

TMVA Study With Combine Results(V3)

Progress Report on Tau Final States of TTTT

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Group Meeting, 2021

Outline

- 1 1Tau1L
- 2 1Tau2L
- 3 2TauXL
- 4 1Tau0L
- 5 1Tau3L
- 6 2Tau0L
- 7 Subchannel Combination
- 8 Event Yield

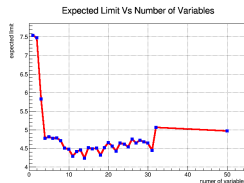
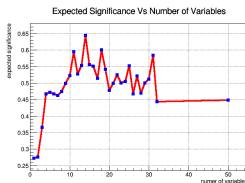
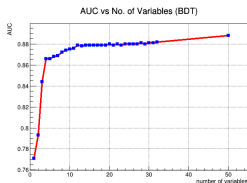
V3 training setup

- Compared to v2 training in 0726, we have added the b tag weight and HLT weight to all MC samples
- The v2 training are in slides with date 20210726
- So the MC corrections we have considered so far are
 - prefiring weight
 - PU weight
 - gen weight
 - B tag efficiency weight
 - HLT efficiency weight

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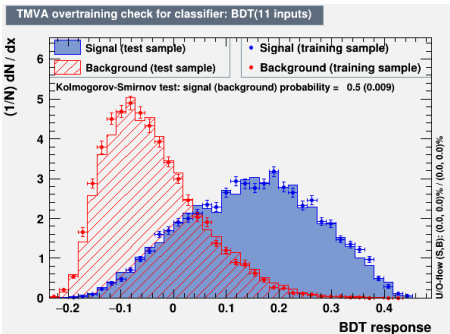
Training performance Vs number of input variables



- We decided to use the 11 variables set as input to BDT training

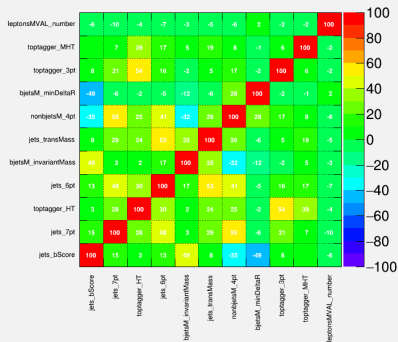
1tau1l		
1: jets_bScore	0.2525	
2: jets_7pt	0.176	
3: toptagger_HT	0.1716	
4: jets_6pt	0.1407	
5: bjetsM_invariantMass	0.1279	
6: jets_transMass	0.104	
7: nonbjetsM_4pt	0.07057	
8: bjetsM_minDeltaR	0.06138	
9: toptagger_3pt	0.05565	
10: toptagger_MHT	0.05139	
11: leptonsMVAL_number	0.04156	

11 input variables set



Correlation Matrix (signal)

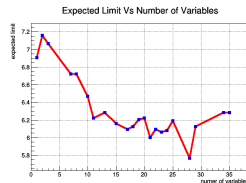
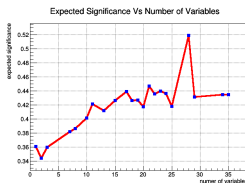
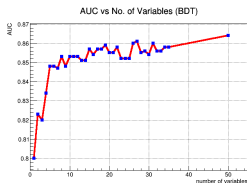
(11 input variables)



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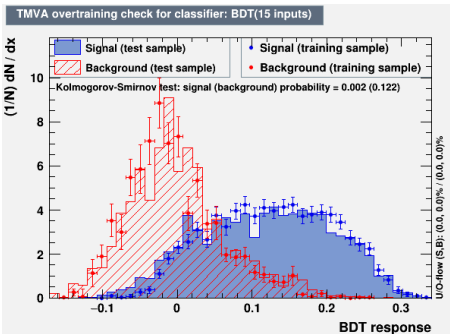
Training performance Vs number of input variables



