

Progress Report on Tau Final States of TTTT

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Outline

- 1 Introduction
- 2 Modification and Correlations
- 3 Event Yield
- 4 Step by Step Event Yield
- 5 Questions and Next Step

Introduction

- Fabio and I have been checking code to account for discrepancy in event yield
- My dealing with gen weights when normalizing to cross section was not correct(Fabio pointed this out)
- Also during the checking of the code I found that ISO requirements of leptons could result in a significant drop of events

Normalization and Weighting

- Global weights for each MC process
 - $\frac{L*\sigma}{\sum genWeight}$
- Event by event weight
 - only gen weights for now

Object Definition

- Electron:loose fakeble tight (SS of TTTT)
 - identification
 - MVANolso94XV2 recommended by SUSY lepton(SS used Spring16_GeneralPurpose_V1 instead)
 - ▶ definiton in the backup
 - tight, VLoose, VLooseFO
 - $\eta < |2.5|$
 - isolation
 - $l_{mini} < l_1 \wedge (p_T^{ratio} > l_2 \vee p_T^{rel} > l_3)$ (same as SS of TTTT)
 - loose, tight WP(tight WP kill most electrons. not used) (we removed ISO requirement for electrons, because even loose ISO result in a significant drop of tight electrons) ▶ check out backup
 - impact parameter
 - HLT emulation(need to understand this, not implemented yet)
 - charge(not implemented yet)
 - missing inner hits;conversion veto;tight charge not available on ntuple

electron	loose	fakeble	tight
ID	Loose	VLoose	Tight
Iso	loose	loose	loose(tight in SS)
HLT emulation	not implemented	not implemented	not implemented
d_0 (cm)	0.05	0.05	0.05
d_z (cm)	0.1	0.1	0.1
SIP_3D	-	<4	<4

Electron Iso Problem

Figure: with loose ISO

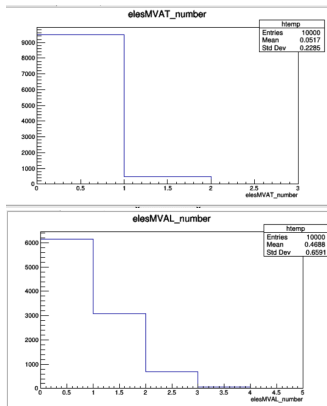
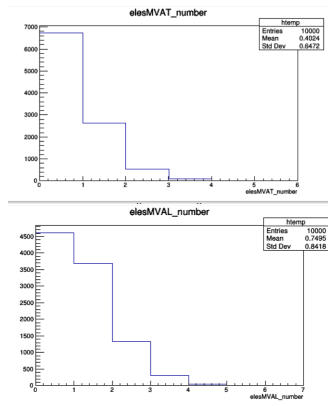


Figure: without loose ISO



- We need a better understanding of this ISO for leptons
- For now we just remove ISO for leptons

Object Definition

- Muon: loose, fakeable, tight (SS of TTTT)
 - ID
 - muon POG Loose ID; muon Medium Id (use POG medium Id instead)
 - $|\eta| < 2.4$
 - ISO: loose and medium WP (removed the Iso requirement for muon too)
 - IP (not implemented, code reason)
 - is d0 dz?
 - quality of the charge reconstruction (not implemented)

muon	loose	fakeable	tight
ID	loose	medium	medium
Iso	loose	loose	tight
HLT emulation	not implemented	not implemented	not implemented
d_z (cm)	0.1	0.1	0.1

Table: electron definition. blue text means different from SS

Event Yield

```

Plotting jetsL_number1Tau0L.
TTTT = 3.29847
TT   = 2968.69
TTX  = 96.6995
VV   = 0.148063
VVV  = 0.644796
WJets = 0
DY   = 0
ST   = 64.7472
H    = 2.37086
Total BKG = 3133.3

Statistics
TTTT = 168.425
TT   = 8518
TTX  = 39248.2
VV   = 1158.64
VVV  = 6.95545
WJets = 0
DY   = 0
ST   = 4061.95
H    = 613.951

