Compact data stream for jets at ATLAS

LUND UNIVERSITY

Search for low-mass dijet resonances using trigger-level jets with the ATLAS detector in pp collisions at √s = 13 TeV, arXiv:1804.03496 [hep-ex]

ATLAS EXPERIMENT

Problem: limited output bandwidth to record high-rate processes

30 MHz → **L1** (Level 1 (hardware)) → 100 kHz (detector readout) → **HLT** (High Level Trigger (software)) → 1-1.5 kHz (offline storage) → Main physics stream → ~140 Hz → Jet triggers → ~40 Hz → j380

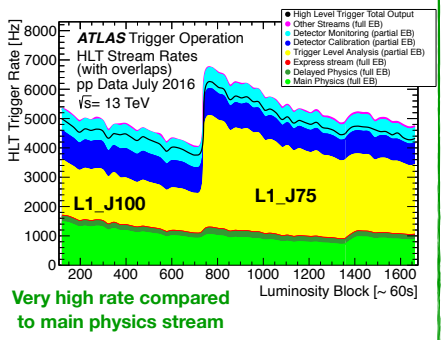
limiting factors driving rates for the ATLAS trigger system

ATLAS physics priorities

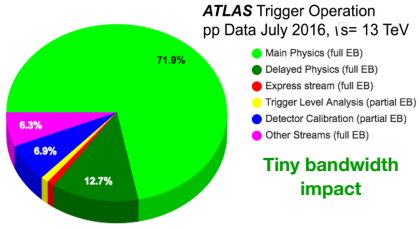
in 2016: single jet trigger E_T > 380 GeV
=> Offline p_T > 440 GeV
=> Dijet mass $m_{jj} \gtrsim 1$ TeV
=> Limits sensitivity to low mass dijet resonances

Only keep what we need

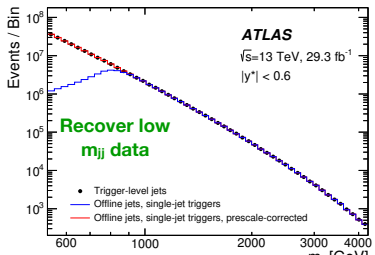
- L1 selection (J100) efficient by ~200 GeV offline
- CMS [1,3] and LHCb [2]: use trigger for analysis
- New to ATLAS: Trigger-Level Analysis (TLA) stream: jets p_T > 20 GeV, event & trigger info
  - 0.5 kB/evt, vs 1 MB for full event
- Recover large part of dijet mass spectrum



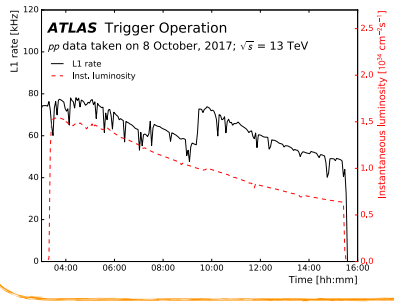
Very high rate compared to main physics stream



