Performance and Calibration of the ATLAS Jet Trigger

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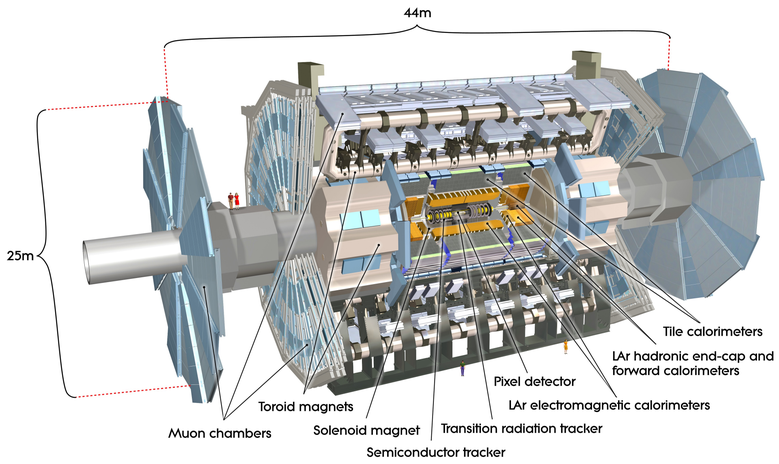
1. The ATLAS Experiment

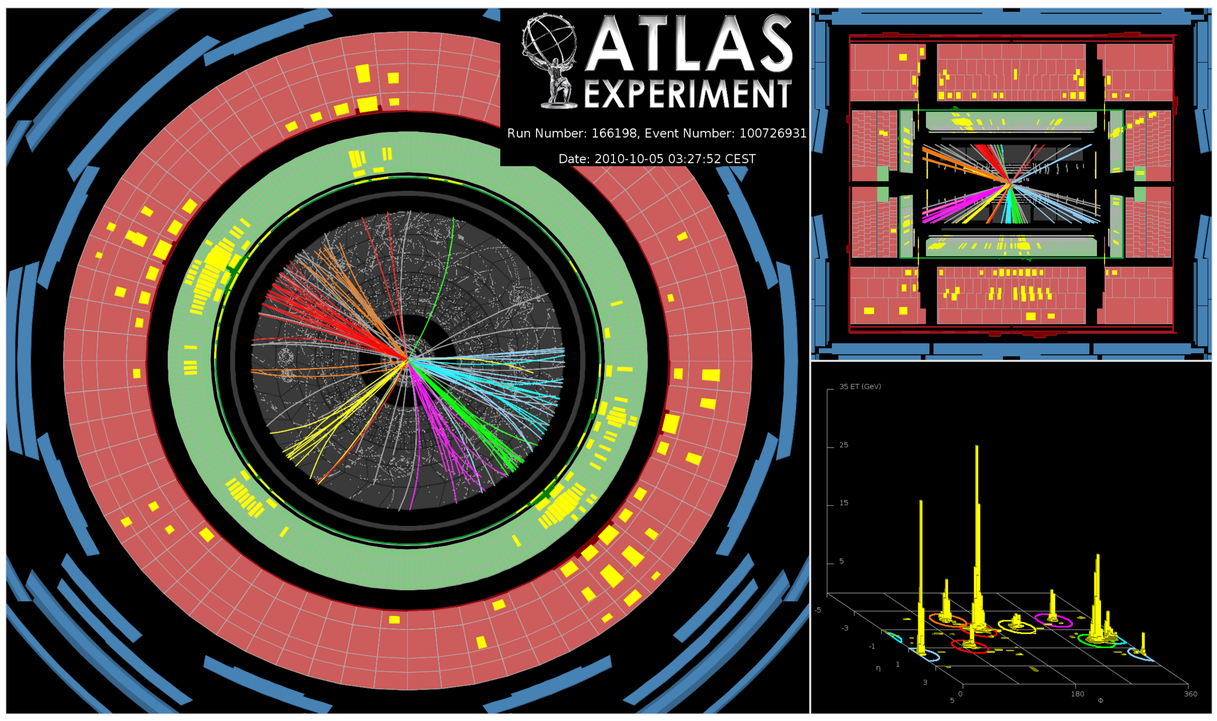
ATLAS (A Toroidal LHC ApparatuS) has been collecting data from *pp* collisions in the LHC at CERN. In particular, since March 30th 2010:

- **Center of mass energy**
  7 TeV
- **Integrated luminosity**
  1.3 fb^{-1}
- **Peak luminosity**
  1.26×10^{33} $cm^{-2}s^{-1}$
- **Data taking efficiency**
  95.8%
- **Bunch crossing rate**
  20 MHz
- **Max. interactions**
  13/bunch crossing



2. Challenges for the ATLAS Jet Trigger

The trigger system is essential to handle the enormous data flow in ATLAS. It is organized in three levels (L1, L2 and Event Filter) to reduce the event rate to $\approx 300 - 400$ Hz.