- We decided to use the 11 variables set as input to BDT training

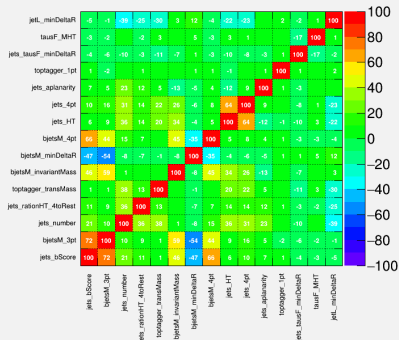
1tau2l		
1: jets_bScore		0.2733
2: bjetsM_3pt		0.2492
3: jets_number		0.1412
4: jets_rationHT_4toRest		0.1379
5: toptagger_transMass		0.135
6: bjetsM_invariantMass		0.1045
7: bjetsM_minDeltaR		0.1026
8: bjetsM_4pt		0.07898
9: jets_HT		0.07386
10: jets_4pt		0.07323
11: jets_aplanarity		0.06977
12: toptagger_1pt		0.06581
13: jets_tausF_minDeltaR		0.05436
14: tausF_MHT		0.05291
15: jetL_minDeltaR		0.04519

15 input variables set



Correlation Matrix (signal)

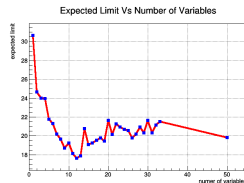
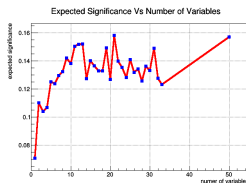
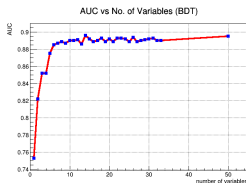
(15 input variables)



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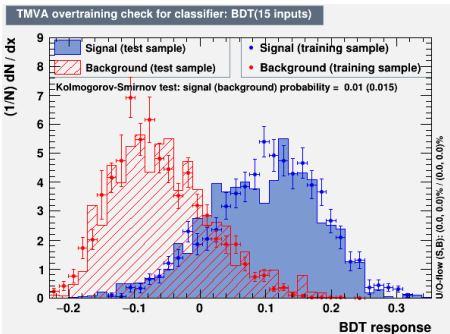
Training performance Vs number of input variables



- We decided to use the 15 variables set as input to BDT training

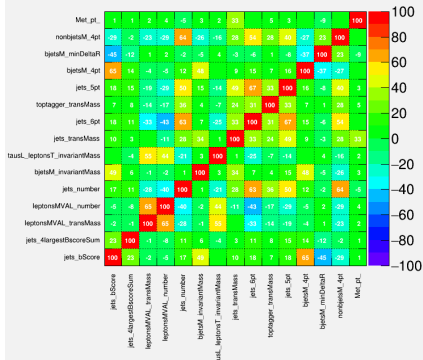
1: jets_bScore	0.2735
2: jets_4largestBscoreSum	0.2068
3: leptonsMVAL_transMass	0.1381
4: leptonsMVAL_number	0.1347
5: jets_number	0.1242
6: bjetsM_invariantMass	0.1228
7: tausL_leptonsT_invariantMass	0.113
8: jets_transMass	0.09937
9: jets_6pt	0.09563
10: toptagger_transMass	0.09544
11: jets_5pt	0.08583
12: bjetsM_4pt	0.08547
13: bjetsM_minDeltaR	0.08434
14: nonbjetsM_4pt	0.08243
15: Met_pt_	0.07096

15 input variables set



Correlation Matrix (signal)

(15 input variables)



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Templates

- Use HT distribution as input to combine
- HT of QCD distribution from Fabio
 - the QCD HT distribution is not scaled to luminosity.
 - scaled QCD_HT to 7679(QCD event yield that Fabio estimated by using the fake rate method)
- HT of other processes from MC

