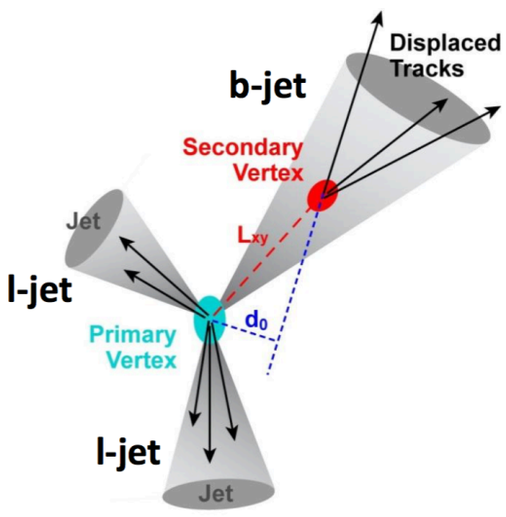
LHCC POSTER SESSION – CERN, 22 FEBRUARY 2017

REAL-TIME FLAVOUR TAGGING SELECTION IN ATLAS

Flavour Tagging

Flavour tagging aims to correctly identify and separate jets stemming from light quarks or gluons (light-jets), and heavy quarks (c- or b-jets).

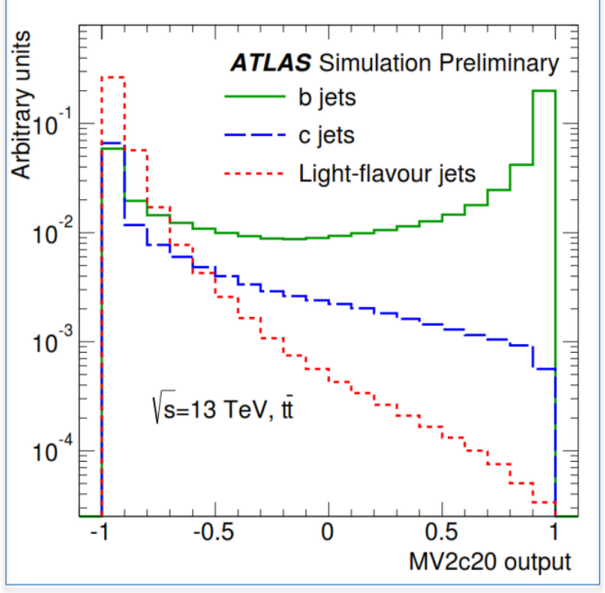
Properties of B-hadrons:
- High Mass (~5 GeV)
- Relatively long lifetime (~1.5 ps)



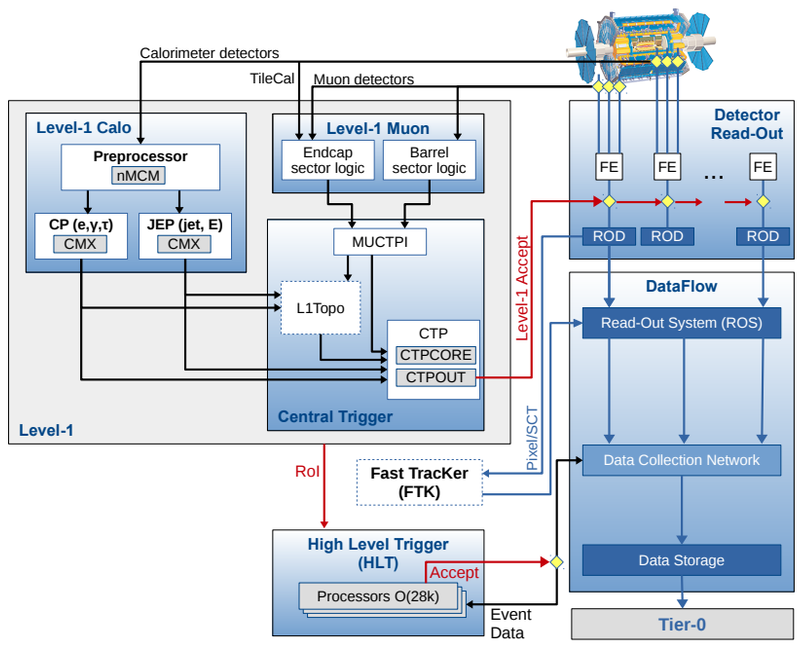
b-tagging Algorithms [1]

The ATLAS b-jet trigger uses the same tools as offline reconstruction:
- Less code maintenance
- Larger online/offline correlation

