Tau Dilepton Analysis: $t\bar{t} \rightarrow \tau_h e, \mu jj$

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S. Demers, K. McFarland, T. Vaiciulis

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Introduction

- We are working on the Cross Section * Branching Ratio measurement for $t\bar{t}$ events where one W decays to a tight electron or muon and the other W decays to a hadronic tau.
- We have "new" Tau ID, consistent with Tony's fake rate study as well as what is recommended by the tau group.
- We have data without the TopEventModule and JetCluModule bug that was formerly removing our tight electrons

Tau ID Cuts

Tau Variable	Cut
π^0 + Track P_T	> 15 GeV
$\mid z_0 \mid$	< 60 cm
$\mid D0 \mid$	< 1 cm
(Track + π^0) Mass	< 1.8 GeV/c^2
Cal Iso: ΔR=0.4/$E_T^{cluster}$	< 0.06
# tracks in Iso Annulus	0
# π^0's in Iso Annulus	0
# tracks in Tau Cone	< 4
$\mid \Sigma$(track charge) in Tau Cone $\mid$	1
μ veto	no stubs in 15 degree cone
e veto: E_{HAD}/Σ (P)	> 0.15
seed track quality	≥ 3 stereo SL ≥ 7 hits ≥ 3 axial SL ≥ 7 hits
seed track $\mid$Z CES$\mid$	> 9 cm < 216 cm

Table 1: Tau Cuts: The tau cone and isolation annulus depend on the energy of the tau candidate.

Acceptance

Cut	# of $e\tau$ events	# of $\mu\tau$ events	# of $\tau\tau$ Events
N_{sig}	8687	8836	4485
$N_{geom+ID}$	3419	2943	481
$N_{geom+\tau ID}$	295	244	46
$N_{oppsign}$	293	243	46
N_{1jet}	272	230	42
N_{2jet}	251	214	37
$N_{\not{E}_T}$	230	189	34
$N_{H_T>200}$	208	171	27
$N_{Zmass\ veto}$	200	165	26

Table 2: ttbar acceptance from Pythia Monte Carlo dataset ttopei. There is no matching between HEPG objects and reconstructed objects. We use 382,036 events from this dataset. Of the tautau events, 14 are taus to electrons and 12 are taus to muons

- Our $t\bar{t}$ acceptance can be written as

$$\epsilon_{t\bar{t}}^{MC} = (\text{Total } N_{Zmass\ veto} \ / \ \text{Total Sample Size}) * \epsilon_{trigger}$$

- Our $\epsilon_{t\bar{t}}^{MC}$ is, for electrons:

$$((200+ 14) /382036) *(0.97) = 0.00054 \pm 0.00004(\text{stat})$$

- Our $\epsilon_{t\bar{t}}^{MC}$ is, for muons:

$$((165 + 12) /382036) *(0.94) = 0.00044 \pm 0.00003(\text{stat})$$

- Our total acceptance is 0.00098 ± 0.0004(stat)

$j \rightarrow \tau$ **fakes**

sample	all cuts	Predictions no iso bins	Predictions with iso bins
20	3006 ± 54	1532 ± 63 (50)	2460 ± 119 (50)
		1480 ± 118 (70)	2670 ± 259 (70)
50	949 ± 30	1719 ± 50 (20)	1145 ± 43 (20)
		821 ± 51 (70)	934 ± 60 (70)
70	263 ± 16	546 ± 26 (20)	325 ± 23 (20)
		310 ± 10 (50)	267 ± 9 (50)

Table 3: Comparison of number of events passing all tau ID cuts in each jet sample with prediction using the other jet samples.

- sample: Identification of Sample (Jet20, Jet50, or Jet70)
- all Cuts: The number of events with a tau candidate that survives all cuts
- no iso bins: For each sample, the other two fake rate predictions are used to generate the number of events expected to pass all tau cuts. This third column using predictions before incorporating isolation information into the fake rate analysis.
- with iso bins: This column is the prediction after incorporating 6 regions of isolation into the fake rate analysis.

Njets Table

- In order to test our analysis (and fake rate calculation in particular) we look at our predictions for the number of events due to signal + background as a function of the number of jets in the event.
- We also have two categories in charge product: same sign and opposite sign events (sign of e/μ and τ)
- A good electron is required for the electron table and a good muon is required for the muon table.
- A good tau is required in all entries
- We make the table before the H_T cut and the Z mass removal cuts in order to have more statistics.
- The 1 jet bin requires a 30GeV jet, $\eta < 2.0$
- The 2 jet bin requires an addition 10GeV jet, $\eta < 2.0$
- The WW and WZ columns are not reported. We have upper limits on their values (enough to see that they are negligible for all but the opposite sign 0 jet row) but a hadronic tau filter needs to be applied to these samples in order to keep from over counting jet fakes.
- In the cases with zero events, we assume we had one event to estimate the error.

Njets Tables - electrons and muons

CP, #jets	$t\bar{t}$	$e \rightarrow \tau$	$j \rightarrow \tau$	$\gamma^*/Z \rightarrow \tau\tau$	Total	Data
-1, 0j	0.05±0.01	4.12±0.22	16.91±	5.72±0.67	26.80	33
-1, 1j	0.05±0.01	0.26±0.06	1.31±	0.84±0.25	2.46	3
-1, $\geq$ 2j	0.54±0.03	0.10±0.03	0.64±	0.92±0.10	2.2	
+1, 0j	0.00+0.002	0.05±0.02	11.23±	0.64±0.23	11.92	10
+1, 1j	0.002±0.002	0.0	0.74±	0.0	0.74	2
+1, $\geq$ 2j	0.002±0.002	0.0	0.64±	0.01±0.01	0.65	

Table 4: Njet table, before the H_T cut and Z removal. CP stands for Charge Product of the electron and tau.

CP, # jets	$t\bar{t}$	$j \rightarrow \tau$	$\gamma^*/Z \rightarrow \tau\tau$	Total	Data
-1, 0j	0.03±0.01	8.08±0.56	3.89±0.54	12.0	12
-1, 1j	0.04±0.01	0.52±0.15	0.74±0.22	1.3	1
-1, $\geq$ 2j	0.45±0.03	0.28± 0.05	0.62±0.08	1.35	
+1, 0j	0.0+0.002	3.75±0.36	0.0+0.08	3.75	2
+1, 1j	0.0+0.002	0.43±0.14	0.0+0.08	0.43	0
+1, $\geq$ 2j	0.002±0.002	0.68±0.22	0.0	0.68	

Table 5: Njet table, before the H_T cut and Z removal. CP stands for Charge Product of the muon and tau. Errors on jet to tau fakes are statistical.

PLANS/TO-DO

- Elena Vataga and Carmine Pagliarone (Pisa) are working on the Drell Yan $\mu\mu$ background estimate.
- WW, WZ filtered events
- Background table
- Systematics