Fake jet rejection at trigger level using the TileCal gap/crack scintillators

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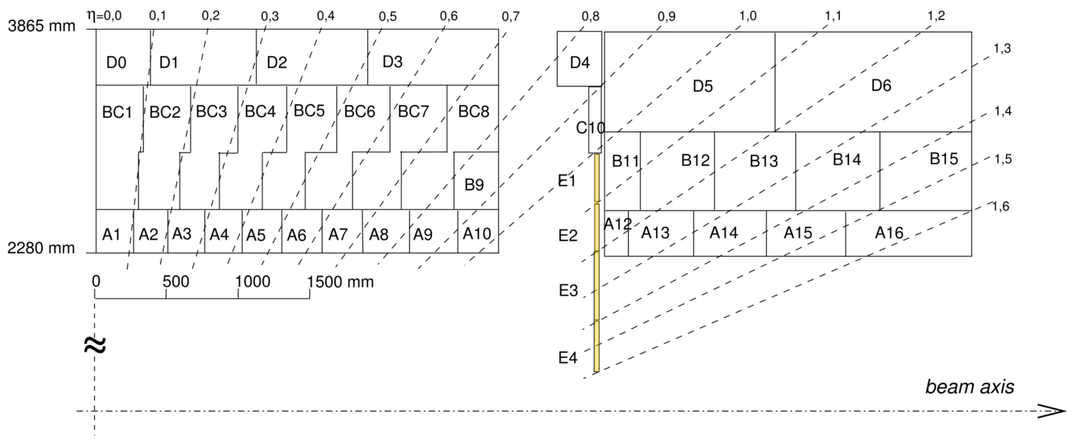
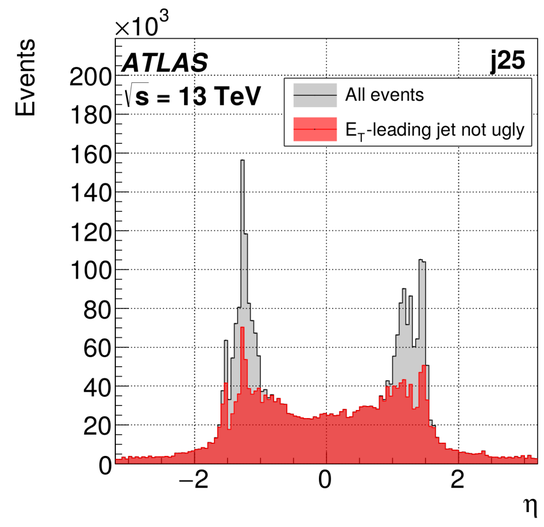
Fake jets in jet trigger

The TileCal is the central hadronic calorimeter of ATLAS [1]. **E1-E4 are the gap/crack scintillators**: response affected by noise, which increases with pile-up [2].



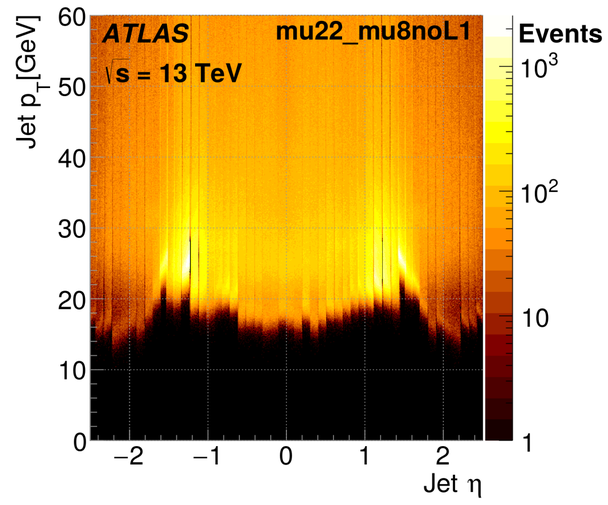
- f_{TG3}: fraction of a jet's energy sampled by the gap/crack scintillators
- **Ugly jet**: f_{TG3} larger than all fractions from other calorimeter layers

