PERFORMANCE OF THE ATLAS TAU TRIGGER IN RUN 2
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TAU LEPTONS
- Longest lived lepton: proper decay length of 87 µm; generally decays in a few cm
- Identified by its decay particles: either leptons or hadrons (pions), and neutrinos
- Quark- and gluon-initiated jets form the major background: discriminate using variables based on displaced vertex, track multiplicity, collimated shower shape
- As heaviest lepton, taus are important in SM Higgs physics and BSM searches

THE ATLAS TRIGGER SYSTEM
- Two-level system reduces rate from collision rate: 40 MHz to avg 1 kHz
- First level (L1) hardware-based: identifies regions of interest (RoIs) from the muon system and calorimeters; output rate max 100 kHz
- Software-based high-level trigger (HLT) refines L1 information
- HLT accesses data from all subsystems; includes tracking information
- Uses algorithms very similar to offline counterparts
- Substantial changes w.r.t. Run 1 to deal with increased LHC collision energy and luminosity: bandwidth increases; hardware improvements; merged two stages into one HLT; optimised algorithms
- Further rate reductions will require changes in triggering strategy

TAU TRIGGER STRATEGY
- ATLAS tau trigger aims to identify hadronic decays
- L1: narrow cascade in both calorimeters
- Energy-dependent isolation cuts to control rate
- Topological L1 triggers may be used in future
- HLT combines energy clusters with tracking
- Topological clustering of cells in RoIs
- Fast-tracking algorithm optimised to perform selections based on no. of core and isolation tracks
- Improvement w.r.t. Run 1: full HLT tracking and 13-variable BDT harmonised with offline selection used in final selection

PERFORMANCE IN RUN 2
- L1 trigger rate measured as function of instantaneous luminosity (6–12 July 2015)
- ‘TAU’, ‘EM’, ‘J’ and ‘XE’ refer to taus, electrons, jets and missing energy; ‘IM’ and ‘HI’ indicate isolation and hadronic veto req.
- Offline Z → ττ events (medium BDT) show trigger observables well-modelled
- Efficiencies measured using tag-and-probe method on Z → ττ → µ+µ− events: tagged muon passed muon trigger; efficiency measured on probe tau

PROSPECTS
- The ATLAS Fast Tracker (FTK) will provide full-scan tracks after L1 selection with trained pattern banks
- Allows for redesign of HLT tau algorithm: tracking can be used before calorimeter information
- HLT energy resolution impact on efficiency can be reduced
- Very useful for e.g. SM H → ττ
- First triggers operational in 2017

Topological triggers at L1 allow for selection by angular criteria
Crucial at higher instantaneous luminosity and pile-up
Exploit kinematic differences between multi-jet and Higgs signal events