BDT and Results for 1tau1l

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Outline

Updates

- BDT training with seperate tt MC samples
- QCD renormalization and factorization scale uncertainties normalized to 1.

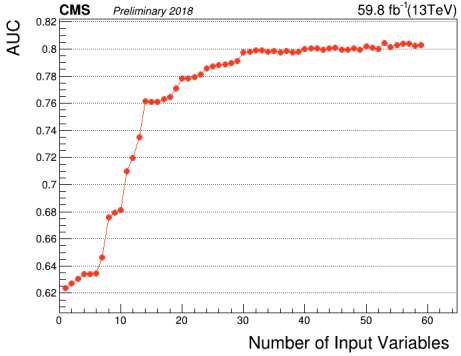
Section 1

2018

BDT in 1tau1l

- Extra tt MC samples with different generator settings for BDT training
  - Only 2018 samples
  - TT extra samples: 39K
- Application with nominal tt MC samples, to ovoid overtraining

Choosing input variables for 1tau1l

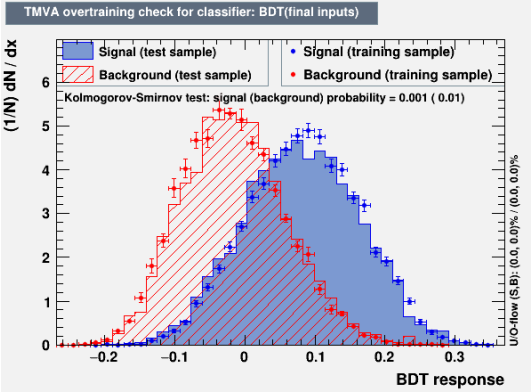


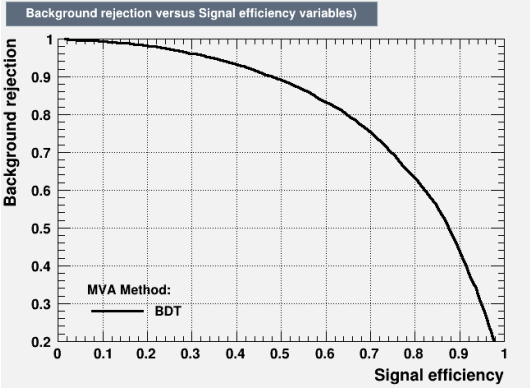
jets_num	n_{jet}
jets_rationHT_4toRest	$HT_{leading\ 4\ jets}/HT_{all\ jets}$
jets_centrality	centrality
jets_7pt	$p_T^{7th\ jet}$
jets_4pt	
jets_MHT	
jets_minDeltaR	
jets_1pt	
jets_tausT_invariantMass	
jets_METDivideHT	
bjetsM_num	
bjetsT_invariantMass	
bjetsT_minDeltaR	
bjetsT_2MET_stransMass	
bjetsT_leptons_minDeltaR	
bjetsM_invariantMass	
bjetsM_minDeltaR	
bjetsM_tausT_minDeltaR	
bjetsM_HT	
tausT_1lepton1_charge	
tausT_leptonsT_invariantMass	
tausT_1pt	
tausT_invariantMass	
muonsTopMVAT_1pt	
tausT_1Met_transMass	
tausT_1lepton1Met1_stransMass	

Table 1: Final 26 inputs for 1tau1l

- 1tau1l SR, with TT extra samples
- AUC with all variables: 0.806
- Input variables picked from only increase of AUC, remove the variables in the plateau: 27

