

## Deep Double-b mis-tag scale factors

The deep double b-tagger signal efficiency scale factors are derived by the BTV-POG [ref] and used as it is in the analysis performed here. Since the background composition can be very different in individual analysis, the mistag scale factors are derived for this analysis using the procedure used in previous version of analysis using 2016 data [ref:Exo-16-050].

The major backgrounds for the analysis are top,  $W(\text{lnu})+\text{Jets}$  and  $Z(\text{nunu})+\text{Jets}$ . However, out of these the contribution from top is almost 50% of the total background. The main contribution is from semi-leptonic  $t\bar{t}$ bar events when lepton produced in the top decay is either lost in the detector due to detector acceptance or reconstruction algorithm or later in the offline selection. In either case the  $t\bar{t}$ bar semileptonic events will appear as a signal candidate studied here. In the signal mass window (100-150 GeV), the fake rate from the top quark jet (decaying into hadronic W and a b-jet) for the given deep double b tagger working point (medium,  $\text{ddb} > \text{XXXX}$ ) is about **XXXX**%. The remaining contribution comes from the cases when two b-jets are merged into one AK8 jet, or a single hadronic W is faking the Higgs boson candidate.

How to measure this scale factor:

1. set up the top CR as done in analysis,
2. now instead of  $n_{\text{jets}} \leq 2$  apply  $n_{\text{jets}} > 2$ , i.e. invert the number of jets selection
3. compare the data MC, if possible see the fraction of 1/2/3 separated as detailed in table below.
4. now subtract the not top backgrounds from data
5. the ratio of data and mc is treated as scale factor,
6. apply 30% systematics on WJets and Diboson normalisation and propagate it to the scale factor measurement.
7. *This is just prior for the parameter that controls the relative normalisation of  $t\bar{t}$ bar in pass and fail region.*

Some intermediate steps which can be studied to understand the top background better are in the table,

how top becomes background	<div>ttbar has<ul style="list-style-type: none"><li>• two b-jets</li><li>• 1 W boson decaying to hadrons</li><li>• 1 W boson decaying to lepton (when this lepton is lost if becomes main background)</li></ul></div>
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	<p>Now, we have only one boosted jet requirement in the SR, It would be good to understand what is selected as <math>H \rightarrow b\bar{b}</math></p> <ol style="list-style-type: none"> <li>1. two b-jets or</li> <li>2. <math>W \rightarrow \text{hadrons}</math> or</li> <li>3. merging of hadronic W and b jet from top into a AK8 jet?</li> </ol>
measure the fake rate in mass window 100-150 (this is infact point 3 in previous row. )	fake rate of top quark induced fat jets for the given DDB working point