**Boosted H → bb Tagger In Run II**

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On behalf of the ATLAS Collaboration @ ICHEP 2016

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**Abstract**

Several searches for Higgs bosons decaying to b-quark pairs benefit from the increased Run II centre-of-mass energy by exploiting the large transverse momentum (boosted) Higgs boson regime, where the two b-jets are merged into one large-radius jet. ATLAS uses a boosted H → bb tagger algorithm [1] to separate the Higgs signal from the background processes.

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**Performance of the Tagger**

- **Anti-k_t R=1.0 (large-R) jets**
  - Pile-up and underlying event contamination removed with trimming, using $f_{cut} = 0.05$ and $R_{cut} = 0.2$ [2]

**Jet Mass**

Calorimeter mass ($m^{calo}$) and track-assisted mass ($m^{TA}$) are studied, while $m^{TA}$ is used to define the benchmarks.

$$m^{TA} = m^{calo} \times \frac{1}{2}$$

**Muon in Jet Correction**

Correction for muonic decays of b hadrons. Find closest muons to any R=0.2 track jet within the large-R jet. Add their momentum to the large-R jet (affects $m^{TA}$ and $p_T(r)$).

**Mass Window Cuts**

- Tight: $76 \text{ GeV} < m^{TA} < 146 \text{ GeV}$ (68% of the mass distr.)
- Loose: $93 \text{ GeV} < m^{TA} < 134 \text{ GeV}$ (90% of the mass distr.)

**Improved mass resolution**

with muon correction and combination of $m^{TA}$ and $m^{TA}$.

**Double b-tagging**

The two leading $p_T$ track jets must both pass the same b-tagging requirement.

Asymmetric b-tagging: Of the two leading $p_T$ track jets, the track jet with the largest b-tagging weight must pass the fixed 60%, 70%, 75%, or 85% b-tagging working point threshold, while the b-tagging requirement of the other jet is varied.

Leading subject simple b-tagging: Only the leading $p_T$ track jet must pass the b-tagging requirement.

**Data/MC Studies with g → bb**

- Cross check the performance of b-tagging and modelling of jet substructure variables
- Use di-jet events, select muons for b-enriched samples
- Correct flavor fractions in MC with impact parameter significance fit for muon and non-muon track jets

**Higgs Tagging**

- Internal structure of a jet is a useful discriminator. To discriminate Higgs jet from the multi-jet and hadronic top decays, $D_{[b]}$ (substructure variable) [4] is used. It is defined as a ratio of the two and three point energy correlation functions.

**Jet Substructure**

- **Boosted** Higgs jet from the multi-jet and hadronic top and b-tagging requires the track jet to pass the centrality and resolution uncertainties, b-tagging requirement.

**Track jet b-tagging**

- Leading two jet must pass the b-tagging requirement.

Figure 1: The calibrated and muon corrected $m^{TA}$ and $m^{TA}$ are shown for different $p_T(r)$ ranges. The effect of the muon correction is shown for $m^{TA}$ and $m^{TA}$.

Figure 2: The rejection of inclusive multi-jets (hadron top) versus Higgs jet efficiency using large-R jets with $p_T(r) > 250 \text{ GeV}$ on the left (right), for various b-tagging requirements. The bars correspond to the 60%, 70%, 75%, and 85% b-tagging working point from left to right.

Figure 3: Higgs jet signal efficiency. Multi-jet background rejection and Hadronic top background rejection as a function of the $p_T(r)$ of large-R jets with one or two associated b-tagged track jets, using the 77% b-tagging WP, and requiring various Higgs jet mass window cuts and a cut on $D_{[b]}$. Statistical and systematic uncertainties are given in shaded bands.

Figure 4: Large-R jet mass distribution before and after b-tagging. The lower panel shows the ratios of the distributions measured in data to their predictions, indicating the uncertainty on the predictions resulting from the template fitting procedure, from the limited simulated sample sizes, jet energy, mass and $D_{[b]}$ scale and resolution uncertainties, b-tagging systematics and their combination.

Figure 5: Double b-tagging rate is plotted for both data and MC, depending on the large-R jet $p_T(r)$ distributions.

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**Different Higgs-tagger configurations have been studied and 5 benchmark taggers are provided for physics analyses. Performance studies with alternative jet mass definitions are presented. Data/MC comparisons shown for the tagger’s performance and good agreement found for the s=13 TeV ATLAS Run 2 Data.**

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**References**

1. ATLAS Collaboration, Enhanced Higgs-W Boson Identification with the ATLAS Detector at √s = 13 TeV. ATLAS-CONF-2016-019.
3. ATLAS Collaboration, Jet mass reconstruction with the ATLAS Detector in every Run 2 Data. ATLAS-CONF-2016-028.