LHCP2020 Poster Session

Calibration of ATLAS trigger b-jet identification efficiency

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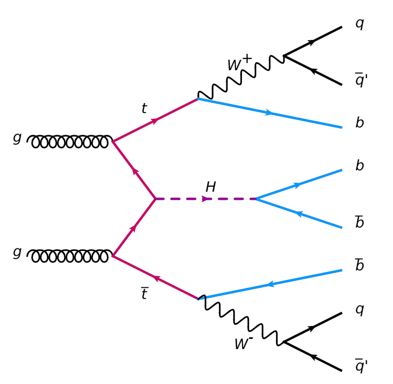
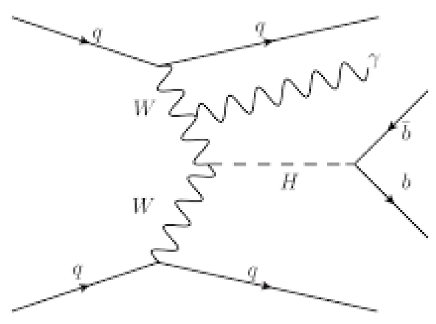
Physics motivation

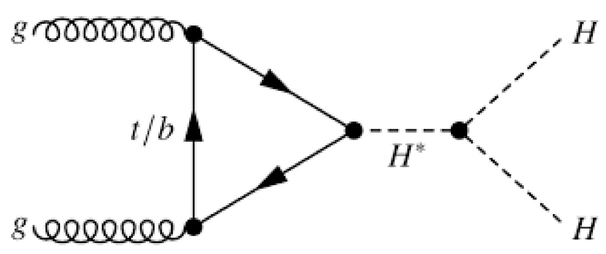
At the LHC, signal of Physics beyond the Standard Model (SM) can be accessed via precision measurements of the SM, like Higgs boson properties, or direct searches of new signal. Triggering efficiently on the presence of b-jets allows to analyse physics processes with b-quarks but without other conventional signature to trigger on.