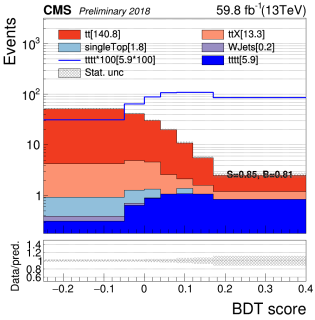
BDT performance with extra tt samples

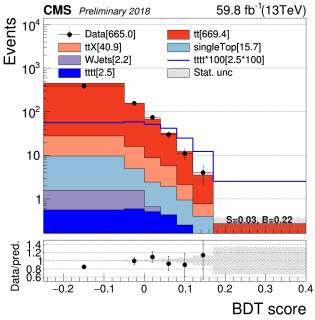


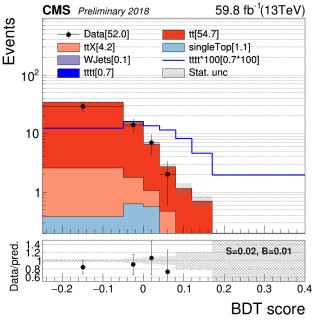


- AUC with 27 input variables: 0.799

BDT in SR and control regions





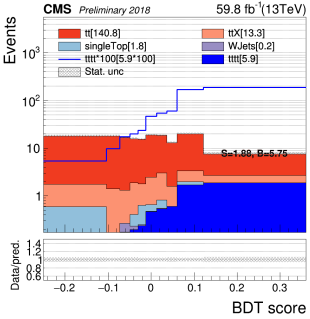


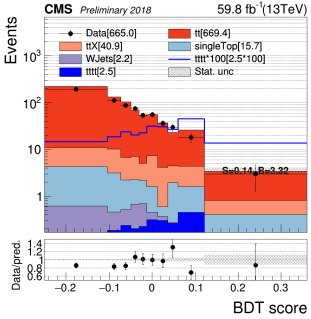
- With nominal tt MC samples
- Add systematic uncertainties

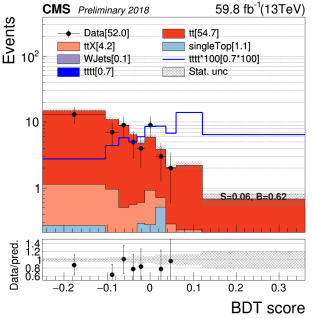
How to optimize binning?

- Dance between statistic uncertainty and significance
- Adaptive binning for background
  - Binning background with roughly the same number of events in each bin except the last one
  - Even background to better contain nuisance parameters
  - Last bin with the highest significance
- Choose the binning with the highest significance

BDT in SR and control regions: BinD

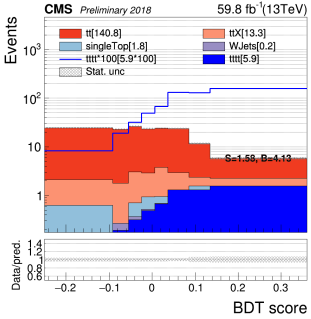


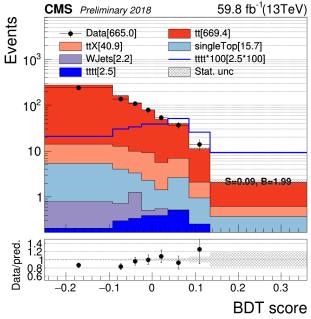


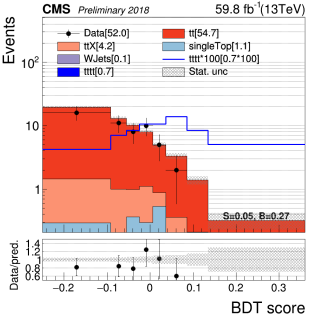


- With nominal tt MC samples
- Add systematic uncertainties

BDT in SR and control regions: BinE







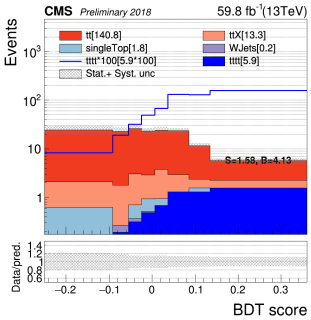
- With nominal tt MC samples
- Add systematic uncertainties