```

```

Plotting jetsL_number1Tau1E.
TTTT = 4.18924
TT   = 6972.13
TTX  = 158.55
VV   = 0.242432
VVV  = 1.08814
WJets = 122.367
DY   = 4.06546
ST   = 187.698
H    = 5.89751
Total BKG = 7452.04

Statistics
TTTT = 213.909
TT   = 20005
TTX  = 63721.2
VV   = 1547.86
VVV  = 9.55483
WJets = 7486.84
DY   = 0.00195151
ST   = 8046.64
H    = 596.171

```

- Still unneglectable difference with ZhangYu's result
- Signal efficiency quiet low in some subchannels
- We might need to loosen subchannel definition

Event Yield

```
Plotting jetsL_number1Tau1Mu.
```

```
TTTT = 6.45513
TT    = 3352.75
TTX   = 126.334
VV    = 0.277917
VVV   = 0.54749
WJets = 0
DY    = 8.13092
ST    = 91.8759
H     = 3.83106
Total BKG = 3583.75
```

```
Statistics
```

```
TTTT = 329.609
TT    = 9620
TTX   = 57138.3
VV    = 1547.86
VVV   = 5.25672
WJets = 0
DY    = 0.00390302
ST    = 8847.01
H     = 495.218
```

```
Plotting jetsL_number1Tau20S.p
```

```
TTTT = 2.52274
TT    = 3333.93
TTX   = 84.4943
VV    = 0.225632
VVV   = 0.221089
WJets = 61.1835
DY    = -4.06546
ST    = 96.935
H     = 11.7043
Total BKG = 3584.63
```

```
Statistics
```

```
TTTT = 128.815
TT    = 9566
TTX   = 36704.9
VV    = 1543.86
VVV   = 1.70661
WJets = 3743.42
DY    = -0.00195151
ST    = 6961.23
H     = 2888.45
```

Event Yield

```
Plotting jetsL_number1Tau2SS.
```

```
TTTT = 2.1919
TT    = 2971.82
TTX   = 64.0112
VV    = 0.394047
VVV   = 0.256958
WJets = 0
DY    = 0
ST    = 117.853
H     = 7.59345
Total BKG = 3161.93
```

```
Statistics
```

```
TTTT = 111.922
TT    = 8527
TTX   = 28808.8
VV    = 2702.5
VVV   = 0.99723
WJets = 0
DY    = 0
ST    = 5797.31
H     = 1328.78
```

```
Plotting jetsL_number2Tau0L.
```

```
TTTT = 0.217993
TT    = 401.494
TTX   = 21.6014
VV    = 0.152053
VVV   = 0.161976
WJets = 0
DY    = 0
ST    = 20.4208
H     = 1.33924
Total BKG = 445.17
```

```
Statistics
```

```
TTTT = 11.131
TT    = 1152
TTX   = 9886.43
VV    = 1540.86
VVV   = 1.74108
WJets = 0
DY    = 0
ST    = 2835.96
H     = 5.73401
```

Event Yield

```
Plotting jetsL_number2Tau1E.
```

```
TTTT = 0.149603
TT    = 320.986
TTX   = 8.07732
VV    = 0.102579
VVV   = 0.0743136
WJets = 0
DY    = 4.06546
ST    = 26.2475
H     = 3.40447
Total BKG = 362.958
```

```
Statistics
```

```
TTTT = 7.63894
TT    = 921
TTX   = 4369.24
VV    = 1538.86
VVV   = 0.707951
WJets = 0
DY    = 0.00195151
ST    = 1570.6
H     = 120.654
```

```
Plotting jetsL_number2Tau1Mu.p
```

```
TTTT = 0.36674
TT    = 2348.67
TTX   = 49.9073
VV    = 0.873818
VVV   = 0.649402
WJets = 0
DY    = 8.13092
ST    = 131.282
H     = 21.411
Total BKG = 2560.93
```

```
Statistics
```

```
TTTT = 18.7263
TT    = 6739
TTX   = 22970.4
VV    = 10780
VVV   = 5.78125
WJets = 0
DY    = 0.00390302
ST    = 10145.2
H     = 519.048
```