Templates of 1Tau0L

Datacard of 1tau0L

```

1 imax *
2 jmax *
3 kmax *
4 -----
5 shapes ** /publicfs/cms/user/huahuil/Tau0TTTT/2016v1/TMVA0output/v46_v3addBtagHLTweights/1tau0L_v1/11bins/dataDriven_1tau0L_forCombine.root $PROCESS_HT
6 bin SR_1tau0L
7 observation -1
8 -----
9 bin SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L SR_1tau0L
10 process TTTT TT TTX VV VVV singleTop TX QCD
11 process 0 1 2 3 4 5 6 7
12 rate -1 -1 -1 -1 -1 -1 -1 -1
13 -----
14 SR_1tau0L autoMCStats 0

```

- templates in 11 bins
- expected significance is 0.02629
- expected limit is 62.7500

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Combination of subchannels

- 1tau1l(BDT), 1tau0l(HT), 1tau2l(BDT), 1tau3l(HT), 2tau0l(HT), 2tauXl(2tau1l+2tau2l)(BDT)
- summed histograms, 11 bins
- find the datacard
here: /publicfs/cms/user/huahuil/TauOfTTTT/2016v1/TMVAOutput/v46
- expected significance: 1.03887 , expected limit(u) 2.0156

Templates for Combine

Backup

back up

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EventSelection

- MET fillters
- HLT requirements
 - `HLT_PFHT450_SixJet40_BTagCSV_p056==1,`
`HLT_PFHT400_SixJet30_DoubleBTagCSV_p056==1`
 - `HLT_PFJet450`
- loose preselection
 - `tausL.size()>0, jets.size()>2( fixed here), bjetsL.size()>1`
 - `HT>400`
- Subchannel requirements

MC reweighting

- genWeight
- prefireWeight
- PileUp reweighting
- HLT reweighting
- btag reweighting

Definition of Backgrounds

Event Yield

raw entries: **1Tau0L**
 TTTT = 203113.000000
 TT = 44554.000000
 TTX = 57222.000000
 VV = 9.000000
 VVV = 91.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 3649.000000
 TX = 7176.000000
 QCD = 176.000000
 background = 7617.663865

weighted: **1Tau0L**
 TTTT = 1430.764472
 TT = 10926571.689225
 TTX = 65546.970776
 VV = 658.169097
 vvv = 11.503905
 WJets = 0.000000
 DY = 0.000000
 singleTop = 145.723309
 TX = 6423.510485
 QCD = 144.812374
 background = 11974.992070

scaled to LUM: **1Tau0L**
 TTTT = 7.838527
 TT = 5251.683484
 TTX = 201.748706
 VV = 0.127246
 vvv = 0.909206
 WJets = 0.000000
 DY = 0.000000
 singleTop = 94.305009
 TX = 11.016494
 QCD = 6415.201926
 background = 11974.992070

raw entries: **1Tau2L**
 TTTT = 34770.000000
 TT = 667.000000
 TTX = 5368.000000
 VV = 0.000000
 VVV = 6.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 2272.000000
 TX = 781.000000
 QCD = 0.000000
 background = 20.899770

weighted: **1Tau2L**
 TTTT = 237.834467
 TT = 40182.042358
 TTX = 4648.931503
 VV = 0.000000
 vvv = 0.572669
 WJets = 0.000000
 DY = 0.000000
 singleTop = 90.269637
 TX = 634.911994
 QCD = 0.000000
 background = 36.223114

scaled to LUM: **1Tau2L**
 TTTT = 1.302990
 TT = 25.476404
 TTX = 11.675957
 VV = 0.000000
 vvv = 0.083739
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.229755
 TX = 0.758159
 QCD = 0.000000
 background = 36.223114

raw entries: **1Tau3L**
 TTTT = 2171.000000
 TT = 0.000000
 TTX = 317.000000
 VV = 0.000000
 VVV = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 22.000000
 TX = 27.000000
 QCD = 0.000000
 background = 0.670864

weighted: **1Tau3L**
 TTTT = 14.140438
 TT = 0.000000
 TTX = 252.808519
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.917097
 TX = 20.204333
 QCD = 0.000000
 background = 0.653472

scaled to LUM: **1Tau3L**
 TTTT = 0.077469
 TT = 0.000000
 TTX = 0.826472
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.002334
 TX = 0.024666
 QCD = 0.000000
 background = 0.653472