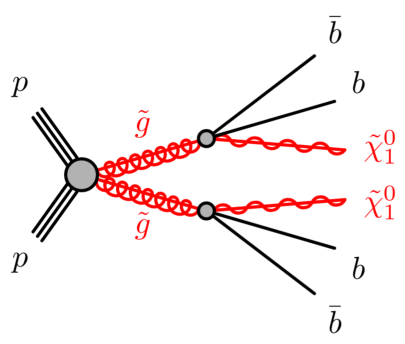
$t\bar{t}H(H \to b\bar{b})$



VBF $H \to b\bar{b}(\gamma)$

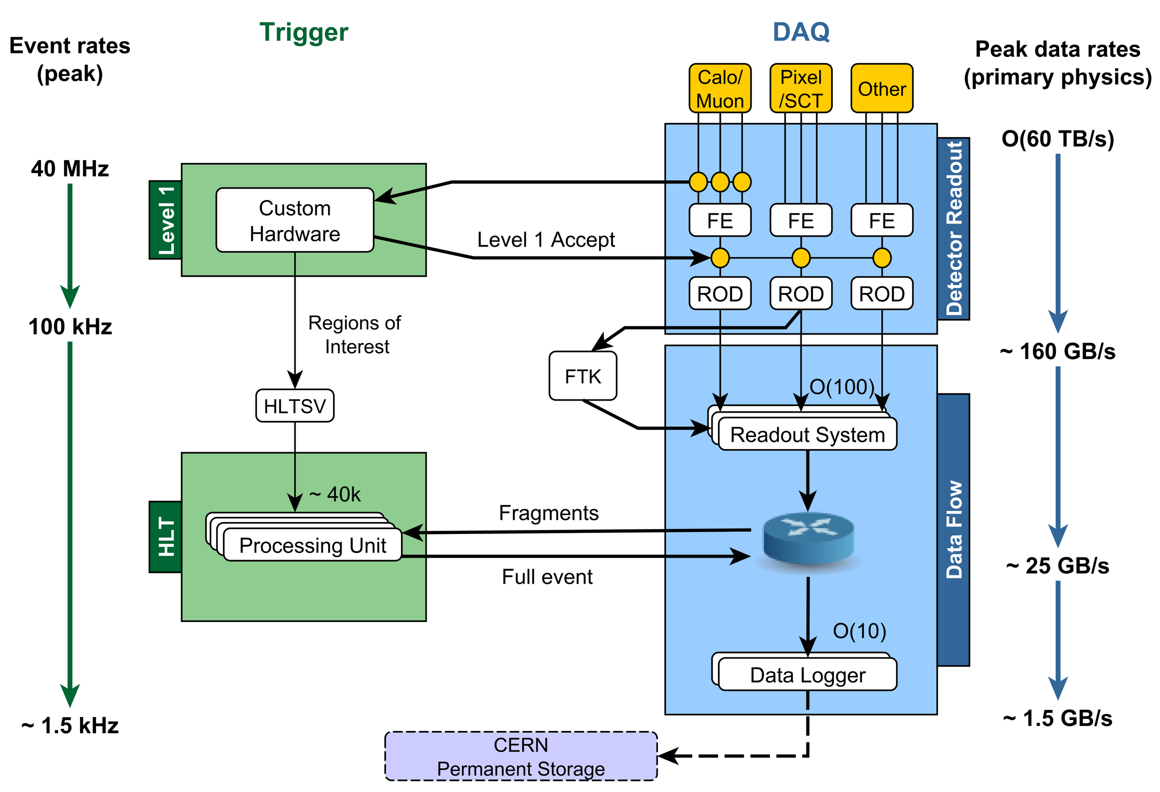


ggF $\to HH$



$\tilde{g}\tilde{g} \to 4b+$ MET

The ATLAS trigger system



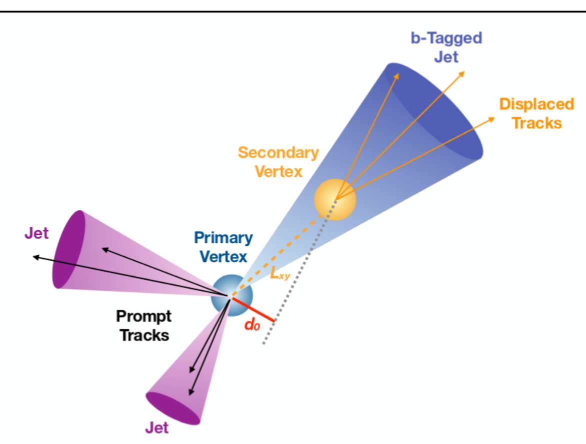
[1]

The Run 2 ATLAS trigger is divided into 2 levels

- Level 1 (L1): acts as hardware-based first filter and uses calorimeters and muon detectors with reduced granularity to identify Regions of Interest (RoI).
- High Level Trigger (HLT): software-based, analyses the L1 RoIs using the full detector and further reduces the trigger rate thanks to object reconstruction algorithms close to offline levels (leptons, missing energy, tracks, jets, b-jets).

