ATLAS LEVEL-1 CALORIMETER AND TOPOLOGICAL TRIGGER

OPERATION AND PERFORMANCE IN RUN 2

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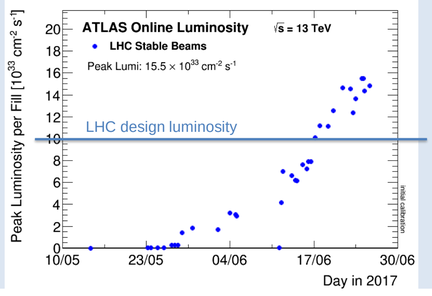
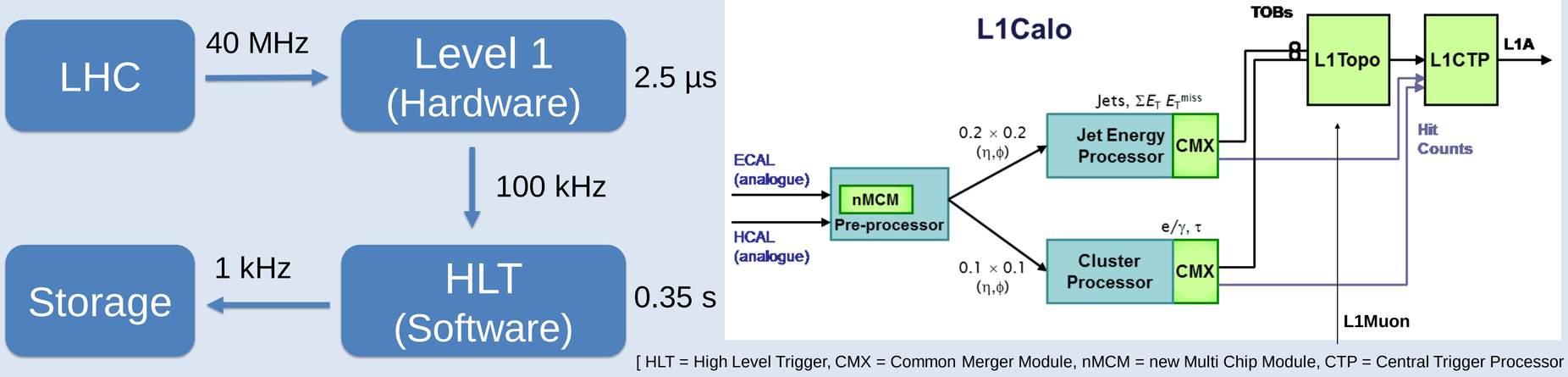
Luminosity 2017



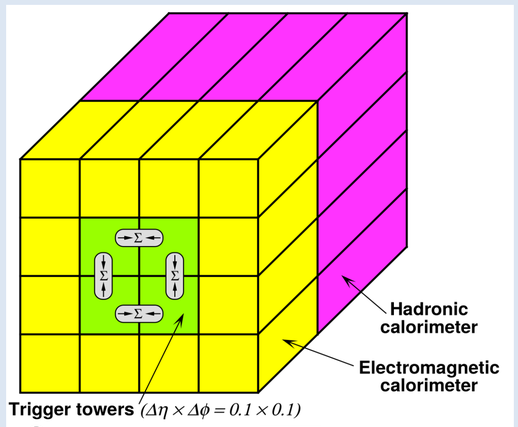
The ATLAS Trigger System



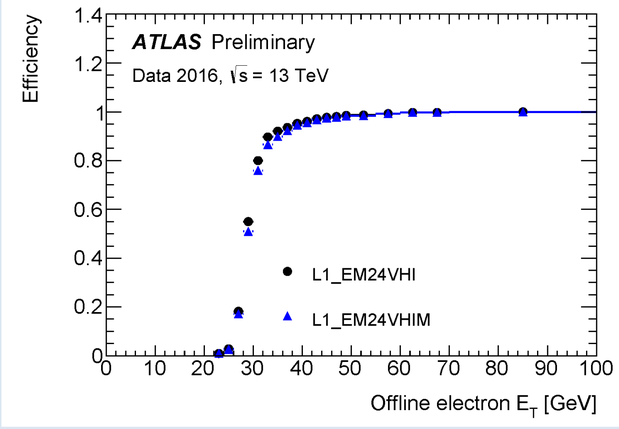
[HLT = High Level Trigger, CMX = Common Merger Module, nMCM = new Multi Chip Module, CTP = Central Trigger Processor]