Too many events with ugly jets pass low E_T jet trigger chains [3]. Most are rejected offline → **Waste of trigger rate!**



η of E_T-leading central ($|\eta| < 3.2$) trigger jet. Events recorded by HLT_j25 (at least one jet with $E_T \geq 25$ GeV and $|\eta| < 3.2$) during 2017 data-taking period B

Just overestimating ugly jet energy? Excess is visible in triggers uncorrelated to jets → **Fake jets.**



(η, p_T) of E_T-leading central trigger jets in events recorded by the di-muon trigger HLT_mu22_mu8noL1 during 2017 data-taking periods B through F

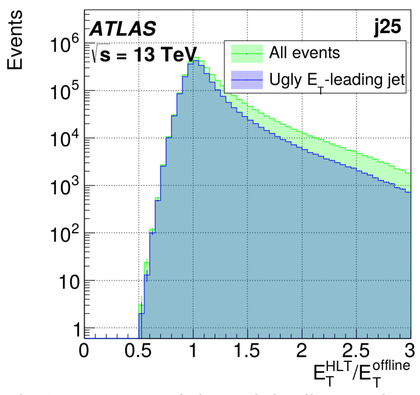
Jet corrections

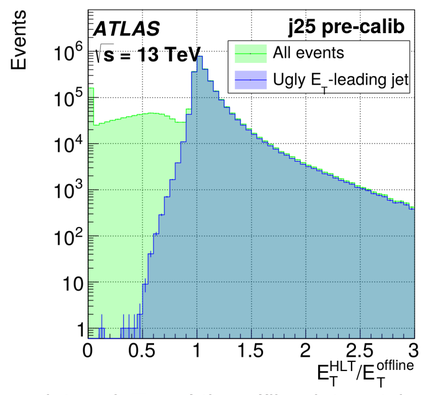
Pre-calib

EM-scale jets
↓
For all ugly jets, do $p^{\text{jet}} \to p^{\text{jet}} \times (1 - f_{TG3})$
↓
Calibrate all jets
↓
Trigger hypo

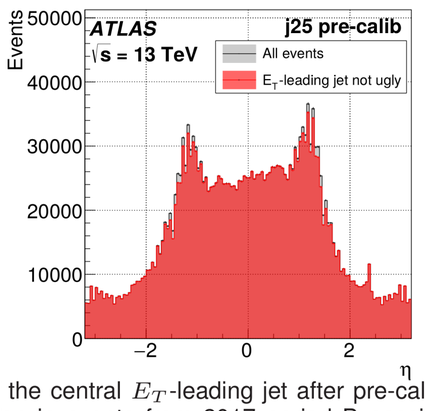
Post-calib

Calibrated jets
↓
For all ugly jets, do $p^{\text{jet}} \to p^{\text{jet}} \times (1 - f_{TG3})$
↓
Trigger hypo





Ratio between E_T of the originally E_T-leading central trigger jet and E_T of the offline jet matched to it, before (left) and after (right) pre-calib correction. Events recorded by j25 during 2017 period B



η of the central E_T-leading jet after pre-calib correction in events from 2017 period B passing the modified j25 chain

