LHCC poster session – CERN, 22 Feb 2017

PERFORMANCE OF THE ATLAS JET TRIGGER AND FUTURE DEVELOPMENTS

The ATLAS experiment at the LHC uses a two-level trigger system to record interesting events maintaining good signal efficiency at lower energies where pileup dominates. A new challenge is to control the increased trigger rate due to the expected higher pileup for LHC Run 2. This poster presents the jet trigger efficiency as a function of the offline jet transverse momentum for proton-proton collision data at the centre-of-mass energy of 13 TeV. In addition, the efficiencies of global sequential calibrated (GSC) jet trigger, trimmed jet and trimmed dijet triggers are shown.

The ATLAS trigger system

- Records the ***most interesting*** events in ***real time***
- Reduces the ***event rate*** from up to ***40 MHz*** to ***1 kHz***
- Consists of ***two levels***
  - *Level 1*
  - *High level trigger*

Jet trigger system

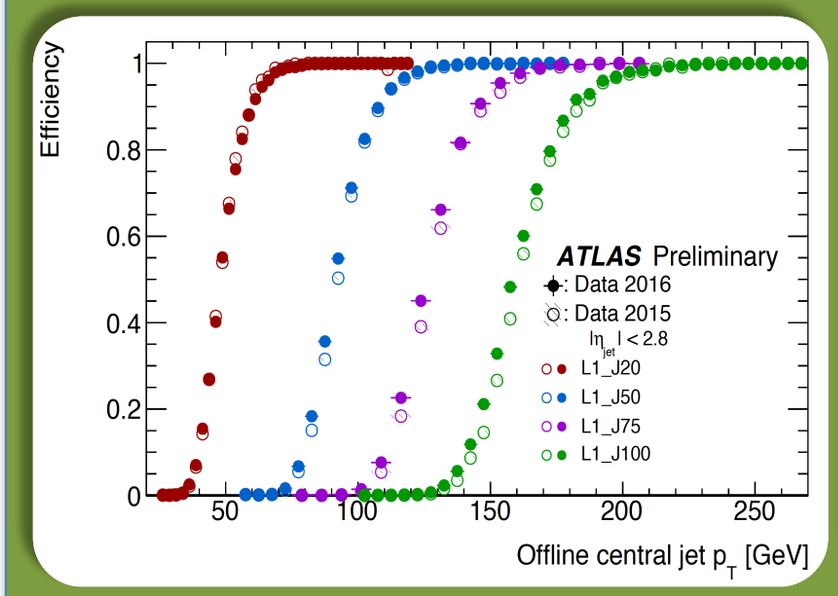
- **Level 1**
  - Uses sliding window algorithm to define jets
  - Events are triggered based on jet energy
- **High level trigger (HLT)**
  - Evaluates events using information from topological clusters
    - Maximize noise suppression
  - Anti-k_t algorithm is used to reconstruct jets
    - Radius parameters ***0.4 and 1.0***

Trigger jet calibration

- Jet energies are first measured at the **electromagnetic (EM)** or **locally calibrated (LCW) scales**
- In order to correct the jet kinematics, a **jet energy scale** (JES) calibration is then applied
- **Dynamic suppression of pileup** is used to correct the impact of pileup on jet energy and jet shapes

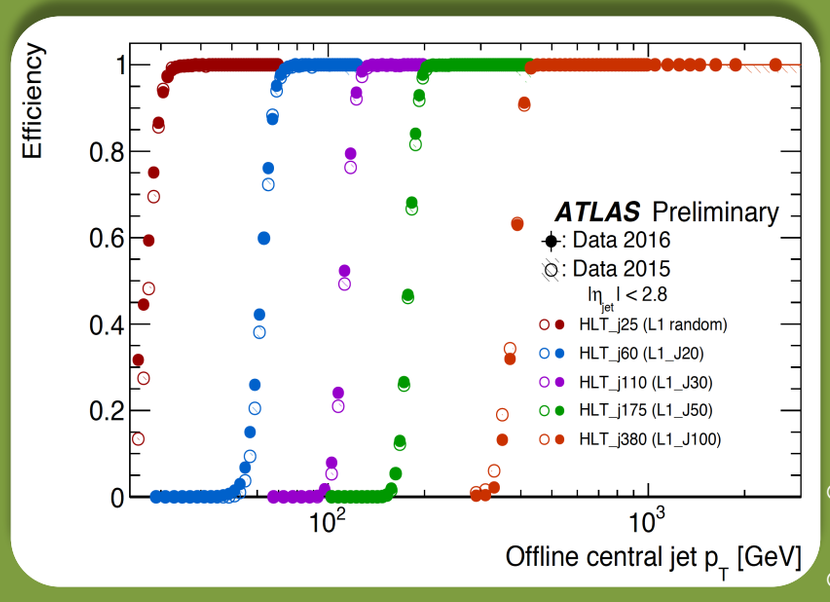
- *Triggers in 2016 (filled circles) become fully efficient at the same point as was observed in 2015 (open circles), despite higher levels of pileup. Only statistical uncertainties are shown.*

