Triggering on hadronic signatures in ATLAS: Developments for 2017 and 2018

Poster link, CDS link

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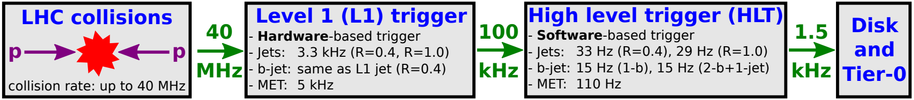
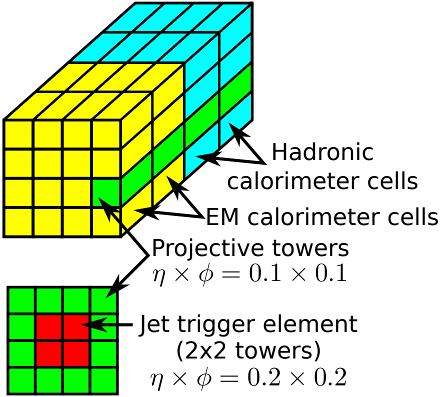
ATLAS trigger overview



- Trigger goal: identify the most interesting events to record
- Two stages: Level-1 (hardware) and HLT (software)
  - Level-1 is quick selection of up to 100,000 events/second
  - HLT is more detailed selection of up to 1,500 events/second
- Hadronic triggers are roughly 1/4 to 1/3 of the total rate

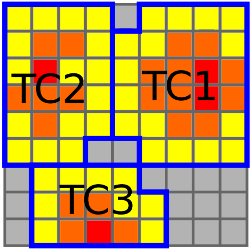
Level 1 (hardware) decision



- L1 jet decision:
  - Sliding window algorithm
  - Window: 0.8×0.8 in $\eta \times \phi$
  - Accept event if window is above E_{T} threshold
- L1 $E_{\mathrm{T}}^{\mathrm{miss}}$ decision:
  - E_x, E_y sum 0.2×0.2 towers
  - Calculate $E_{\mathrm{T}}^{\mathrm{miss}}$ from E_x, E_y
  - Accept event if $E_{\mathrm{T}}^{\mathrm{miss}}$ is above threshold

Topoclustering in the HLT

- Read out full calorimeter for every L1 jet or $E_{\mathrm{T}}^{\mathrm{miss}}$ accepted event
- Group energy deposits into noise-suppressed clusters
  - Used both in the trigger and offline (normal analysis)

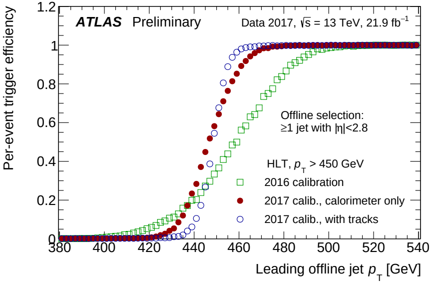


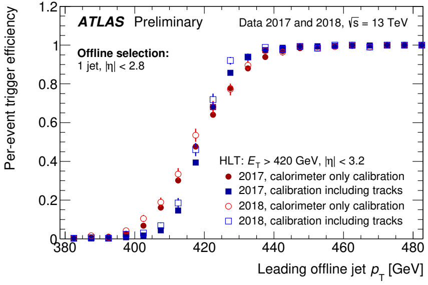
Topoclustering

- seed cells $|E| > 4\sigma$
- growth cells $|E| > 2\sigma$
- boundary cells
- final topoclusters $\eta \times \phi = \mathrm{dynamic}$

Jet triggers

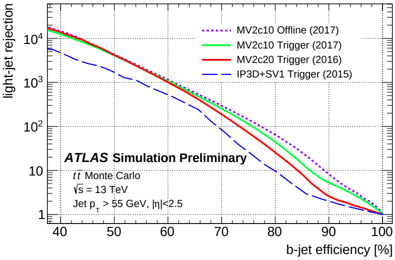
- Jet triggers significantly improved in 2017
- A few changes with respect to 2016 calibration
  - Apply the full calorimeter-based offline calibration
  - Apply a two-stage refined jet calibration, even closer to offline
    1. Loose cut on full-calorimeter calibration, then reconstruct tracks
    2. Apply a further track-based correction to the jet
- Both revised calibrations working similarly well in 2018 data

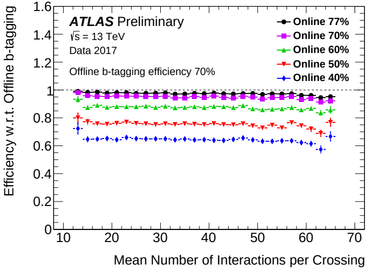




b-jet triggers

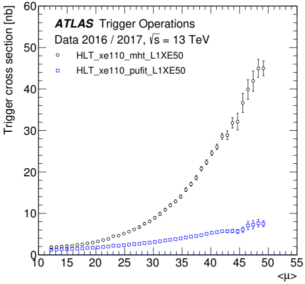
- Continuing to improve b-tagging algorithms year-by-year
  - 2017 performance very close to offline tagging performance
- Trigger b-jet efficiency now very similar to offline 70% working point
  - Trigger 70% working point within 5% of offline, ∼independent of pileup
  - Looser trigger working point can be used for even higher efficiency

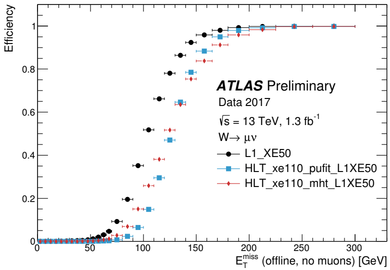




E_T^{miss} triggers

- Traditional E_T^{miss} triggers are strongly pileup dependent
  - Example: negative vector sum of jets (H_T^{miss})
- 2017: deployed a new algorithm "pufit" (pile-up fit)
  - Idea: fit the pileup distribution event-by-event, subtract from hard towers, and sum hard towers for the E_T^{miss} computation
- New pufit algorithm provides significant benefits
  - Strongly suppressed pileup dependence, improved signal efficiency





Large-R jet triggers

- Standard jet triggers are inefficient for hadronic particle decays
  - Energy extends beyond typical jet size, need large-R jets
- Two significant improvements in 2017 for such events
  1. New hardware to build simple large-R jets (L1 topological decisions)
     - Reduces L1 dependence on jet type (quark/gluon, W/Z, top)-like
  2. New HLT algorithm uses jet mass to enrich trigger in hadronic decays
     - Lower trigger thresholds for the same trigger rate