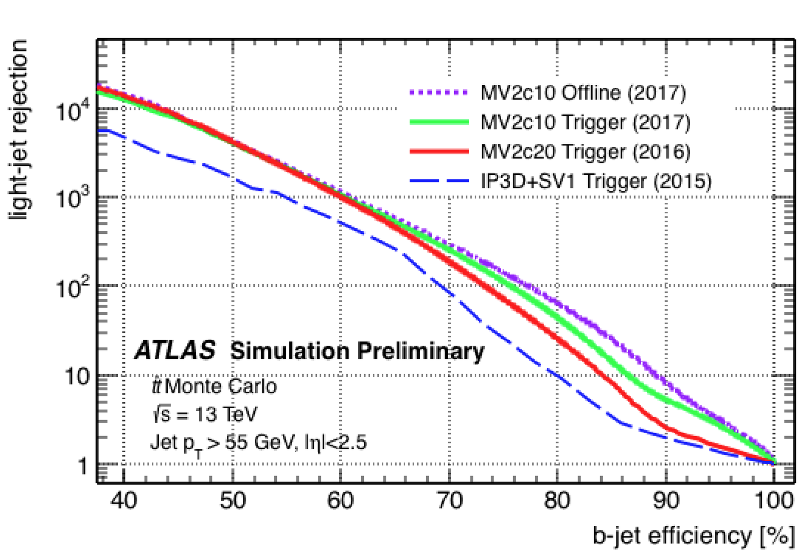
Identification of b-jets

The lifetime of b-hadrons allows them to travel a few millimetres before decaying. Jets from those decays have tracks originating from a vertex displaced by a measurable length from the interaction point.



Starting from 2016, the ATLAS trigger system used the Boosted Decision Tree (BDT) based MV2 tagger at HLT level, bringing the capability of online b-jet