Level 1 single-jet trigger efficiencies



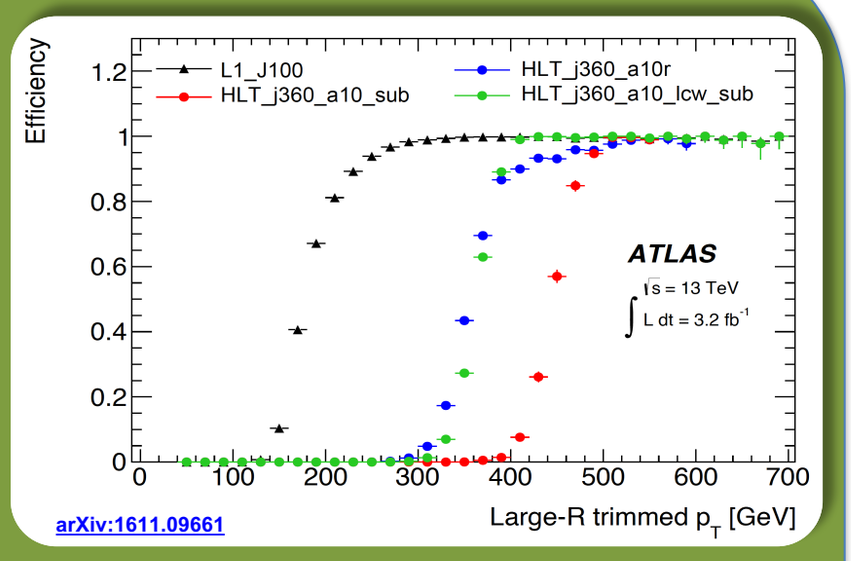
- Triggers denoted by ***L1_JX*** accept events containing a jet (reconstructed at L1) with E_T > ***X GeV***

HLT single-jet trigger efficiencies



- Triggers denoted by ***HLT_JX (L1_JY)*** accept an event (from ***L1_JY***) which contains a jet with E_T > ***X GeV***