Level-1 Calorimeter Trigger (L1Calo)

Electromagnetic Isolation



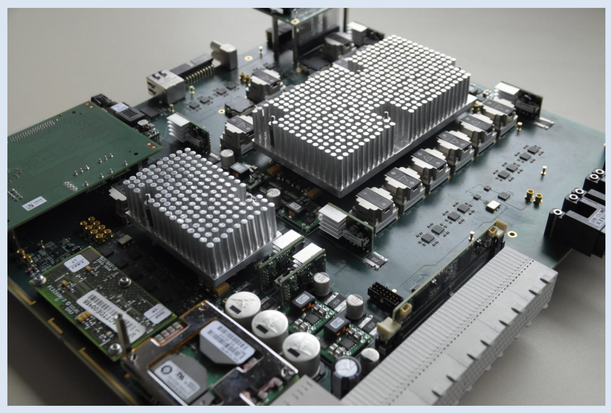
- Cluster Processor (CP) searches for e/γ
- Local E_T maxima are identified (clusters)
- Cluster E_T is compared to predefined thresholds that can vary with η (V)
- E_T -dependent hadronic isolation (H) and electromagnetic isolation (I) possible
- EM Isolation first used in LHC Run 2
- Optimized isolation for 2017 (IM)
- Rate reduction of ~ 10% for lowest unprescaled trigger (e.g L1_EM24VHI)
- Electron efficiency loss only ~ 1%

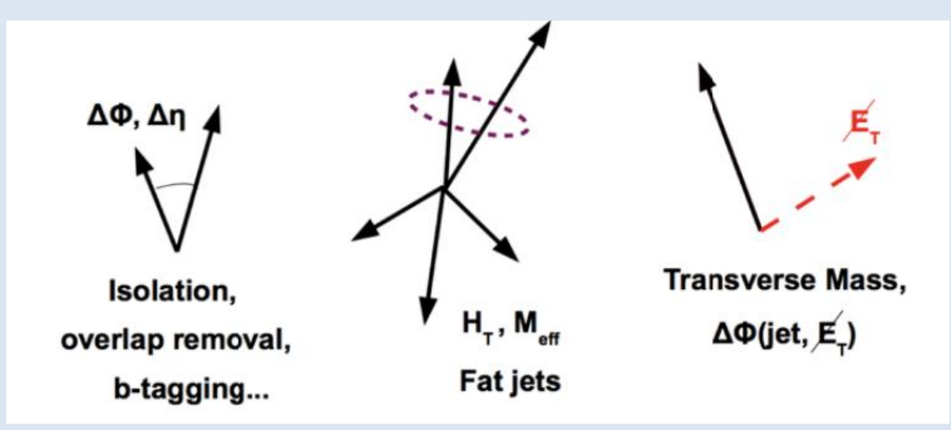


Level-1 Topological Trigger (L1Topo)