Event Yield

```
Plotting jetsL_number2Tau20S.  
TTTT = 0.0688172  
TT = 26.1389  
TTX = 2.28731  
VV = 0  
VVV = 0.00931301  
WJets = 0  
DY = 0  
ST = 3.71031  
H = 0.312595  
Total BKG = 32.4585  
  
Statistics  
TTTT = 3.51391  
TT = 75  
TTX = 1180.62  
VV = 0  
VVV = 0.259203  
WJets = 0  
DY = 0  
ST = 254.441  
H = 4.92912
```

```
Plotting jetsL_number2Tau25S.  
TTTT = 0.0487277  
TT = 21.2597  
TTX = 1.39614  
VV = 0  
VVV = 0.0231754  
WJets = 0  
DY = 0  
ST = 3.70935  
H = 0.123497  
Total BKG = 26.5118  
  
Statistics  
TTTT = 2.48811  
TT = 61  
TTX = 812  
VV = 0  
VVV = 0.159802  
WJets = 0  
DY = 0  
ST = 249.604  
H = 3.12639
```

Subchannel Categorization

channel	subchannel	lepton	tau	Ljet	M b jet	BR	theoretical yield
1Tau 0L	1Tau 0L	0 tight electrons or muons	1 tight tau	≥ 8	≥ 2	0.0856	36.808
1Tau 1L	1Tau 1E	exact 1 tight electron	1 tight tau	≥ 6	≥ 2	0.0428	18.404
	1Tau 1Mu	1 tight muon	1 tight tau	≥ 6	≥ 2	0.0428	18.404
1Tau ≥ 2 L	1Tau 2OSL	2 tight leptons of the opposite charge	1 tight tau	≥ 4	≥ 2	0.00357	1.535
	1Tau 2SSL	2 tight leptons of the same charge	1 tight tau	≥ 4	≥ 2	0.00357	1.535
	1Tau 3L	3 tight leptons	1 tight tau	≥ 2	≥ 2	0.00186	0.807
2Tau+anything	2Tau 0L	0 tight electrons or muons	2 tight tau	≥ 6	≥ 2	0.0139	5.977
	2Tau 1L	exact 1 tight electron or 1 tight muon	2 tight tau	≥ 4	≥ 2	0.00464	1.995
	2Tau 2OSL	2 tight leptons of the opposite charge	2 tight tau	≥ 2	≥ 2	0.000193	0.08299
	2Tau 2SSL	2 tight leptons of the same charge	2 tight tau	≥ 2	≥ 2		

Table: Subchannel definition

- step 0: MET filters and ≥ 1 loose tau, ≥ 3 loose jet, 1 loose b jet
- step 1: tau requirement
- step 2: lepton requirement
- step 3: jet requirement
- step 4: b jet requirement

