The possibility to identify and tag jets originating from b-quarks (flavor tagging) at the trigger level is a crucial aspect for many physics analyses, such as: fully hadronic tt, single top, VH (H→b-quark), fully hadronic tH, supersymmetric Higgs bosons produced in association with a b-quark (bA→bbb), exotics signatures decaying to multi b-jets final state, supersymmetric signatures such as 3rd generation squarks.

ATLAS Detector

The ATLAS Detector (A Toroidal Lhc Apparatu5) detector consists of four main parts.
- The Inner Detector is composed of different subsystems:
  - Pixel detector: 3 + 1 (Inertable B-Layer - IBL) layers and 3 disks of silicon pixels.
  - SemiConductor Tracker (SCT): 4 layers and 9 disks of stereo silicon strips.
  - Transition Radiation Tracker (TRT): Straw drift tubes (tube diameter 30 μm).
- The Calorimeters consist of electromagnetic (liquid argon - LA) and hadronic calorimeters (both LAr and steel/scintillator).
- The Muon Spectrometer is designed with two separate sets of detectors: trigger chambers and precision chambers.
- The Magnet system consists of four superconducting magnets: a central solenoid surrounded by 2 end-cap toroids and a barrel toroid.

b-tagging Algorithms

In Run 2, the b-jet trigger uses the same algorithms as the offline reconstruction:
- IP3D: Track based algorithm. Using 2D histogram of transverse & longitudinal IP of the tracks in order to use their correlation.
- SV1: Secondary vertex fitting algorithm. Using SV information of mass, direction, track, multiplicity, etc.
- JetFitter: Fits vertices along b flight direction which is assumed same as jet axis. Using SV information.

The variables built from the three basic algorithms are then combined.

In Run 1 the combination was done through a Neutral Network resulting in the MV1 tagging algorithm.

For Run 2, intermediate tagging algorithms have been removed for a better management of the calibration. The combination is done using a Boosted Decision Tree (BDT). The resulting MV2 tagging algorithm is trained with different c-jet-lightjet- jet proportions, e.g. MV2c0 is trained with 20% of c-jets and 80% of light-jets, this last being the best compromise between c-jet rejection and light rejection.

Algorithms: Tuning and Performance

The offline algorithms used by the trigger system have been tuned to use online quality track and jet objects. The adaptation procedure is as following:
1. Run the offline tuning framework using the online tracks and jets to obtain reference histograms for the IP3D and SV1 taggers.
2. Run the tuning using the new reference histograms to obtain input for the MVA-based training (JetFitter and MV2c20).
3. Optimize both JetFitter and MVc20.
4. Feed desired b-tagging efficiency operating point to offline optimization framework to obtain an optimal MV2c20 working point (WP).

More Run 2 Improvements

The individual RoI processing adopted in Run 1 led to some inefficiencies in CPU usage and to double counting of tracks in overlapping RoIs.

For Run 2, a new approach is used: all RoIs are first merged into a single, topologically unique, “Super RoI”. This is collectively processed by the fast tracking step:
- Intrinsically eliminates track duplications,
- Allows to constrain the track finding to a single PV,
- Leads to improved performance in the higher pile-up scenarios.

The b-jet trigger then processes each RoI individually (each RoI corresponds to a different jet object in the context of b-jet tagging in the HLT), performing precision tracking and SV finding on each jet for tagging purposes.

FTK tracks can be used to define track-jets, granting larger acceptance at low $E_T$ w.f.t. calorimetric jets.