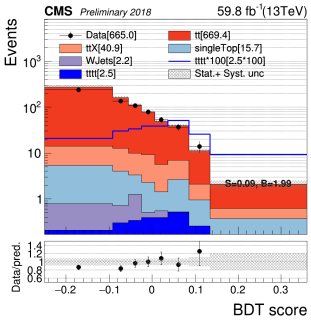
Section 1

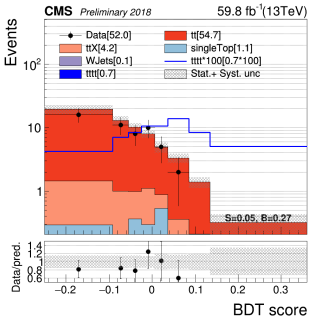
2018

1.1 Old Theory Uncertainties

Results with systematics

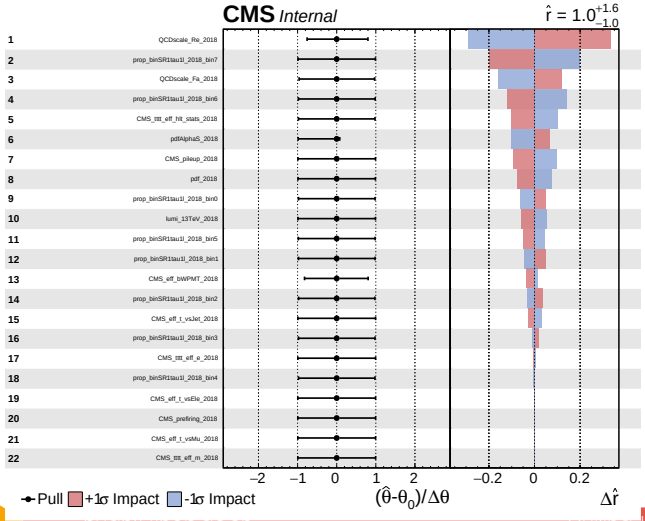






- The results without systematics: sig = 0.87, limit = 2.53
- With all systematics: significance=0.78; limit = 3.10
- Seems problem with QCD renormalization and factorization scale

Impacts



- Seems some problems with QCD renormalization and factorization scale, and pdf

Section 1

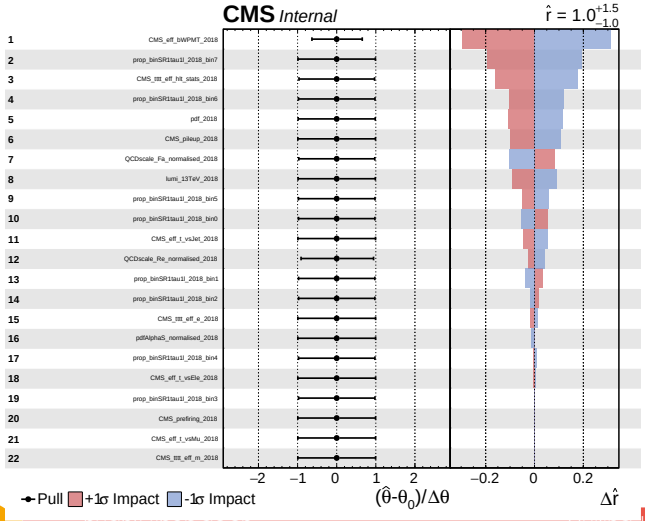
2018

1.2 New Theory Uncertainties

BDT in SR and control regions: BinE; pdf and QCD scale renormalized

- QCD renormalization has around 30% variation on 4tops signal. Number 1 impact parameter
- Re-normalize QCD scale for all the samples:
  $\sum genWeight / \sum genWeight * QCQScale$
- Results considering all systematics(except energy scale): significance=0.795; limit = 2.88

Impacts

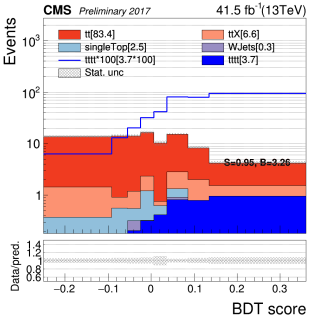


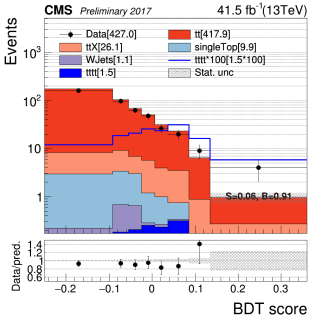
- Does it make sense that btag WP constrained?

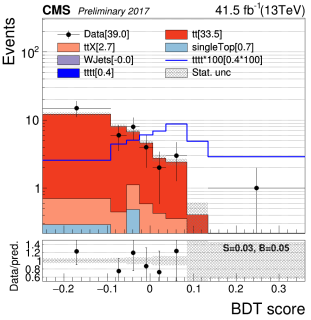
Section 2

2017

BDT in SR and control regions: BinE





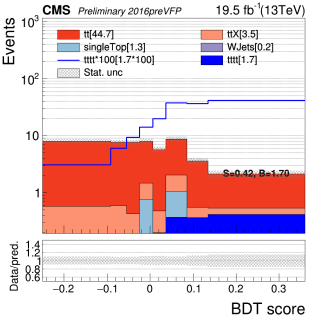


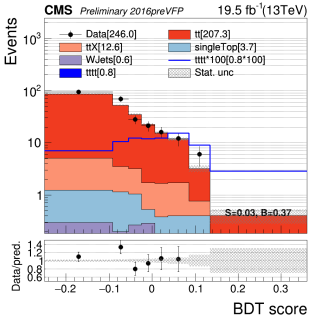
- With nominal tt MC samples
- With 2018 training of extra tt samples
- Might have to rebinning with more bg in each bin, because of the lower lumi in 2016preVFP and 2016postVFP