1Tau0L

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

Plotting jetsL_number1Tau0L. TTTT = 88.9628 TT = 1.28443e+06 TTX = 14388.9 VV = 436.56 VVV = 463.694 WJets = 156140 DY = 4557.4 ST = 67294 H = 7141.42 Total BKG = 1.53486e+06 significance = 0.0718063	Plotting jetsL_number1Tau0L. TTTT = 27.912 TT = 313975 TTX = 3938.07 VV = 118.605 VVV = 143.986 WJets = 62407.2 DY = 752.11 ST = 16945.1 H = 1913.05 Total BKG = 400193 significance = 0.0441206	Plotting jetsL_number1Tau0L. TTTT = 7.93783 TT = 216433 TTX = 2329.06 VV = 92.1422 VVV = 107.932 WJets = 51516.5 DY = 451.266 ST = 12575.2 H = 1380.58 Total BKG = 284886 significance = 0.0148717	Plotting jetsL_number1Tau0L. TTTT = 3.76439 TT = 4790.75 TTX = 156.906 VV = 0.763451 VVV = 3.16152 WJets = 122.367 DY = -4.06546 ST = 142.259 H = 11.8266 Total BKG = 5223.96 significance = 0.0520641	Plotting jetsL_number1Tau0L. TTTT = 3.29847 TT = 2968.69 TTX = 96.6995 VV = 0.148063 VVV = 0.644796 WJets = 0 DY = 0 ST = 64.7472 H = 2.37086 Total BKG = 3133.3 significance = 0.0588957
--	---	---	---	--

- in step 2 lepton requirement kill too much signal, might need to loosen this lepton requirement(we loosen tight lepton in modification, which result in decrease of signal events in this channel)
- step4 b jet requirement we loose very little signal events, as Fabio suggests we could try to tighten b jet requirement in all subchannel

1Tau1E

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```

Plotting jetsL_number1Tau1E.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063

```

```

Plotting jetsL_number1Tau1E.
TTTT = 27.912
TT = 313975
TTX = 3938.07
VV = 118.605
VVV = 143.986
WJets = 62407.2
DY = 752.11
ST = 16945.1
H = 1913.05
Total BKG = 400193
significance = 0.0441206

```

```

Plotting jetsL_number1Tau1E
TTTT = 6.78073
TT = 50782.4
TTX = 682.175
VV = 15.0125
VVV = 20.0254
WJets = 7464.39
DY = 85.3746
ST = 2433.1
H = 263.725
Total BKG = 61746.2
significance = 0.0272865

```

```

Plotting jetsL_number1Tau1E
TTTT = 5.24155
TT = 12424.7
TTX = 279.231
VV = 2.16062
VVV = 6.1752
WJets = 978.936
DY = 16.2618
ST = 393.523
H = 23.5408
Total BKG = 14124.5
significance = 0.0440953

```

```

Plotting jetsL_number1Tau1E.
TTTT = 4.18924
TT = 6972.13
TTX = 158.55
VV = 0.242432
VVV = 1.08814
WJets = 122.367
DY = 4.06546
ST = 187.698
H = 5.89751
Total BKG = 7452.04
significance = 0.048515

```

- step 3 is where we loose most signal events
- we can add truth signal event number as a indicator

1Tau1Mu

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number1Tau1Mu
TTTT = 88.9628
TT   = 1.28443e+06
TTX  = 14388.9
VV   = 436.56
VVV  = 463.694
WJets = 156140
DY   = 4557.4
ST   = 67294
H    = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number1Tau1Mu.
TTTT = 27.912
TT   = 313975
TTX  = 3938.07
VV   = 118.605
VVV  = 143.986
WJets = 62407.2
DY   = 752.11
ST   = 16945.1
H    = 1913.05
Total BKG = 400193
significance = 0.0441206
```

```
Plotting jetsL_number1Tau1Mu
TTTT = 10.8142
TT   = 45884.6
TTX  = 880.846
VV   = 10.8808
VVV  = 15.1708
WJets = 3365.09
DY   = 223.6
ST   = 1926.99
H    = 243.971
Total BKG = 52551.2
significance = 0.0471693
```

```
Plotting jetsL_number1Tau1Mu.
TTTT = 8.12226
TT   = 8019.08
TTX  = 252.466
VV   = 1.3882
VVV  = 3.6024
WJets = 550.652
DY   = 40.6546
ST   = 227.695
H    = 23.4504
Total BKG = 9118.99
significance = 0.0850179
```

```
Plotting jetsL_number1Tau1Mu.
TTTT = 6.45513
TT   = 3352.75
TTX  = 126.334
VV   = 0.277917
VVV  = 0.54749
WJets = 0
DY   = 8.13092
ST   = 91.8759
H    = 3.83106
Total BKG = 3583.75
significance = 0.107732
```



