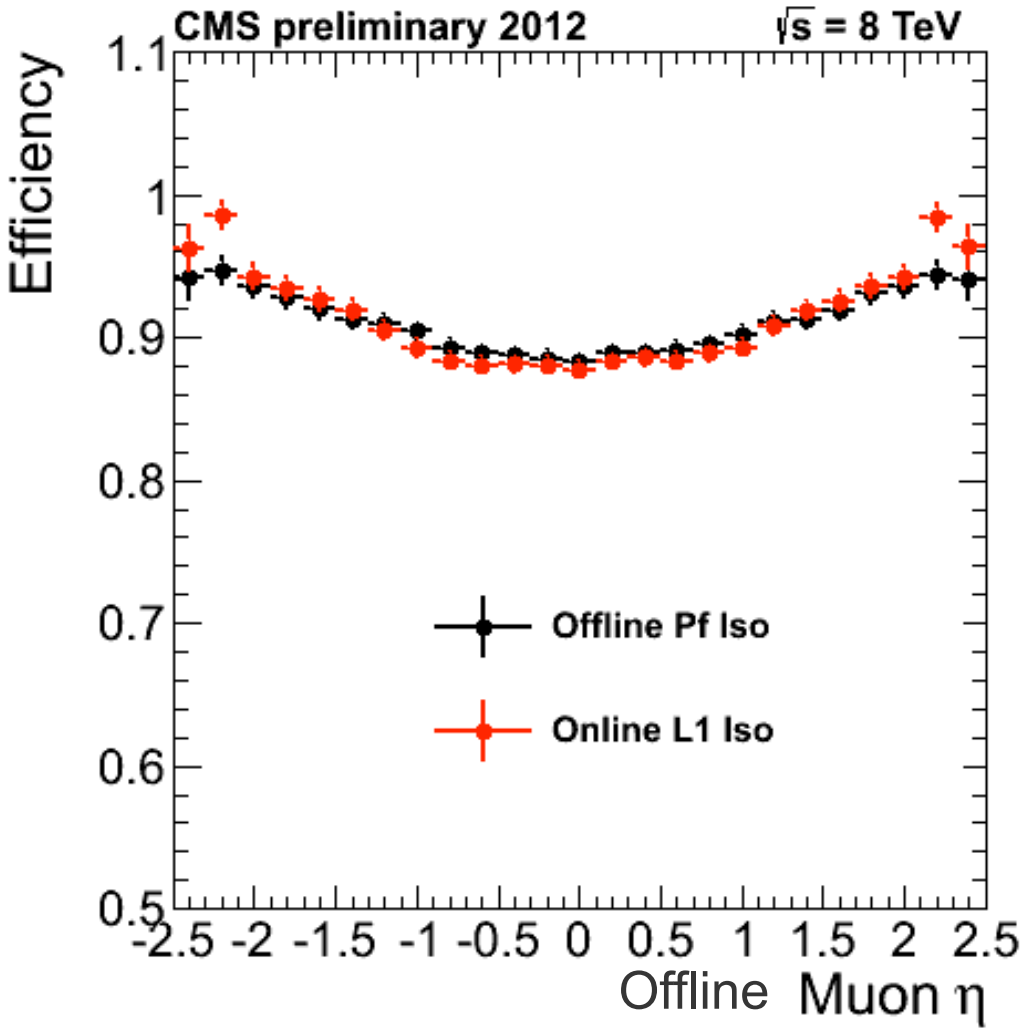
Denominator: Good offline muon without isolation criteria which are matched in $\Delta R<0.3$ to an L1 muon of 20 GeV.

Numerator: Same as denominator but requiring isolation at Level-1 (red data points) or offline (black data points).

Muons above 30 GeV offline p_T look fine.

Integrated over all pileup epochs. See backup for NPV variation.