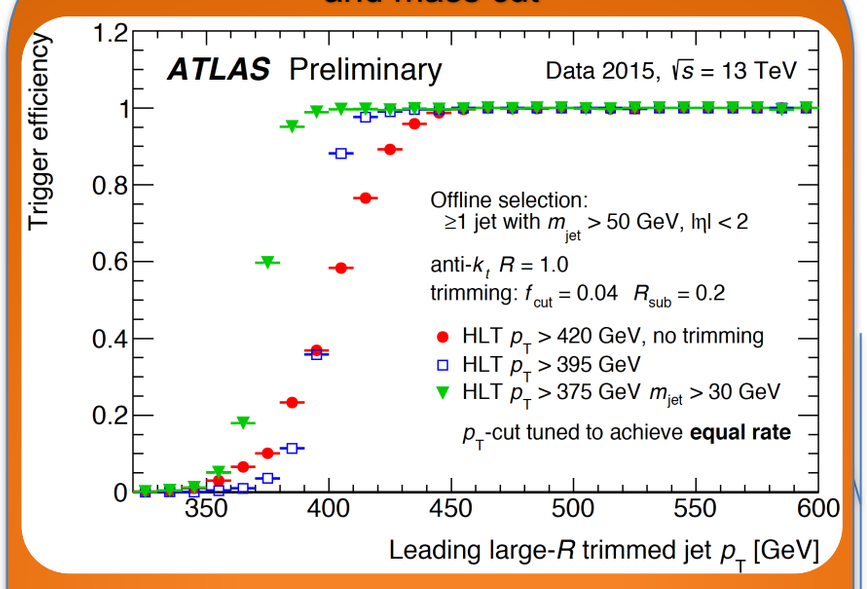
Large-R single-jet trigger efficiency



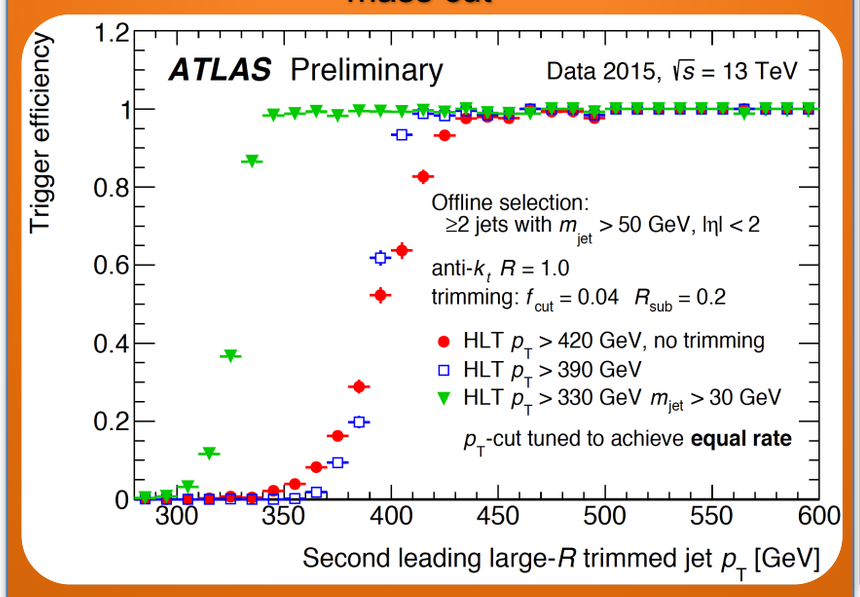
- HLT jets are reconstructed using anti-k_t (R=1.0) from clusters (a10) and small-R jets (a10r)
- The ***trimming*** algorithm is applied to offline jets
- ***Dynamical pileup subtraction*** at HLT based on event p_T density times jet area significantly improves trigger efficiency

Future developments

Single-jet trigger efficiencies with trimming and mass cut



Dijet trigger efficiencies with trimming and mass cut



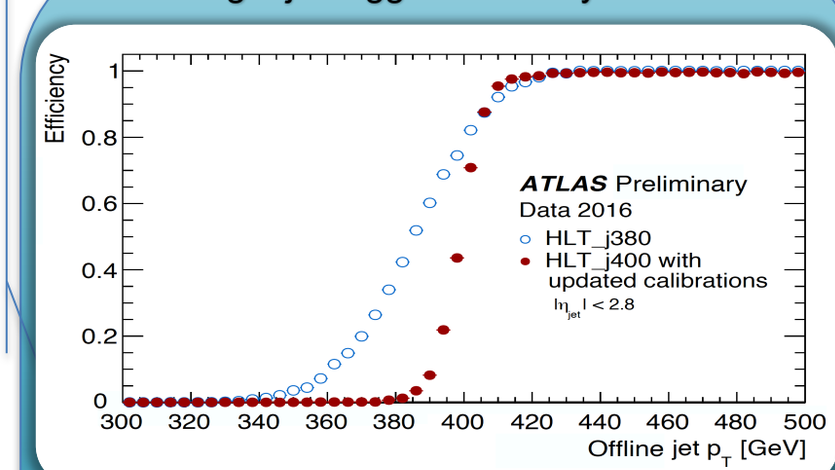
- Global sequential calibration was implemented at HLT and added for commissioning during summer 2016
- GSC corrects jets based on their longtitudinal shower shape and associated track characteristics without changing the overall energy scale
- Most unprescaled jet chains in 2017 will use GSC

Grooming at HLT

- The trimming algorithm is implemented at HLT level, which grooms jets by discarding soft jet components
- This significantly improves the pileup stability and enhances the discrimination of jets with hard substructure from standard QCD jets
- It is also possible to apply a jet mass cut at HLT level which results in a significant reduction of the trigger rate while improving the signal efficiency

- Thresholds used in the figure are chosen to achieve equal rate
- Red circles represent the standard large-R jet triggers used in 2015 and 2016
- ***Trimming***: sharper turn on region
- ***Mass cut***: plateau region extended to lower p_T for equivalent rate

HLT single-jet trigger efficiency with GSC



- Efficiencies are shown with and without applying the updated calibration to jets at HLT level. The updated calibration includes MC calibration, addition of global sequential and the application of in situ corrections. Trigger efficiency increases rapidly when GSC is applied

Conclusion

- Despite increased levels of pileup in 2016, single-jet triggers at L1 and the HLT become fully efficient at the same point as in 2015
- Applying the GSC at the HLT increases the sharpness of turn-on region for triggers
- Applying trimming and mass cuts at the HLT significantly improves the trigger performance by making the turn on region sharper and p_T thresholds lower for equivalent rate

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ATLAS EXPERIMENT