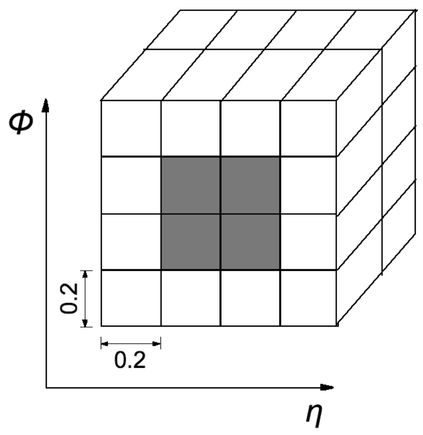


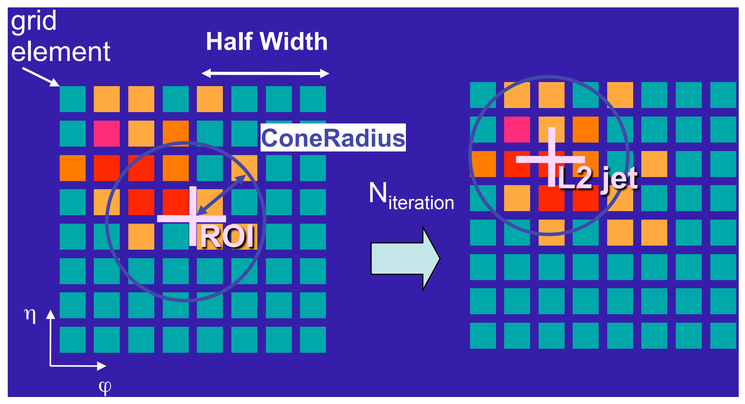
Jets are the most commonly produced objects in ATLAS. High performance of the jet trigger is fundamental to achieve the physics goals of ATLAS, since this is the primary mean for selecting events containing jets with high transverse momentum (p_T), used in physics analyses ranging from QCD to SUSY and Higgs searches.

3. Implementation of the Jet Trigger

- **L1 - fast decision with limited resolution:**
  - Implemented with custom designed hardware.
  - Reconstructs jets with a sliding window algorithm on groups of 0.2×0.2 calorimeter towers to find local E_T maximum.
  - Defines Region of Interest (RoI) if E_T is above threshold.
- **L2 - full resolution around L1 RoI:**
  - Accesses calorimeter cells.
  - Reconstructs jets using simplified cone algorithm ($R = 0.4$).
- **EF - sophisticated offline-like algorithms:**
  - Reads out whole calorimeter for events passing L2.
  - Topological clusters are input into jet reconstruction.
  - Anti-k_t algorithm with $R = 0.4$ and $R = 1.0$ are running (others can be used).

Jet energies in the trigger are measured at the electromagnetic scale.