Event Yield

1Tau1Mu

raw entries:
 TTTT = 89724.000000
 TT = 15606.000000
 TTX = 17067.000000
 VV = 6.000000
 VVV = 9.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 2182.000000
 TX = 2671.000000
 QCD = 0.000000
 background = 79.017827

1Tau1Mu

weighted:
 TTTT = 647.159654
 TT = 1688209.876922
 TTX = 17472.582836
 VV = 305.662566
 vvv = 0.552725
 WJets = 0.000000
 DY = 0.000000
 singleTop = 94.305557
 TX = 2273.767231
 QCD = 0.000000
 background = 917.492732

1Tau1Mu

scaled to LUM
 TTTT = 3.545502
 TT = 852.609624
 TTX = 49.028447
 VV = 0.065354
 vvv = 0.071893
 WJets = 0.000000
 DY = 0.000000
 singleTop = 12.665731
 TX = 3.050683
 QCD = 0.000000
 background = 917.492732

1Tau1E

raw entries:
 TTTT = 72315.000000
 TT = 13097.000000
 TTX = 14703.000000
 VV = 2.000000
 VVV = 19.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 2808.000000
 TX = 2223.000000
 QCD = 2.000000
 background = 80.467156

1Tau1E

weighted:
 TTTT = 513.277994
 TT = 1448391.193256
 TTX = 14753.171723
 VV = 325.633749
 vvv = 1.443064
 WJets = 0.000000
 DY = 0.000000
 singleTop = 104.998125
 TX = 1922.406987
 QCD = 1.982286
 background = 792.915969

1Tau1E

scaled to LUM
 TTTT = 2.812024
 TT = 730.386112
 TTX = 40.681656
 VV = 0.025008
 vvv = 0.193717
 WJets = 0.000000
 DY = 0.000000
 singleTop = 16.906290
 TX = 2.572573
 QCD = 2.150613
 background = 792.915969

1Tau1L

raw entries:
 TTTT = 162039.000000
 TT = 28703.000000
 TTX = 31770.000000
 VV = 8.000000
 VVV = 28.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 4990.000000
 TX = 4894.000000
 QCD = 2.000000
 background = 159.484982

1Tau1L

weighted:
 TTTT = 1160.437649
 TT = 3136601.070179
 TTX = 32225.754558
 VV = 711.498316
 vvv = 1.995789
 WJets = 0.000000
 DY = 0.000000
 singleTop = 199.303682
 TX = 4196.174218
 QCD = 1.982286
 background = 1710.408702

1Tau1L

scaled to LUM
 TTTT = 6.357526
 TT = 1582.995737
 TTX = 89.710103
 VV = 0.091362
 vvv = 0.265610
 WJets = 0.000000
 DY = 0.000000
 singleTop = 29.572021
 TX = 5.623256
 QCD = 2.150613
 background = 1710.408702

Event Yield

1Tau2OS
raw entries:
TTTT = 23128.000000
TT = 640.000000
TTX = 4007.000000
VV = 0.000000
VVV = 4.000000
WJets = 0.000000
DY = 0.000000
singleTop = 1362.000000
TX = 533.000000
QCD = 0.000000
background = 16.398838

1Tau2OS
weighted:
TTTT = 156.599596
TT = 37897.226837
TTX = 3362.744573
VV = 0.000000
vvv = 0.466219
WJets = 0.000000
DY = 0.000000
singleTop = 78.949653
TX = 436.919577
QCD = 0.000000
background = 33.525491

1Tau2OS
scaled to LUM:
TTTT = 0.857940
TT = 24.255139
TTX = 8.477954
VV = 0.000000
vvv = 0.068256
WJets = 0.000000
DY = 0.000000
singleTop = 0.200943
TX = 0.523198
QCD = 0.000000
background = 33.525491