General Functionality

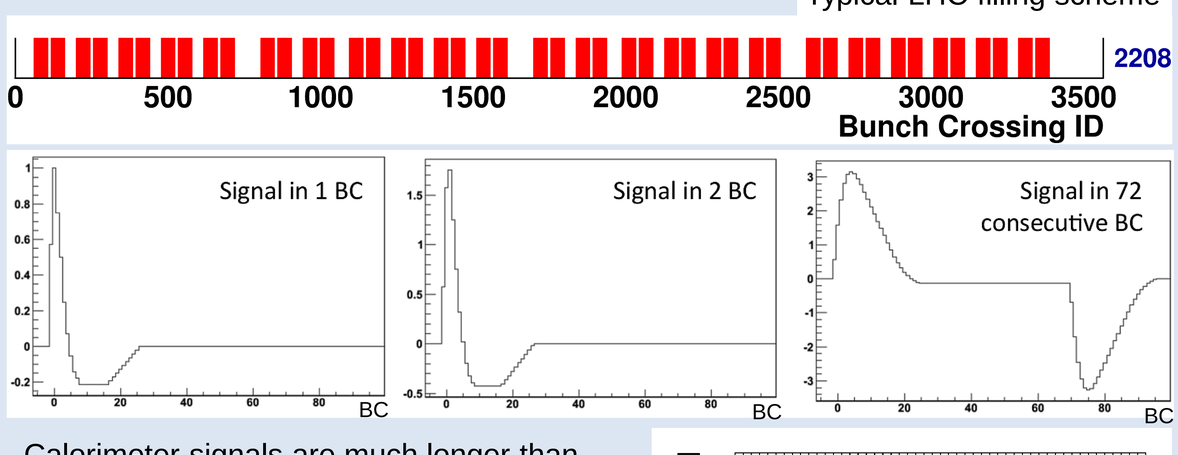
- Operates on Trigger Objects (TOBs) from L1Calo and L1Muon
- Topological and kinematic selection (angles, hardness of interaction, invariant mass)
- Real-time event information processed on powerful FPGAs (200ns / event)
- Very important to discover and measure new & rare physics with rising luminosity