1Tau2OS

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number1Tau20S.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number1Tau20S.
TTTT = 27.912
TT = 313975
TTX = 3938.07
VV = 118.605
VVV = 143.986
WJets = 62407.2
DY = 752.11
ST = 16945.1
H = 1913.05
Total BKG = 400193
significance = 0.0441206
```

```
Plotting jetsL_number1Tau20S.
TTTT = 3.43018
TT = 8123.98
TTX = 183.054
VV = 1.87651
VVV = 3.181
WJets = 673.019
DY = 28.4582
ST = 298.785
H = 54.9846
Total BKG = 9367.34
significance = 0.0354347
```

```
Plotting jetsL_number1Tau20S.
TTTT = 3.43018
TT = 8123.98
TTX = 183.054
VV = 1.87651
VVV = 3.181
WJets = 673.019
DY = 28.4582
ST = 298.785
H = 54.9846
Total BKG = 9367.34
significance = 0.0354347
```

```
Plotting jetsL_number1Tau20S.
TTTT = 2.52274
TT = 3333.93
TTX = 84.4943
VV = 0.225632
VVV = 0.221089
WJets = 61.1835
DY = -4.06546
ST = 96.935
H = 11.7043
Total BKG = 3584.63
significance = 0.0421209
```



1Tau2SS

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number1Tau2SS
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number1Tau2SS.
TTTT = 27.912
TT = 313975
TTX = 3938.07
VV = 118.605
VVV = 143.986
WJets = 62407.2
DY = 752.11
ST = 16945.1
H = 1913.05
Total BKG = 400193
significance = 0.0441206
```

```
Plotting jetsL_number1Tau2SS.
TTTT = 3.01045
TT = 6996.87
TTX = 138.905
VV = 1.60508
VVV = 2.35863
WJets = 244.734
DY = 4.06546
ST = 325.613
H = 33.7581
Total BKG = 7747.91
```

```
Plotting jetsL_number1Tau2SS.
TTTT = 3.01045
TT = 6996.87
TTX = 138.905
VV = 1.60508
VVV = 2.35863
WJets = 244.734
DY = 4.06546
ST = 325.613
H = 33.7581
Total BKG = 7747.91
significance = 0.0341944
```

```
Plotting jetsL_number1Tau2SS.
TTTT = 2.1919
TT = 2971.82
TTX = 64.0112
VV = 0.394047
VVV = 0.256958
WJets = 0
DY = 0
ST = 117.853
H = 7.59345
Total BKG = 3161.93
significance = 0.0389668
```



1Tau3L

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number1Tau3L.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number1Tau3L.
TTTT = 27.912
TT = 313975
TTX = 3938.07
VV = 118.605
VVV = 143.986
WJets = 62407.2
DY = 752.11
ST = 16945.1
H = 1913.05
Total BKG = 400193
significance = 0.0441206
```

```
Plotting jetsL_number1Tau3L.
TTTT = 2.28466
TT = 2026.64
TTX = 54.0628
VV = 0.407948
VVV = 0.596161
WJets = 122.367
DY = 36.5891
ST = 67.1259
H = 11.8583
Total BKG = 2319.65
significance = 0.0474129
```

```
Plotting jetsL_number1Tau3L.
TTTT = 2.28466
TT = 2026.64
TTX = 54.0628
VV = 0.407948
VVV = 0.596161
WJets = 122.367
DY = 36.5891
ST = 67.1259
H = 11.8583
Total BKG = 2319.65
significance = 0.0474129
```