1Tau2SS
raw entries:
TTTT = 11642.000000
TT = 27.000000
TTX = 1381.000000
VV = 0.000000
VVV = 2.000000
WJets = 0.000000
DY = 0.000000
singleTop = 310.000000
TX = 248.000000
QCD = 0.000000
background = 4.500932

1Tau2SS
weighted:
TTTT = 61.234870
TT = 2284.815521
TTX = 1266.186930
VV = 0.000000
vvv = 0.106450
WJets = 0.000000
DY = 0.000000
singleTop = 11.319984
TX = 197.982417
QCD = 0.000000
background = 4.697623

1Tau2SS
scaled to LUM:
TTTT = 0.445050
TT = 1.221266
TTX = 3.197103
VV = 0.000000
vvv = 0.015482
WJets = 0.000000
DY = 0.000000
singleTop = 0.028812
TX = 0.234961
QCD = 0.000000
background = 4.697623

1Tau2L
raw entries:
TTTT = 34770.000000
TT = 667.000000
TTX = 5388.000000
VV = 0.000000
VVV = 6.000000
WJets = 0.000000
DY = 0.000000
singleTop = 2272.000000
TX = 781.000000
QCD = 0.000000
background = 20.899770

1Tau2L
weighted:
TTTT = 237.834467
TT = 40182.042358
TTX = 4648.931503
VV = 0.000000
vvv = 0.572669
WJets = 0.000000
DY = 0.000000
singleTop = 90.269637
TX = 634.911994
QCD = 0.000000
background = 38.223114

1Tau2L
scaled to LUM:
TTTT = 1.302990
TT = 25.476404
TTX = 11.675057
VV = 0.000000
vvv = 0.083739
WJets = 0.000000
DY = 0.000000
singleTop = 0.229755
TX = 0.758159
QCD = 0.000000
background = 38.223114

Event Yield

raw entries: 2Tau1E
 TTTT = 2096.000000
 TT = 84.000000
 TTX = 1019.000000
 VV = 0.000000
 VVV = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 264.000000
 TX = 224.000000
 QCD = 0.000000
 background = 3.216961

weighted: 2Tau1E
 TTTT = 14.575899
 TT = 7131.027984
 TTX = 879.771138
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 20.237012
 TX = 176.538770
 QCD = 0.000000
 background = 6.165002

scaled to LUM1
 2Tau1E
 TTTT = 0.079855
 TT = 3.886848
 TTX = 2.010843
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.051507
 TX = 0.215803
 QCD = 0.000000
 background = 6.165002

raw entries: 2Tau1Mu
 TTTT = 2657.000000
 TT = 98.000000
 TTX = 1115.000000
 VV = 0.000000
 VVV = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 261.000000
 TX = 261.000000
 QCD = 0.000000
 background = 3.437374

weighted: 2Tau1Mu
 TTTT = 18.414775
 TT = 9481.765216
 TTX = 974.397172
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 10.958391
 TX = 206.778042
 QCD = 0.000000
 background = 7.426357

scaled to LUM1
 2Tau1Mu
 TTTT = 0.100886
 TT = 4.892178
 TTX = 2.250460
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.027891
 TX = 0.255828
 QCD = 0.000000
 background = 7.426357

raw entries: 2Tau1L
 TTTT = 4753.000000
 TT = 182.000000
 TTX = 2134.000000
 VV = 0.000000
 VVV = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 525.000000
 TX = 485.000000
 QCD = 0.000000
 background = 6.654336

weighted: 2Tau1L
 TTTT = 32.990674
 TT = 16612.793200
 TTX = 1854.168310
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 31.195403
 TX = 383.316812
 QCD = 0.000000
 background = 13.591359

scaled to LUM1
 2Tau1L
 TTTT = 0.180741
 TT = 8.779026
 TTX = 4.261302
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.079399
 TX = 0.471632
 QCD = 0.000000
 background = 13.591359