identification close to the offline one. MV2 combines the output of three low-level taggers

- IP2D/IP3D: based on impact parameter 2D (d_0) or 3D (d_0,z_0) distributions
- SV1: based on secondary vertex related information such as invariant mass and energy fraction
- JetFitter: based on topology of the decay chains inside the jets

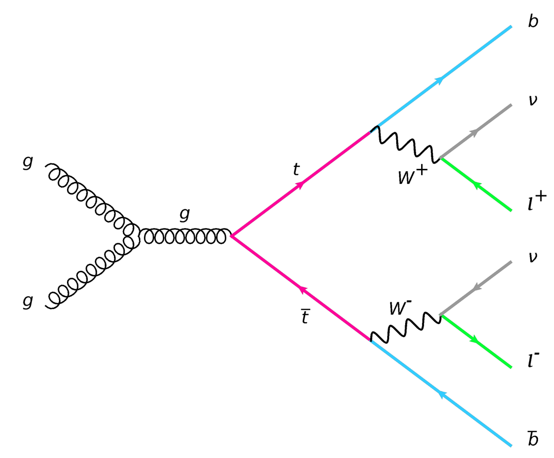


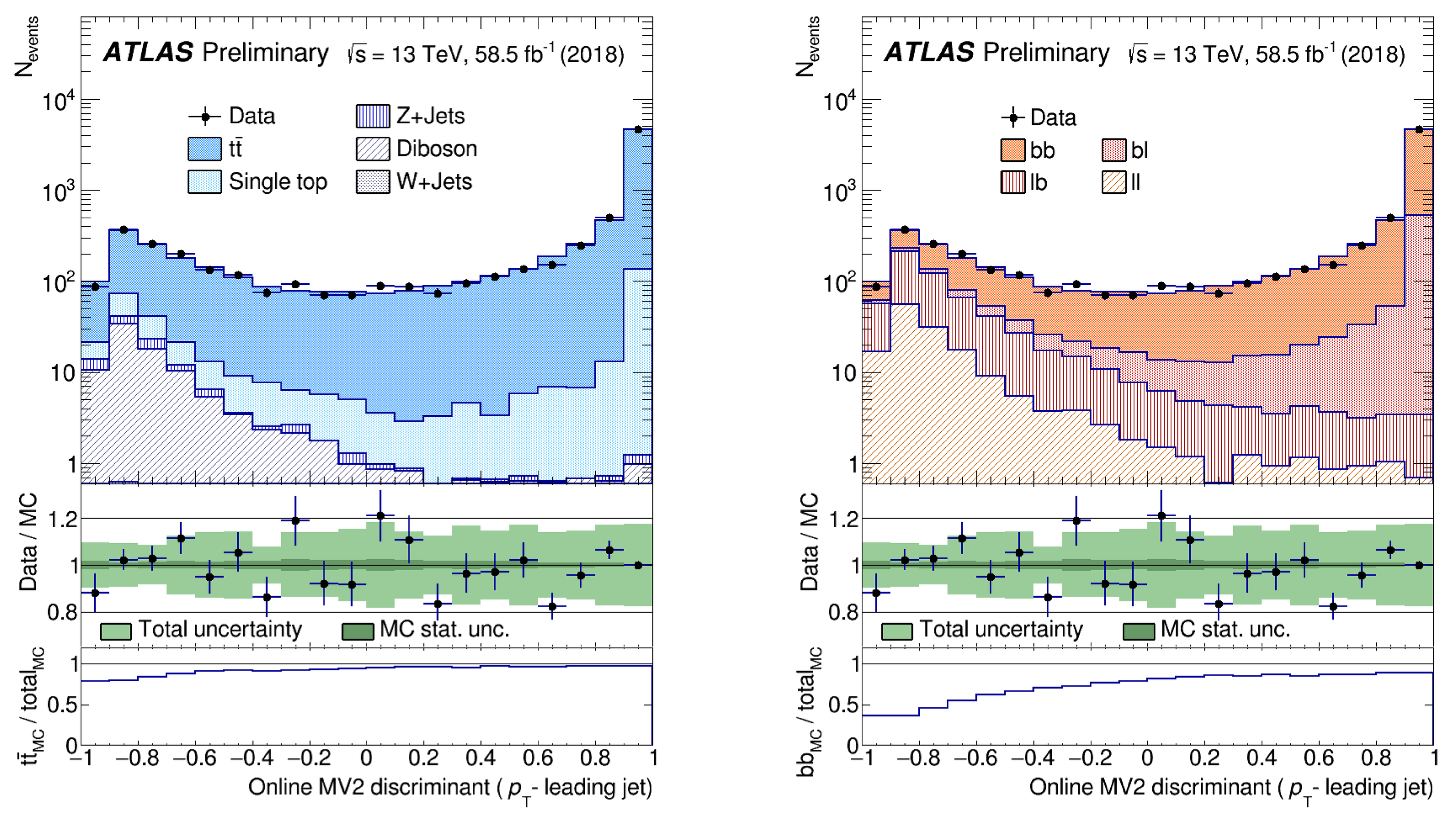
[2]