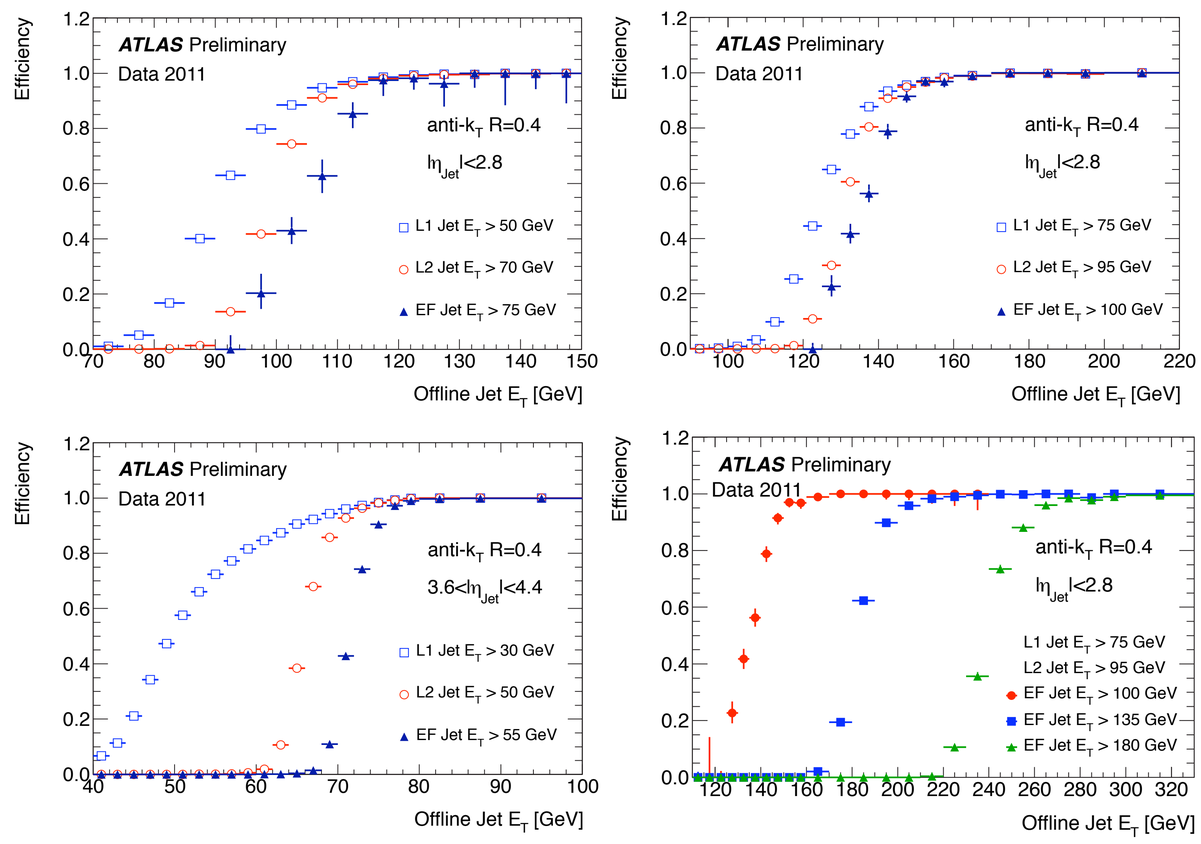


4. Jet Trigger Menu

Several inclusive single jet and multijet, combination and topological triggers are available in ATLAS, both in the central ($|\eta| < 3.2$) and forward ($3.2 < |\eta| < 4.9$) regions of the detector.

Trigger chains currently running unprescaled	Thresholds L1 (GeV)	L2 (GeV)	EF (GeV)	Rates for 1×10^{33} $cm^{-2}s^{-1}$ L1 (Hz)	L2 (Hz)	EF (Hz)
Inclusive single-jet chains						
1 central jet	75	95	240	275	160	2.8
1 forward jet	75	95	100	3.9	1.1	0.6
Inclusive multi-jet chains						
3 central jets	3×50	3×70	3×75	12	4.9	4.2
5 central jets	5×10	5×25	5×30	60	7.9	3.0
Topological and combination chains						
1 central "fat" jet, anti-k_T $R = 1.0$	75	95	240	275	160	2.7
2 forward jets with $\Delta\eta > 5$	2×30	2×50	2×55	2.2	<0.5	<0.5
1 central jet + E_T^{miss}	50 + 20	70 + 20	75 + 45	711	338	20
1 central jet with $H_T > 350$	75	95	100	275	160	11

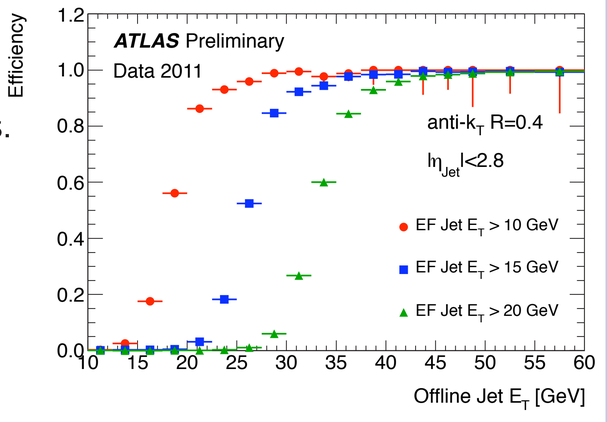
5. Jet Trigger Efficiency in 2011



The efficiency of several jet trigger chains was tested with respect to offline jets, using data collected in 2011. Results show the jet trigger is behaving well, both in the central and in the forward region and in a large E_T range, revealing only a weak dependence on pile-up (see bottom plot in section 6).

6. Improving the Jet Trigger

- **Recent changes at L2:**
  - "Cleaning" jets from detector effects improves rejection in noisy conditions.
  - Pile-up noise suppression reduces rates.
- **Recent changes at the EF:**
  - Reading out the whole calorimeter reduces pathologies associated with overlapping RoIs and allows the design of low p_T jet triggers.
  - Changing from the cone algorithm to anti-k_t, which is theoretically superior and used offline, improves resolutions.
  - Using topological clusters increases stability under pile-up.
- **Plans for future improvements:**
  - Applying hadronic calibration at L2 and EF can improve resolutions w.r.t. offline, sharpen turn-on curves and increase rejection.
  - A better integration between L1 speed and L2 flexibility is under study and will allow us to overcome limitations at L1 and improve performance.



7. Summary & Conclusions

High performance of the ATLAS jet trigger is essential for many physics analyses. The jet trigger is implemented in three levels, that identify and select events with high p_T jets, both in the central and forward region of the detector. It is also flexible enough to select events based on their topology. Recent changes to the jet trigger have greatly improved its performance. This was evaluated with data taken in 2011 and results show the ATLAS jet trigger is efficiently selecting events, even under pile-up. Studies are ongoing to further improve the performance of the ATLAS jet trigger.

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