The new tagger (MV2c20) uses a BDT to separate b-jets from light- and c-jets



The ATLAS Trigger System [2]



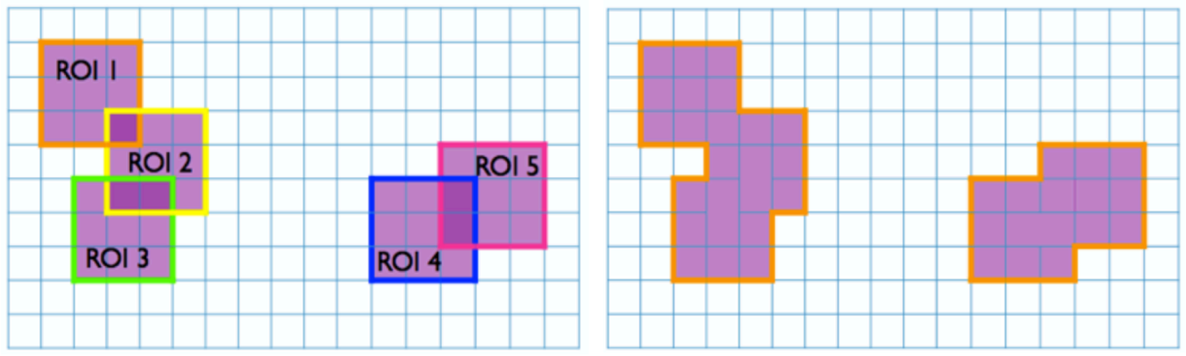
ATLAS uses a two-level trigger: the hardware-based Level 1 Trigger (L1) and the software-based High Level Trigger (HLT).
- L1 uses Trigger Objects from calorimeters and muon detectors with a reduced granularity.
  - Identify Regions of Interests (RoI)
  - Fast electronics (~2.5 μs)
  - **Reduce rate: 40 MHz ➔100 kHz**
- HLT uses Trigger Objects from all the detectors with full granularity
  - Analyse the L1-RoIs
  - Latency ~ms
  - **Further reduce rate: 100 kHz ➔1 kHz**
- Two additional components included recently:
  - L1Topo in 2016 (provides topological selections based on L1 Trigger Objects)
  - Fast Tracker in 2017 (provides global ID track reconstruction using associative memories)

b-jet Trigger Configuration

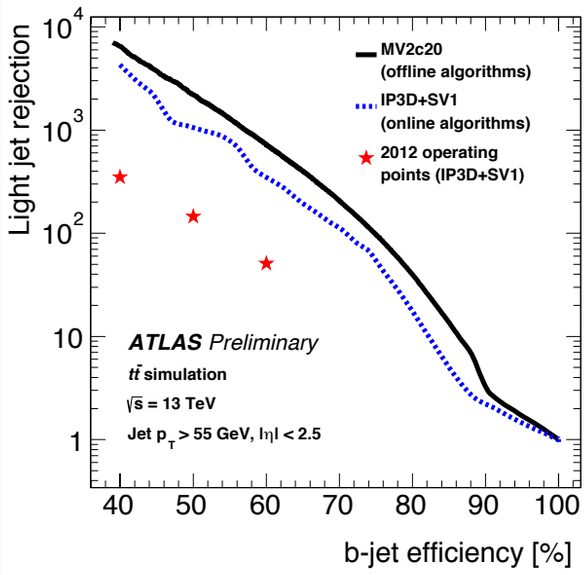
Track reconstruction during Run-1 (and default for 2015):
- Perform track reconstruction within each L1 Jet RoI
- Put all the tracks together and find the Primary Vertex

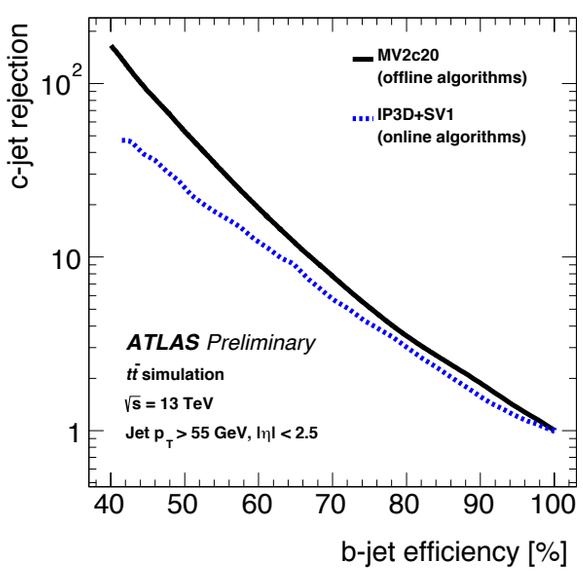
In a high-pile-up environment, such as Run-2, this is not an optimal approach:
- Some regions of detector are being processed multiple times (track overlapping) while finding Primary Vertex.
- May duplicate tracks and bias the Primary Vertex coordinates
- Costly in terms of Time and CPU