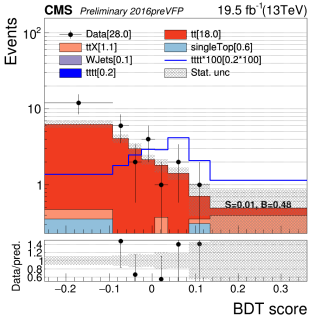
Section 3

2016preVFP

BDT in SR and control regions: BinE





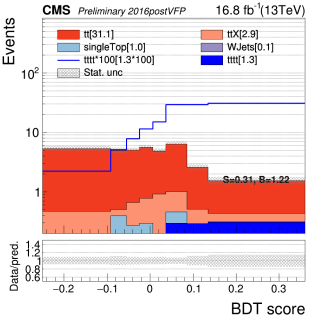


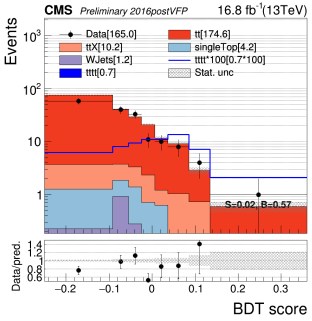
- With nominal tt MC samples
- With 2018 training of extra tt samples
- Might have to rebinning with more bg in each bin, because of the lower lumi in 2016preVFP and 2016postVFP

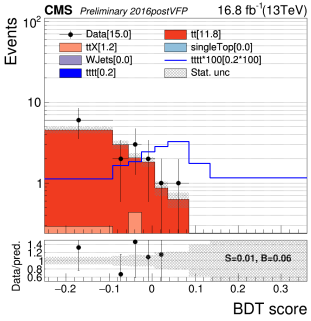
Section 4

2016postVFP

BDT in SR and control regions: BinE





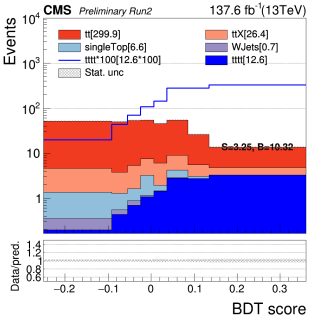


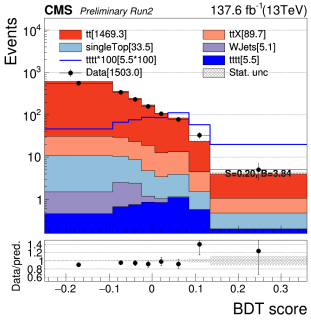
- With nominal tt MC samples
- With 2018 training of extra tt samples
- Might have to rebinning with more bg in each bin, because of the lower lumi in 2016preVFP and 2016postVFP

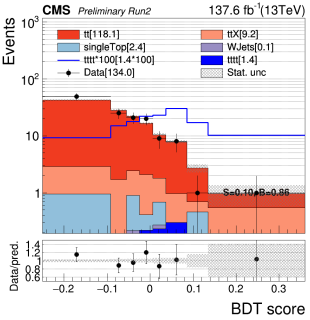
Section 5

Combination

Combination of 3 years







- Add data hists: not using quadratic sum of the statistical uncertainties;
- Add signal and background hists: using quadratic sum of the systematic uncertainties;
- Careful with correlation of the systematics

Section 6

Back up

jets_num jets_rationHT_4toRest jets_centrality jets_7pt jets_4pt jets_MHT jets_minDeltaR jets_1pt jets_tausT_invariantMass jets_METDivideHT	
bjetsM_num bjetsT_invariantMass bjetsT_minDeltaR bjetsT_2MET_stransMass bjetsT_leptons_minDeltaR bjetsM_invariantMass bjetsM_minDeltaR bjetsM_tausT_minDeltaR	