```
Plotting jetsL_number1Tau3L.
TTTT = 1.59733
TT = 715.51
TTX = 23.2565
VV = 0.00949312
VVV = 0.12889
WJets = 61.1835
DY = 4.06546
ST = 18.8468
H = 2.98215
Total BKG = 825.983
significance = 0.0555252
```



2Tau0L

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

Plotting jetsL_number2Tau0L	Plotting jetsL_number2Tau0L	Plotting jetsL_number2Tau0L	Plotting jetsL_number2Tau0L	Plotting jetsL_number2Tau0L
TTTT = 88.9628	TTTT = 0.878379	TTTT = 0.325707	TTTT = 0.259026	TTTT = 0.217993
TT = 1.28443e+06	TT = 4636.7	TT = 3590.1	TT = 692.508	TT = 401.494
TTX = 14388.9	TTX = 127.241	TTX = 78.5983	TTX = 35.613	TTX = 21.6014
VV = 436.56	VV = 9.42925	VV = 8.03013	VV = 0.998239	VV = 0.152053
VVV = 463.694	VVV = 5.4585	VVV = 4.42008	VVV = 1.25656	VVV = 0.161976
WJets = 156140	WJets = 856.569	WJets = 795.386	WJets = 183.551	WJets = 0
DY = 4557.4	DY = 32.5237	DY = 28.4582	DY = 0	DY = 0
ST = 67294	ST = 327.427	ST = 241.568	ST = 37.5381	ST = 20.4208
H = 7141.42	H = 165.731	H = 139.553	H = 14.3747	H = 1.33924
Total BKG = 1.53486e+06	Total BKG = 6161.08	Total BKG = 4886.11	Total BKG = 965.839	Total BKG = 445.17
significance = 0.0718063	significance = 0.0111898	significance = 0.0046594	significance = 0.00833362	significance = 0.0103293



2Tau1E

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```

Plotting jetsL_number2Tau1E.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063

```

```

Plotting jetsL_number2Tau1E.
TTTT = 0.878379
TT = 4636.7
TTX = 127.241
VV = 9.42925
VVV = 5.4585
WJets = 856.569
DY = 32.5237
ST = 327.427
H = 165.731
Total BKG = 6161.08
significance = 0.0111898

```

```

Plotting jetsL_number2Tau1E.
TTTT = 0.191064
TT = 617.925
TTX = 19.4292
VV = 1.00083
VVV = 0.788555
WJets = 61.1835
DY = 4.06546
ST = 59.2691
H = 15.2175
Total BKG = 778.879
significance = 0.00684527

```

```

Plotting jetsL_number2Tau1E.
TTTT = 0.191064
TT = 617.925
TTX = 19.4292
VV = 1.00083
VVV = 0.788555
WJets = 61.1835
DY = 4.06546
ST = 59.2691
H = 15.2175
Total BKG = 778.879
significance = 0.00684527

```

```

Plotting jetsL_number2Tau1E.
TTTT = 0.149603
TT = 320.986
TTX = 8.07732
VV = 0.102579
VVV = 0.0743136
WJets = 0
DY = 4.06546
ST = 26.2475
H = 3.40447
Total BKG = 362.958
significance = 0.00785094
Finished jetsL_number2Tau1E.