Event Yield

2Tau2OS

raw entries:
 TTTT = 349.000000
 TT = 2.000000
 TTX = 119.000000
 VV = 0.000000
 VVV = 1.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 4.000000
 TX = 36.000000
 QCD = 0.000000
 background = 0.457729

weighted: 2Tau2OS

TTTT = 1.742122
 TT = 128.041055
 TTX = 89.103619
 VV = 0.000000
 vvv = 0.023104
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.789504
 TX = 27.397718
 QCD = 0.000000
 background = 0.315323

2Tau2OS

scaled to LUM
 TTTT = 0.009544
 TT = 0.082630
 TTX = 0.197712
 VV = 0.000000
 vvv = 0.003314
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.002009
 TX = 0.029659
 QCD = 0.000000
 background = 0.315323

2Tau2SS

raw entries:
 TTTT = 145.000000
 TT = 0.000000
 TTX = 16.000000
 VV = 0.000000
 VVV = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 3.000000
 TX = 5.000000
 QCD = 0.000000
 background = 0.041054

weighted: 2Tau2SS

TTTT = 1.149720
 TT = 0.000000
 TTX = 13.407157
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.109063
 TX = 3.997032
 QCD = 0.000000
 background = 0.027471

2Tau2SS

scaled to LUM
 TTTT = 0.006299
 TT = 0.000000
 TTX = 0.022974
 VV = 0.000000
 vvv = 0.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.000278
 TX = 0.004219
 QCD = 0.000000
 background = 0.027471

2Tau2L

raw entries:
 TTTT = 494.000000
 TT = 2.000000
 TTX = 135.000000
 VV = 0.000000
 VVV = 1.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 7.000000
 TX = 41.000000
 QCD = 0.000000
 background = 0.498783

weighted: 2Tau2L

TTTT = 2.891843
 TT = 128.041055
 TTX = 102.510776
 VV = 0.000000
 vvv = 0.023104
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.898568
 TX = 31.394750
 QCD = 0.000000
 background = 0.342794

2Tau2L

scaled to LUM
 TTTT = 0.015843
 TT = 0.082630
 TTX = 0.220685
 VV = 0.000000
 vvv = 0.003314
 WJets = 0.000000
 DY = 0.000000
 singleTop = 0.002287
 TX = 0.033878
 QCD = 0.000000
 background = 0.342794

raw entries: 1Tau0L
 TTTT = 203113.000000
 TT = 44554.000000
 TTX = 57222.000000
 VV = 9.000000
 VVV = 91.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 3649.000000
 TX = 7176.000000
 QCD = 176.000000
 background = 7617.663865

weighted: 1Tau0L
 TTTT = 1430.764472
 TT = 10926571.689225
 TTX = 65546.970776
 VV = 658.169097
 vvv = 11.503905
 WJets = 0.000000
 DY = 0.000000
 singleTop = 145.723309
 TX = 6423.510485
 QCD = 144.812374
 background = 11974.992070

scaled to LUMI:
 TTTT = 7.838527
 TT = 5251.683484
 TTX = 201.748706
 VV = 0.127246
 vvv = 0.909206
 WJets = 0.000000
 DY = 0.000000
 singleTop = 94.305009
 TX = 11.016494
 QCD = 6415.201926
 background = 11974.992070

raw entries: 2Tau0L
 TTTT = 10326.000000
 TT = 2280.000000
 TTX = 6499.000000
 VV = 1.000000
 VVV = 3.000000
 WJets = 0.000000
 DY = 0.000000
 singleTop = 2359.000000
 TX = 1402.000000
 QCD = 0.000000
 background = 31.983311

weighted: 2Tau0L
 TTTT = 77.248934
 TT = 336188.897693
 TTX = 5995.065693
 VV = 1.044382
 vvv = 0.336248
 WJets = 0.000000
 DY = 0.000000
 singleTop = 114.408151
 TX = 1197.673991
 QCD = 0.000000
 background = 188.250681

scaled to LUMI:
 TTTT = 0.423213
 TT = 165.386551
 TTX = 14.826004
 VV = 0.038168
 vvv = 0.048388
 WJets = 0.000000
 DY = 0.000000
 singleTop = 5.968664
 TX = 1.982906
 QCD = 0.000000
 background = 188.250681