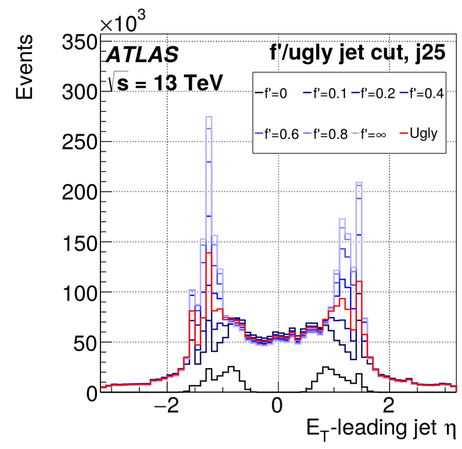
Jet cuts

Ugly jet cut

Reject ugly jets
↓
Trigger hypo

f' jet cut

Reject jets with $f_{TG3} > f'$
↓
Trigger hypo



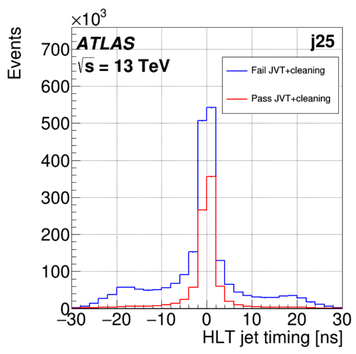
η of the central E_T-leading trigger jet in events from 2017 period B passing the j25 chain modified by an ugly jet cut or f' jet cuts for various f' values

Other strategies

Ugly event cut
Reject event if any jet is ugly

f' event cut
Reject event if any jet has $f_{TG3} > f'$

Use trigger jet timing information



Timing of central E_T-leading jet in events recorded by j25 during 2017 period B. Events separated into those in which the matched offline jet either passes or fails the JetVertexTagger [4] and cleaning [5] requirements

Impact of corrections/cuts on jet trigger

Offline acceptance rate: $\dfrac{\#\text{ of events passing chain AND offline selection}}{\#\text{ of events passing chain}}$

- Apply jet cleaning [5] and JetVertexTagger [4]
- ≥1 offline jet in kinematic region of 99% trigger efficiency

	Offline acceptance rate[%]								
	2016 period B			2016 period L			2017 period B		
Correction	j15	j25	j35	j15	j25	j35	j15	j25	j35
None	12.3	6.88	8.65	16.1	8.29	9.49	15.5	5.31	7.75
Pre-calib	12.8	8.07	9.35	16.3	8.76	9.75	16.7	7.79	8.70
Post-calib	14.5	9.09	9.67	17.0	9.18	9.85	15.8	6.60	8.48
0.1 event cut	12.2	9.08	9.78	13.0	9.04	10.0	10.4	6.30	8.86
0.2 event cut	12.8	9.51	10.3	14.0	9.37	10.4	11.6	6.42	9.00
Ugly event cut	12.9	9.31	10.1	14.5	9.30	10.2	12.4	6.23	8.82
0.1 jet cut	15.7	10.4	10.8	17.6	9.83	10.4	16.0	7.59	9.39
0.2 jet cut	15.1	9.65	10.1	17.3	9.41	10.0	15.9	6.98	8.78
Ugly jet cut	14.7	9.14	9.69	17.1	9.17	9.84	15.9	6.59	8.48

Offline acceptance rates for various correction and cut strategies, for j15, j25 and j35. Events recorded during 2016 periods B and L and 2017 period B. Highest and 2nd highest offline acceptance rates are highlighted for each trigger of each period

Conclusions

f' jet cuts significantly increase offline acceptance rates, consistently across periods and chains.

A jet cut with $f' \sim 0.2$ seems the best compromise between effectiveness and undesirable impact on recorded data. Tighter cuts could lead to **lack of statistics or bias** in data used for deriving jet η-intercalibration [6].

Pre-calib correction performs better in 2017, thus it should be preferred if the difference between 2016 and 2017 is understood and the 2017 performance is expected to persist.

Studied strategies considered either too ineffective or too aggressive for implementation in the 2018 jet trigger.

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References

[1] G. Aad *et al.* [ATLAS Collaboration], Eur. Phys. J. C **70** (2010) 1193.
[2] S. Amor Santos *et al.*, ATL-TILECAL-INT-2014-001.
[3] N. Anjos *et al.*, ATL-DAQ-INT-2015-001.
[4] The ATLAS collaboration, ATLAS-CONF-2014-018.
[5] The ATLAS Collaboration, ATLAS-CONF-2012-020.
[6] M. Aaboud *et al.* [ATLAS Collaboration], Phys. Rev. D **96** (2017) no.7, 072002.