```



2Tau1Mu

Figure: step 0 Figure: step1 Figure: step2 Figure: step3 Figure: step4

```
Plotting jetsL_number2Tau1Mu.
TTTT = 88.9628
TT   = 1.28443e+06
TTX  = 14388.9
VV   = 436.56
VVV  = 463.694
WJets = 156140
DY   = 4557.4
ST   = 67294
H    = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number2Tau1Mu.
TTTT = 0.878379
TT   = 4636.7
TTX  = 127.241
VV   = 9.42925
VVV  = 5.4585
WJets = 856.569
DY   = 32.5237
ST   = 327.427
H    = 165.731
Total BKG = 6161.08
significance = 0.0111898
```

```
Plotting jetsL_number2Tau1Mu.
TTTT = 0.437695
TT   = 4260.7
TTX  = 95.0162
VV   = 9.0344
VVV  = 5.1337
WJets = 856.569
DY   = 32.5237
ST   = 299.815
H    = 153.509
Total BKG = 5652.3
significance = 0.00582159
```

```
Plotting jetsL_number2Tau1Mu.
TTTT = 0.437695
TT   = 4260.7
TTX  = 95.0162
VV   = 9.0344
VVV  = 5.1337
WJets = 856.569
DY   = 32.5237
ST   = 299.815
H    = 153.509
Total BKG = 5652.3
significance = 0.00582159
```

```
Plotting jetsL_number2Tau1Mu.
TTTT = 0.36674
TT   = 2348.67
TTX  = 49.9073
VV   = 0.873818
VVV  = 0.649402
WJets = 0
DY   = 8.13092
ST   = 131.282
H    = 21.411
Total BKG = 2560.93
significance = 0.00724652
```



2Tau2OS

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number2Tau205.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number2Tau205.
TTTT = 0.878379
TT = 4636.7
TTX = 127.241
VV = 9.42925
VVV = 5.4585
WJets = 856.569
DY = 32.5237
ST = 327.427
H = 165.731
Total BKG = 6161.08
significance = 0.0111898
```

```
Plotting jetsL_number2Tau205.
TTTT = 0.0957457
TT = 77.0227
TTX = 4.86067
VV = 0.0448414
VVV = 0.0497514
WJets = 0
DY = 0
ST = 5.95331
H = 3.7747
Total BKG = 91.706
significance = 0.00999295
```

```
Plotting jetsL_number2Tau205.
TTTT = 0.0957457
TT = 77.0227
TTX = 4.86067
VV = 0.0448414
VVV = 0.0497514
WJets = 0
DY = 0
ST = 5.95331
H = 3.7747
Total BKG = 91.706
significance = 0.00999295
```

```
Plotting jetsL_number2Tau205.
TTTT = 0.0688172
TT = 26.1389
TTX = 2.28731
VV = 0
VVV = 0.00931301
WJets = 0
DY = 0
ST = 3.71031
H = 0.312595
Total BKG = 32.4585
significance = 0.0120663
Finished jetsL_number2Tau205.
```



2Tau2SS

Figure: step 0

Figure: step1

Figure: step2

Figure: step3

Figure: step4

```
Plotting jetsL_number2Tau2SS.
TTTT = 88.9628
TT = 1.28443e+06
TTX = 14388.9
VV = 436.56
VVV = 463.694
WJets = 156140
DY = 4557.4
ST = 67294
H = 7141.42
Total BKG = 1.53486e+06
significance = 0.0718063
```

```
Plotting jetsL_number2Tau2SS.
TTTT = 0.878379
TT = 4636.7
TTX = 127.241
VV = 9.42925
VVV = 5.4585
WJets = 856.569
DY = 32.5237
ST = 327.427
H = 165.731
Total BKG = 6161.08
significance = 0.0111898
```

```
Plotting jetsL_number2Tau2SS.
TTTT = 0.0782208
TT = 60.9909
TTX = 4.16644
VV = 0
VVV = 0.0883804
WJets = 0
DY = 0
ST = 5.43236
H = 1.03211
Total BKG = 71.7102
significance = 0.00923199
```

```
Plotting jetsL_number2Tau2SS.
TTTT = 0.0782208
TT = 60.9909
TTX = 4.16644
VV = 0
VVV = 0.0883804
WJets = 0
DY = 0
ST = 5.43236
H = 1.03211
Total BKG = 71.7102
significance = 0.00923199
```