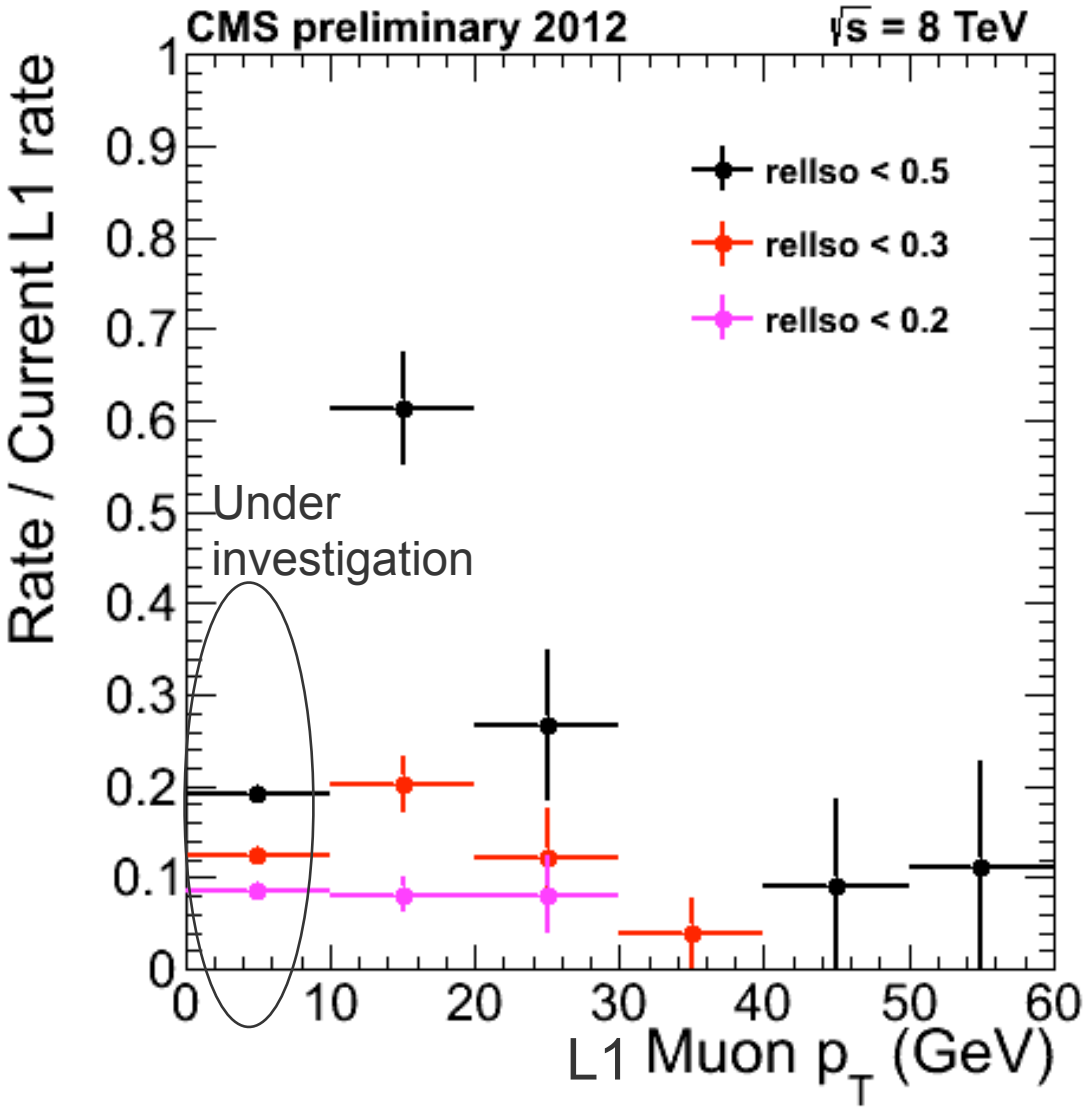
L1 Muon efficiency as a function of η



Comparable in performance to our current trigger

All these efficiencies are somewhat biased (at the level of a few − several percent) because of the trigger leg. Have Tag&Probe machinery in place to compute these more rigorously

