The ATLAS jet trigger

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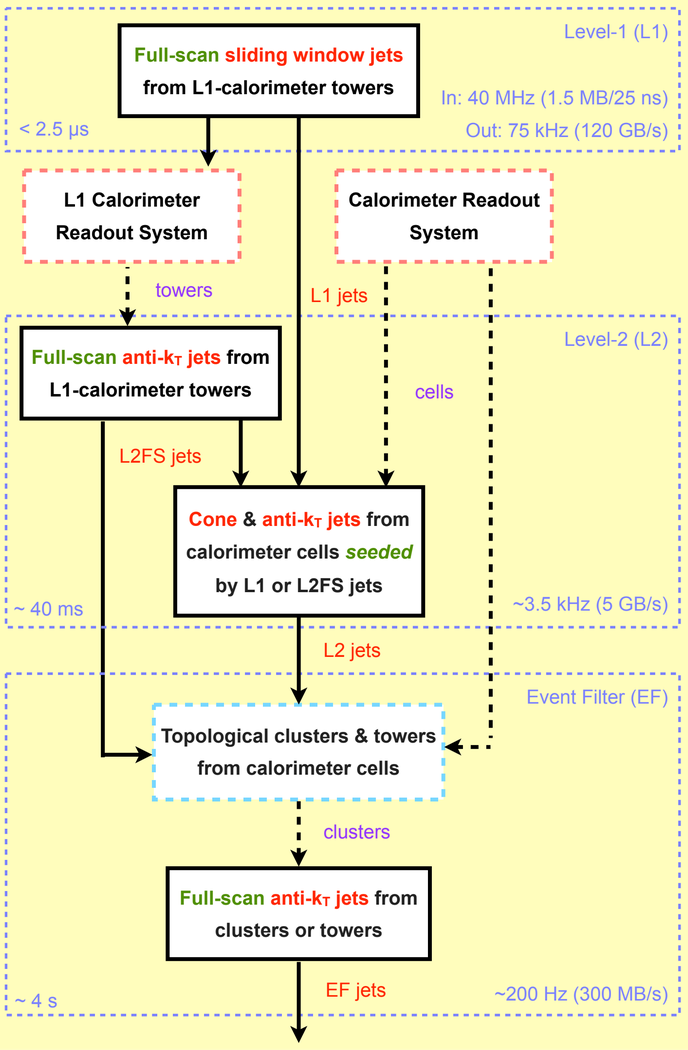
Overview

With the LHC colliding proton bunches every 50 ns and up to 40 proton-proton interactions per bunch crossing, the ATLAS trigger system has to be highly flexible in order to maintain an unbiased efficiency for a wide variety of physics studies whilst providing a fast rejection of uninteresting events.



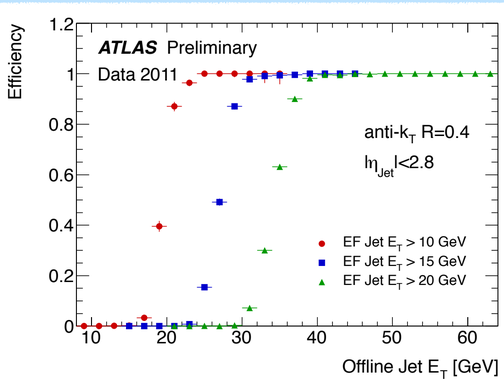
The jet trigger

- The primary means of selecting events with high transverse energy (E_T) jets.
- Fundamental to achieving the physics goals of ATLAS (QCD, top, new particles etc).
- A three level system. The first, L1, is hardware based, and the following two (HLT) are software based.
- Designed in an Region of Interest (RoI) based approach, wherein the HLT only has access to the regions of the calorimeter nearby a L1 jet above a given E_T threshold.
- Recent improvements have allowed the implementation of the full calorimeter unpacking at EF, and the introduction of a full-scan (FS) at L2 (also referred to as L1.5).
- It is now also possible to run a variety of jet algorithms, both at L2 and at EF using FastJet*.

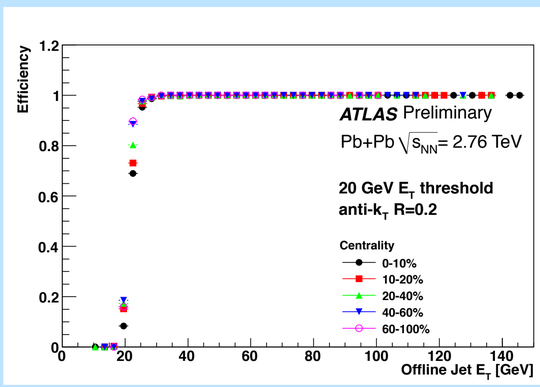
Performance in 2011

The jet trigger functioned exceptionally well in 2011 and was used to collect at integrated luminosity of ~5 fb^{-1} of proton-proton and ~160 μb^{-1} of lead-lead collision data.