```
Plotting jetsL_number2Tau2SS.
TTTT = 0.0487277
TT = 21.2597
TTX = 1.39614
VV = 0
VVV = 0.0231754
WJets = 0
DY = 0
ST = 3.78935
H = 0.123497
Total BKG = 26.5118
significance = 0.00945491
```



Next Step

- Refine subchannel categorization
- BSM code checking to make sure on cut in this step
- Submit lepton dataset(JetHT done); also we have some extension samples available in DAS, might submit these too if necessary
- Rerun BDT with our correlation
- Finish HLT study
 - add lepton pt cut for subchannel selection, different channels should have different cut stradgy
- Any suggestion for how Fabio and I should share the work

Electron ID

SUSY electron MVA recommendation

Figure: Cuts/Equations for MVA Ids (94X MVA)

Cuts/Equations for MVA (2016 - MVANoIso94XV2)

6

Different from
2017/2018

Tight

Region	MVA value, $10 < ePt < 40$	MVA value $ePt \geq 40$
$ \eta < 0.8$	$> 3.447 + 0.063(pt - 25)$	> 4.392
$0.8 \leq \eta < 1.479$	$> 2.522 + 0.058(pt - 25)$	> 3.392
$1.479 \leq \eta < 2.5$	$> 1.555 + 0.075(pt - 25)$	> 2.680

VLoose

Region	ePt: 5-10	$10 < ePt < 25$	$ePt \geq 25$
$ \eta < 0.8$	> 1.309	$> 0.887 + 0.088(pt - 25)$	> 0.887
$0.8 \leq \eta < 1.479$	> 0.373	$> 0.112 + 0.099(pt - 25)$	> 0.112
$1.479 \leq \eta < 2.5$	> 0.071	$> -0.017 + 0.137(pt - 25)$	> -0.017

VLooseFO

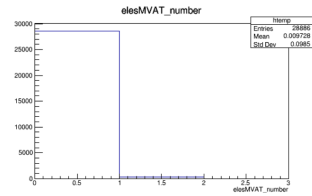
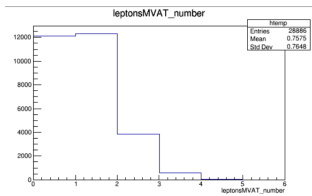
Region	ePt: 5-10	$10 < ePt < 25$	$ePt \geq 25$
$ \eta < 0.8$	> -0.259	$> -0.388 + 0.109(pt - 25)$	> -0.388
$0.8 \leq \eta < 1.479$	> -0.256	$> -0.696 + 0.106(pt - 25)$	> -0.696
$1.479 \leq \eta < 2.5$	> -1.630	$> -1.219 + 0.148(pt - 25)$	> -1.219

Electron Iso

Figure: electron ISO in SS

Table 7: Isolation working points

2016			
isolation value	loose WP (e/μ)	μ (Medium) WP	e (Tight) WP
I_1	0.4	0.16	0.12
I_2	0	0.76	0.80
I_3	0	7.2	7.2



Tau in ttH

Hadronic τ			
Observable	Loose	Fakeable	Tight
p_T	> 20 GeV	> 20 GeV	> 20 GeV
$ \eta $	< 2.3	< 2.3	< 2.3
$ d_z $	< 0.2 cm	< 0.2 cm	< 0.2 cm
Decay mode finding	New	New	New
Decay modes	All	All except 2-prong($+\pi^0$) ¹	All except 2-prong($+\pi^0$) ¹
DeepTau vs. jets	$> \text{WP-VVLoose}$	$> \text{WP-VVLoose}$	Channel-dependent
DeepTau vs. muons	–	$> \text{WP-VLoose}$	$> \text{WP-VLoose}$
DeepTau vs. electrons	–	$> \text{WP-VVVLoose}$	$> \text{WP-VVVLoose}$

Variable definition

- transverse energy

$$E_T^2 = m^2 + (p_T^{\vec{)}}^2 \quad (1)$$

- transverse mass

$$M_T^2 = (E_{T1} + E_{T2})^2 - (p_{T1}^{\vec{}} + p_{T2}^{\vec{}})^2 \quad (2)$$