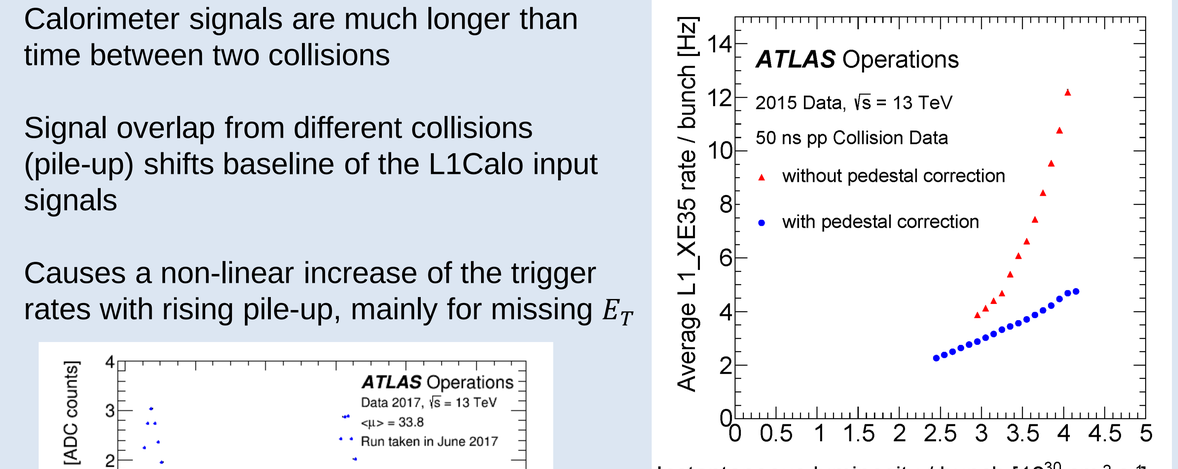




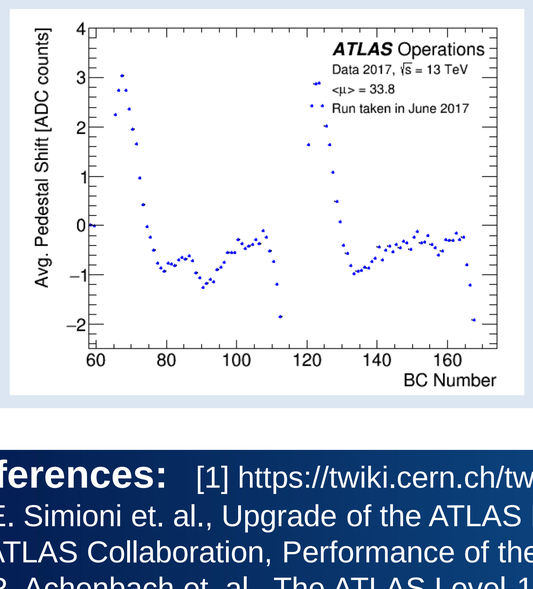
Dynamic Pedestal Correction

Typical LHC filling scheme





- Calorimeter signals are much longer than time between two collisions
- Signal overlap from different collisions (pile-up) shifts baseline of the L1Calo input signals
- Causes a non-linear increase of the trigger rates with rising pile-up, mainly for missing E_T

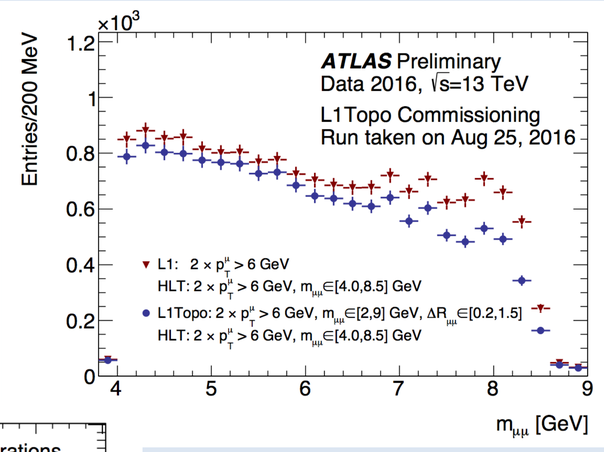


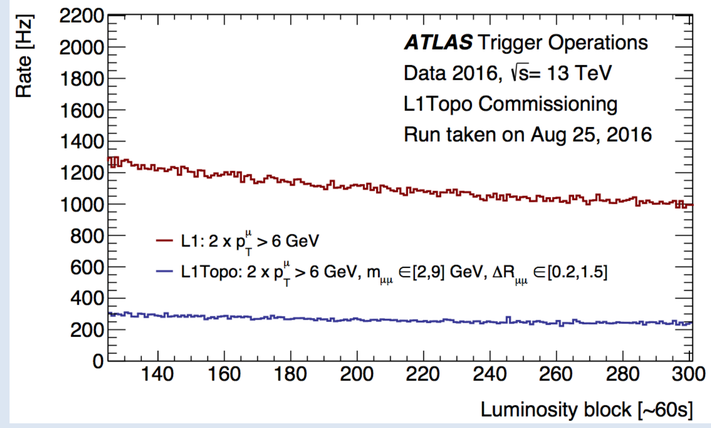
In Run 2: dynamic pedestal correction

→ Calculate average input signal
→ Subtract and restore flat baseline
→ Ensure linear trigger rates

Performance

- Achieve higher signal purity by drastically reducing background rates at Level-1, without raising the trigger threshold
- B-Physics, SM Higgs and Lepton Flavour Violation triggers already active in 2016 (e.g. di-muon and di-tau triggers)





- Rate reduction has only minor impact on HLT efficiency
- Results from early comissioning, further improvements expected!
- Over 100 algorithms already implemented in L1Topo

Conclusion

- Many improvements made to the L1Calo Trigger for LHC Run 2
- Successfully mitigated effects of increasing luminosity and pile-up
- L1Topo expected to be fully operational for 2017 data-taking

References: [1] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TriggerOperationPublicResults
[2] E. Simioni et. al., Upgrade of the ATLAS Level-1 Trigger with event topology information, *J. Phys.: Conf. Ser.* 664 (2015) 082052
[3] ATLAS Collaboration, Performance of the ATLAS Trigger System in 2015, *Eur. Phys. J. C* 77 , 5 (2017) 317
[4] R. Achenbach et. al., The ATLAS Level-1 Calorimeter Trigger, JINST 3 (2008) P03001