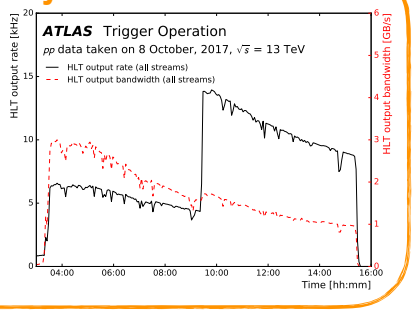
Tiny bandwidth impact



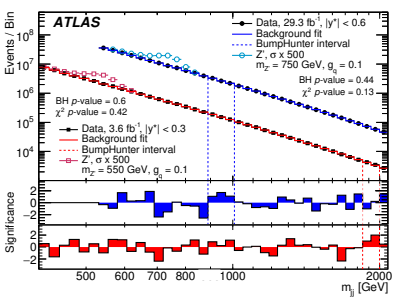
Developments in 2017 and beyond

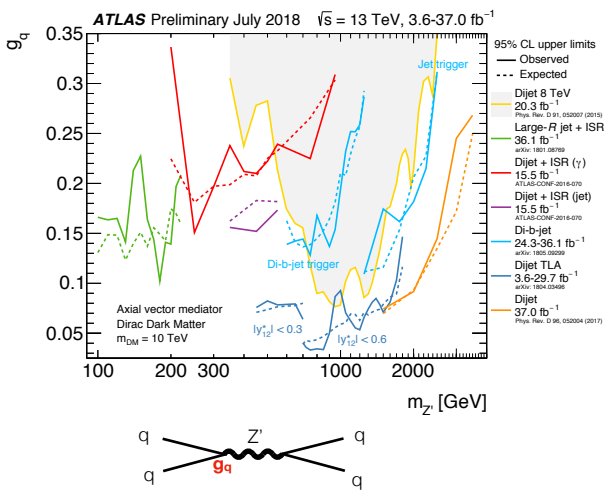


Make use of L1 rate at end of fill (below 10^{34} cm^{-2}s^{-1}) to run extra TLA trigger (J50 + L1Topo DETA) -> sensitivity to lower masses



Results: set strongest limits in targeted mass range





- No bumps in spectrum -> set limits in Dark Matter mediator (Z') model
- Sets limits down to 450 GeV in $m_{Z'}$, vs 1500 GeV for normal dijet search
- Similar sensitivity around 1500 GeV
- Other methods of accessing low masses use ISR => cross-section penalty

Calibrate the jets

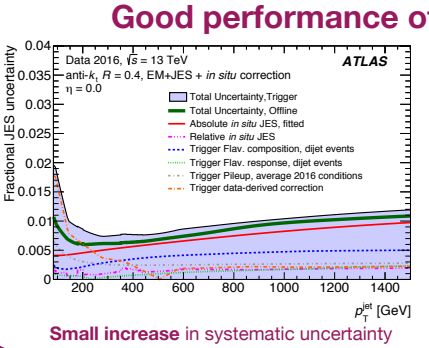
Calibration	Purpose
Origin correction	Jet origin to vertex
Pileup subtraction (Jet area / Residual)	Remove contributions from pileup
Jet Energy Scale correction	Restore hadronic energy
Global Sequential Correction	Reduce flavour (quark / gluon) dependence
Eta intercalibration	Corrects along eta to central region
Trigger - Offline scale factors	Correct residual (% level) differences
In-situ correction	Calorimeter response corrected to MC truth

Applied to?

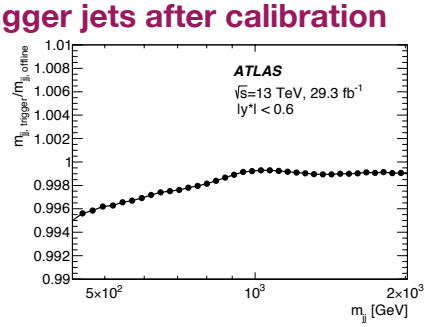
Offline & TLA | TLA specific | TLA only | Offline only

Save enough HLT information to **calibrate jets**
- as close as possible to offline
- but **no tracks** (only partial tracking at HLT)

Good performance of trigger jets after calibration



Small increase in systematic uncertainty



Excellent agreement with offline dijet mass

William Kalderon (Lund University), on behalf of the ATLAS Collaboration

[1] CMS, *Search for narrow resonances in dijet final states at √s = 8 TeV with the novel CMS technique of data scouting*, Phys. Rev. Lett. 117 (2016) 031802
[2] LHCb, *Tesla : an application for real-time data analysis in High Energy Physics*, Comput. Phys. Commun. 208 (2016) 35
[3] CMS, *Search for dijet resonances in proton–proton collisions at √s = 13 TeV and constraints on dark matter and other models*, Phys. Lett. B 769 (2017) 520
Other figures from https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TriggerOperationPublicResults