b-jet trigger calibration using $t\bar{t}$ events

To achieve high b-jet purity, a data sample enriched with dileptonic $t\bar{t}$ events is used. Events are required to have:

- leptons with different charge and flavor ($e\mu$) to minimize contributions from non $t\bar{t}$ processes
- exactly 2 offline jets to minimize the contribution of radiation
- both offline jets matched to HLT jets with a geometrical requirement $\Delta R < 0.2$





[2]

Selected events are classified according to jet p_T and b-tagging discriminant. b-jet identification efficiency is then extracted with a likelihood method [3]. Efficiency is defined as:

$$\epsilon_b^{trig} = \frac{N_{jets}(\text{pass online b-tag})}{N_{jets}(\text{total})}$$

The method is applied again in order to measure the conditional b-jet identification efficiency, defined as:

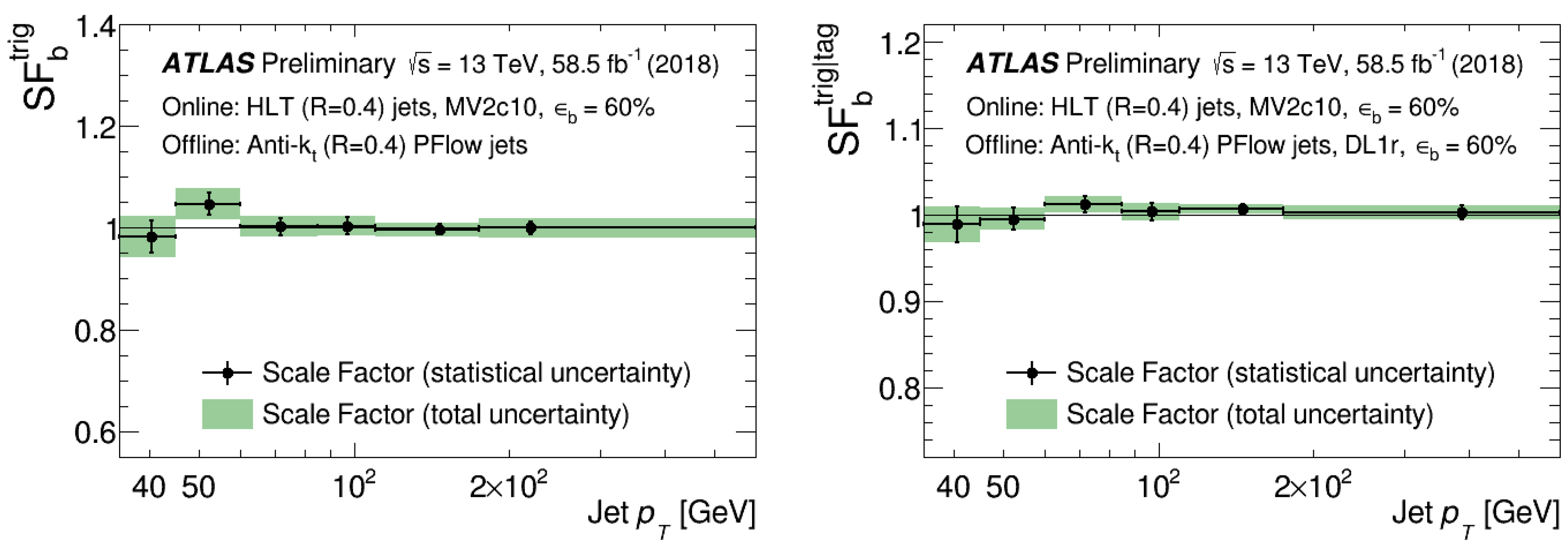
$$\epsilon_b^{trig|tag} = \frac{N_{jets}(\text{pass online and offline b-tag})}{N_{jets}(\text{pass offline b-tag})}$$

All combinations of online and offline working points are calibrated.

These measured efficiencies are used to correct possible deviations in the simulation by evaluating data-to-simulation Scale Factors (SF):

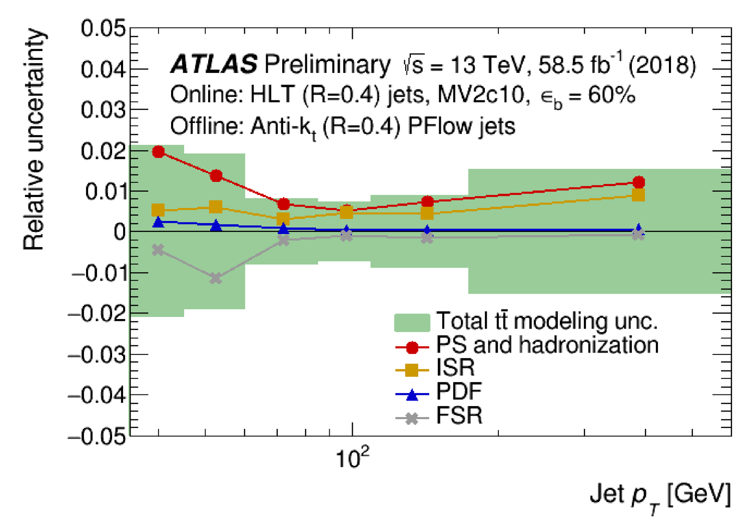
$$SF_b = \frac{\epsilon_b^{data}}{\epsilon_b^{MC}}$$

The conditional SFs are intended for analysis that use both online and offline b-tagging to calibrate the combination of these two b-jet identification algorithms.



[2]

The modeling uncertainties on $t\bar{t}$ were computed based on the difference between the nominal MC sample and other samples generated with alternative parton shower and hadronization model, additional initial-state radiation (ISR), final-state radiation (FSR), and alternative parton density function (PDF).



[2]

References

[1] Overview of TDAQ system, *ATLAS public*, ApprovedPlotsDAQ twiki

[2] ATLAS b-jet Trigger Public Results, *ATLAS public*, BJetTriggerPublicResults twiki

[3] ATLAS b-jet identification performance and efficiency measurement with $t\bar{t}$ events in pp collisions at $\sqrt{s} = 13$ TeV, *ATLAS Collaboration*, CERN-EP-2019-132, arXiv:1907.05120 [hep-ex]