Solution for Run-2 (commissioned during 2015, default for 2016):
- Merge the L1-RoIs into topologically unique “Super-RoI”
- Perform fast track reconstruction and primary vertex finding on these “Super-RoIs”
- Split the “Super-RoIs” into the original L1-RoIs
- Perform a precision track reconstruction on the original L1-RoIs with a constraint on the Primary Vertex



Performance in Run-2 [3]





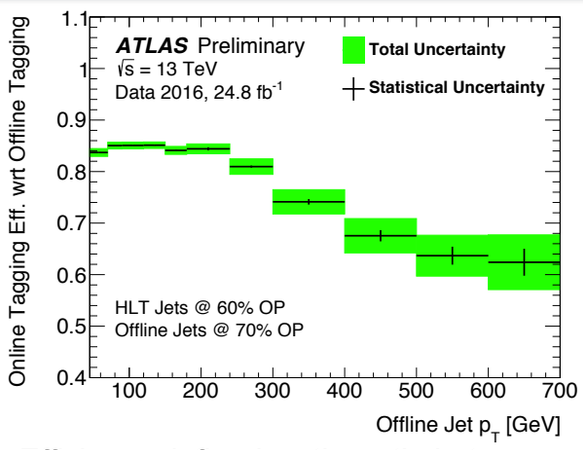
During Run-1 the ATLAS Trigger used Likelihood-based algorithms (IP3D+SV1)
- Not optimal correlation with offline tools

The improvement between Run-1 and Run-2 is due to:
- Inclusion of the Insertable B-Layer (IBL)
- Improved tracking performance
- Adaptation of the offline *b*-tagging algorithms for use in the trigger

Trigger Efficiency [4]

The b-jet Trigger Efficiency is derived using a data driven technique:
- Efficiency for $p_T < 240$ GeV is measured in data
- Efficiency is extrapolated to higher p_T using high b-purity Monte Carlo di-lepton $t\bar{t}$ sample

Selection:
- Events triggered with a single lepton trigger
- 1 loose electron and 1 medium muon
- 2 b-tagged jets
- $\Delta R < 0.4$ matching online/offline jets



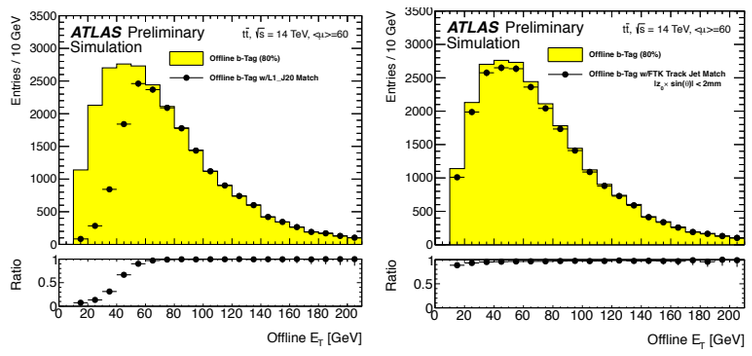
Efficiency defined as the ratio between:
- Online jets matched to offline jets, both satisfying b-tagging requirement
- Offline jets that satisfy the b-tagging requirements

Fast TracKer (FTK) [5]

FTK is an electronic hardware system that uses data from the silicon detectors (pixel and strip) tracker.
- Perform global track reconstruction after L1 trigger
- Use pattern matching on specially pre-processed data in an associative memory
- HLT flavour triggers will use FTK tracks directly, with no need for further HLT-level processing

Trigger Menu adapted for FTK during 2016 [6], commissioning in 2017

FTK operates in two stages:
- Pattern recognition and initial track fitting
- Extrapolation of tracks (with more stringent cuts) and removal of duplicates.



References: [1] ATL-PHYS-PUB-2015-022; [2] https://arxiv.org/abs/1611.09661; [3] ATL-DAQ-PUB-2016-001; [4] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/BJetTriggerPublicResults ; [5] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/FTKPublicResults ; [6] ATL-DAQ-PUB-2017-001

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