- New cell based noise suppression applied at L2 and EF allowed trigger rates to be kept under control in the face of increasing harsh pileup conditions.
- The flexibility of the EF full calorimeter reconstruction enabled the collection of low E_T jets.
  - And the use of specialist triggers for lead-lead collisions which recover the original jet energy without the large contributions expected from the large underlying event.



The efficiency of the EF inclusive jet trigger for three choices of low E_T threshold. The EF-jet conditions were applied to random-triggered events.



The efficiency of the jet trigger used for the 2011 heavy ion run, for different centralities of collisions. Centrality is characterised by the amount of energy in the forward calorimeters.

New trigger selections

A very complete and versatile set of triggers is now available for physics analysis, including:

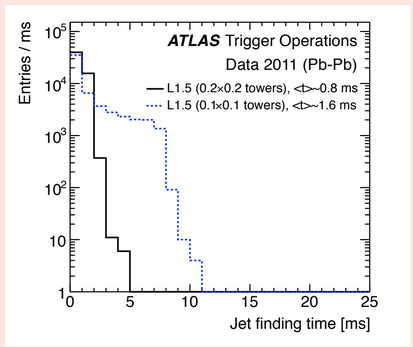
- Inclusive jet triggers with full calorimeter reconstruction at EF.
- Anti-k_T running at L2 on all towers (full-scan) and subsets of cells (partial-scan).
- H_T (Σp_T) based triggers for L2 and EF used to select highly energetic events.
- Multi-jet triggers with full-scan reconstruction at both L2 and EF.
- Dedicated triggers for boosted objects, including:
  - "Fat" jet reconstruction (anti-k_T R=1.0) at both L2 and EF.
  - Narrow jet reconstruction (anti-k_T R=0.2) to probe jet substructure.
- Triggers with jet "cleaning" at L2 and EF. These remove spurious jets.

L2 Full-scan

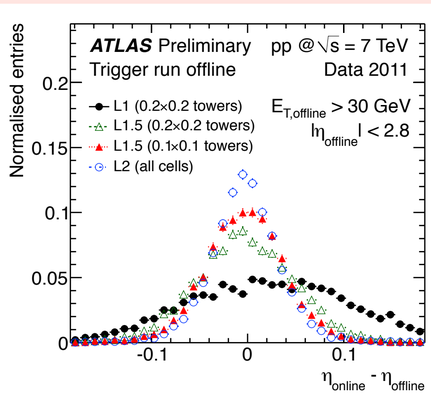
The L2 full-scan (L2FS or L1.5) jet trigger is a new style L2 trigger algorithm which uses L1 calorimeter towers to reconstruct jets across the entire detector.

By studying the L1 calorimeter data with the L2 software layer L2FS is able to provided several key enhancements to the jet trigger functionality, including:

- The ability to study the entire detector at L2.
- The ability to run the same jet algorithms as used in offline analysis such as anti-k_T.
- Enhanced L2 input rate.
- Increased flexibility of the trigger system.
- Ability to apply jet specific calibrations to L1 calorimeter based jets to further improve rejection.

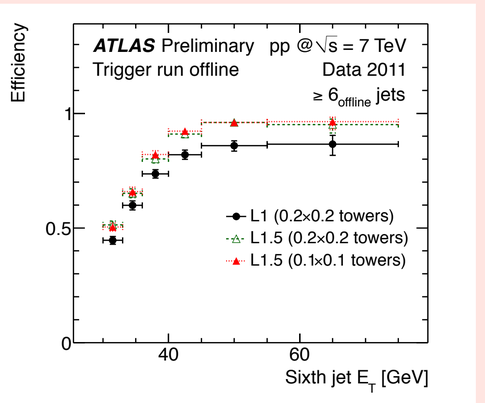


The time to find L1.5 jets using the anti-k_T jet with R=0.4.



The jet position resolution of the L1, L1.5 and L2 jet triggers.

The jet finding algorithm for L1 is a sliding window, for L1.5 it is anti-k_T with R=0.4 and for L2 a three-iteration cone R=0.4 seeded by a L1 jet.



The efficiency for L1 (sliding window) and L1.5 (anti-k_T R=0.4) jets to satisfy a six jet trigger in events where at least six jets have been identified offline.

The gain in efficiency is achieved due to the difference in jet algorithm.

Further reading

The ATLAS Collaboration, "Performance of the ATLAS Trigger System in 2010". Eur. Phys. J. C 72 (2011).

The ATLAS Collaboration, "The ATLAS Experiment at the CERN Large Hadron Collider". JINST 3 S08003 (2008).

(*) M.Cacciari et al, "FastJet User Manual". arxiv:1111.6097v1 (2011).

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