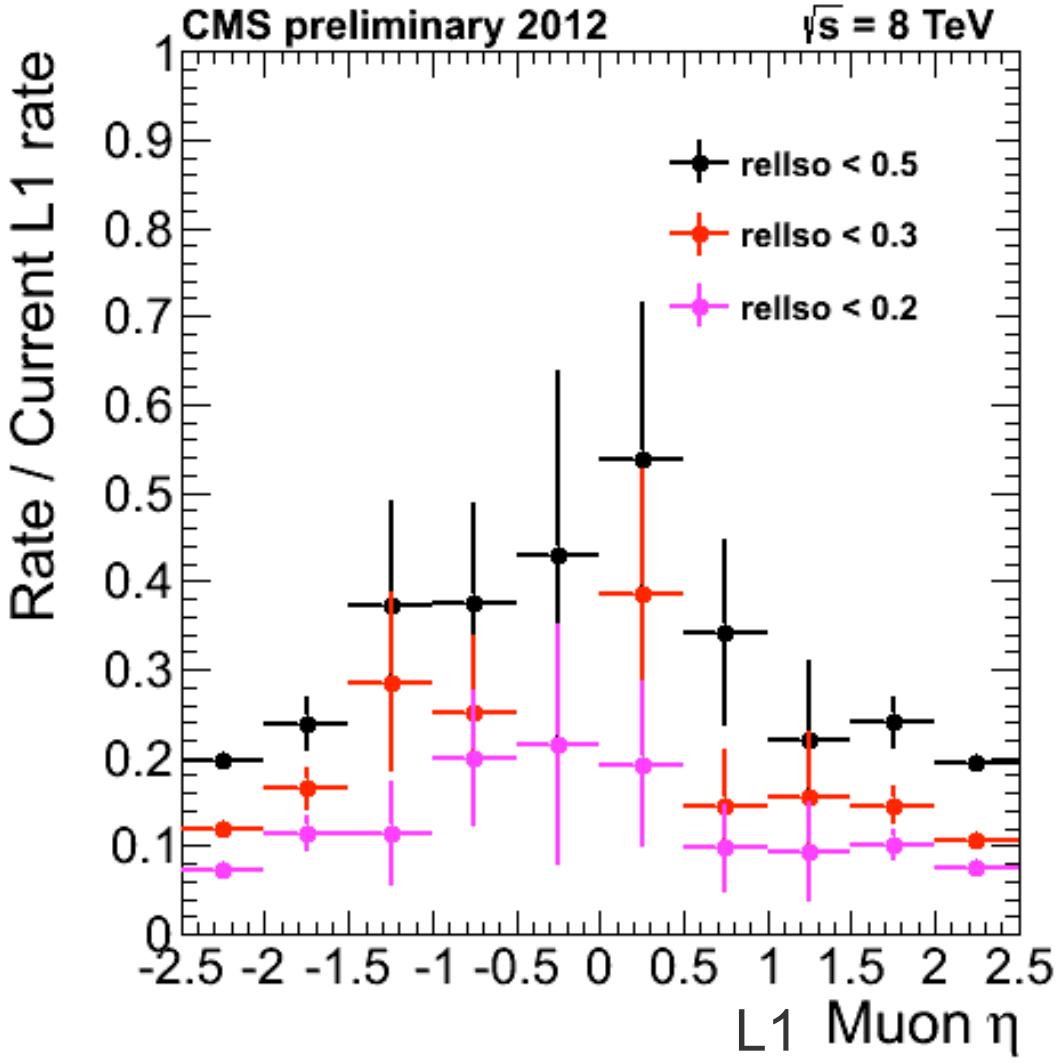
Muon Level-1 rate drop after isolation vs p_T



relIso = UCT15 region p_T / L1 mu p_T

- Consistent with the previous study by Dave Evans et al. Need to run over more MinBias events.
- Seems large dependence on p_T

Muon Level-1 rate drop after isolation vs η



- Much of the gain is coming from the endcaps

Things to do

- More rigorous estimation of efficiency & rates using tag & probe tool and with larger statistics for ZeroBias samples

- Try to incorporate both Phase-1 and Phase-2 configurations of Calorimeter upgrade to compare the impact on muon isolation performance

- Try to incorporate planned improvements in DT/CSC

- Expand the study. Look at some physics samples ($WH \rightarrow Wbb$, $H \rightarrow WW \rightarrow \ell\nu jj$) to estimate the likely improvements in physics performance.

BACKUP SLIDES