## Features used for classification

['aplanarityA', 'aplanarityP', 'aplanorityA', 'aplanorityP', 'b\_0\_mass', 'b\_1\_mass', 'centrality', 'dShapeA', 'dShapeP', 'diH\_mass', 'eVis', 'hT', 'h\_bb\_mass', 'h\_tt\_mass', 'maxJetEta', 'maxJetMass', 'maxJetPT', 'meanJetEta', 'meanJetMass', 'meanJetPT', 'minJetEta', 'minJetMass', 'minJetPT', 'nBJets', 'nJets', 'nPhotons', 'nTauJets', 'sT', 'sphericityA', 'sphericityP', 'spherocityA', 'spherocityP', 't\_0\_mass', 't\_1\_mass', 'upsilonA', 'upsilonP', 't\_0\_px', 't\_0\_py', 't\_0\_pz', 't\_1\_px', 't\_1\_py', 't\_1\_pz', 'b\_0\_px', 'b\_0\_py', 'b\_0\_pz', 'b\_1\_px', 'b\_1\_py', 'b\_1\_pz', 'h\_tt\_px', 'h\_tt\_py', 'h\_tt\_pz', 'h\_bb\_px', 'h\_bb\_py', 'h\_bb\_pz', 'diH\_px', 'diH\_py', 'diH\_pz', 'mPT\_px', 'mPT\_py', 'b\_0\_|p|', 'b\_0\_E', 'b\_1\_|p|', 'b\_1\_E', 't\_0\_|p|', 't\_0\_E', 't\_1\_|p|', 't\_1\_E', 'diH\_|p|', 'diH\_E', 'h\_bb\_|p|', 'h\_bb\_E', 'h\_tt\_|p|', 'h\_tt\_E', 'hl\_mT']

## Mu Tau\_h b b event selection

### Object requirements

* Primary-muon requirements: pT > 19 GeV, eta < 2.1, isolation < 0.1
* Additional-muon requirements: pT > 10 GeV, eta < 2.4, isolation < 0.3
* Additional-electorn requirements: pT > 10 GeV, eta < 2.5, isolation < 0.3
* Tau-jet requirements: pT > 20 GeV, eta < 2.3, tau-tagged by Delphes tagger
* b-jet requirements: pT > 30 GeV, eta < 2.4, b-tagged by Delphes tagger

### Multiplicity requirements

* Exactly one primary muon
* No additional muons (excluding the one which is primary)
* No additional electrons
* At least one tau-jet with opposite charge to primary muon
* At least two b-jets

### Final-state selection:

* b-pair selected as pair whose invariant mass is closest to 125 GeV
* t\_0 = hardest tau jet
* t\_1 = primary muon
* b\_0 = hardest jet in b-pair
* b\_1 = second-hardest jet in b-pair
* mPT = missing momentum

### Higgs reconstruction:

* h\_bb = b\_0 + b\_1
* h\_tt = t\_0 + t\_1 + mPT
* diH = h\_bb + h\_tt

### MC Truth checks applied to signal:

* Event contains diHiggs -> bbtautau - if failed, skip event (signal sample is a mixture of bbbb, bbtautau, & tautautautau)
* b-quarks for higgs decay within 0.5 of selected b-jets, tau lepton within 0.5 of selected tau-jet, gen particle of selected muon decended from a higgs - if passed, flag event as matched

## Extra features:

* ['maxJetEta', 'maxJetMass', 'maxJetPT', 'meanJetEta', 'meanJetMass', 'meanJetPT', 'minJetEta', 'minJetMass', 'minJetPT', 'nBJets', 'nJets', 'nPhotons', 'nTauJets'] calculated by looping over all jets and photons in accepted event (no cuts applied)
* eVis = sum of energy of all electrons, muons, photons, and jets
* hT = sum of transverse energy of all jets
* sT = hT + sum of pT of all electrons, muons, and photons
* centrality = sum of pT of all electrons, muons, photons, and jets divided by eVis
* Spherocity and sphericity calculated according to page 19 of https://arxiv.org/pdf/1010.3698.pdf for all event objects (e.g. aplanarityA) and selected final-states (e.g. aplanarityP)
* hl\_mT = transverse mass of muon = sqrt(2\*t\_1\_pT\*mPT\_pT\*(1-cos(deltaphi(t\_1\_phi, mPT\_phi))))