$l + \tau$ channels with NN cuts

ATLAS Workshop on τ lepton Physics

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Serban Protopopescu, BNL

$l + \tau$ event selection

Event sample: 200 pb^{-1} @14 TeV

To convert to 100 pb^{-1} @10 TeV: Divide W, Z events/2.5, $t\bar{t}$ events/4.0

- $p_T > 15$ GeV
- $|\eta| < 2.5$
- μ:
  - isCombinedMuon()
  - $\Delta R(\mu, jet) > 0.4$
  - Track Isolation ptcone20$<$ 2.5 GeV
  - Cal. Isolation etcone40$<$ 4.0 GeV
- e:
  - Medium

- τ:
  - $0 <$no. of tracks< 4
  - charge$\neq 0$
  - both TauRec and Tau1P3P required
  - Remove e or μ overlap
  - elikelihood$_\tau > 0$ (only for $e + \tau$)

Define (as suggested by Ryan Reece)

cosadd$\equiv$

$\frac{1}{2}[(p_x^l \cdot \not{E}_T{}^x + p_y^l \cdot \not{E}_T{}^y)/p_T^l + (p_x^\tau \cdot \not{E}_T{}^x + p_y^\tau \cdot \not{E}_T{}^y)/p_T^\tau]/\not{E}_T$

cosdif$\equiv$

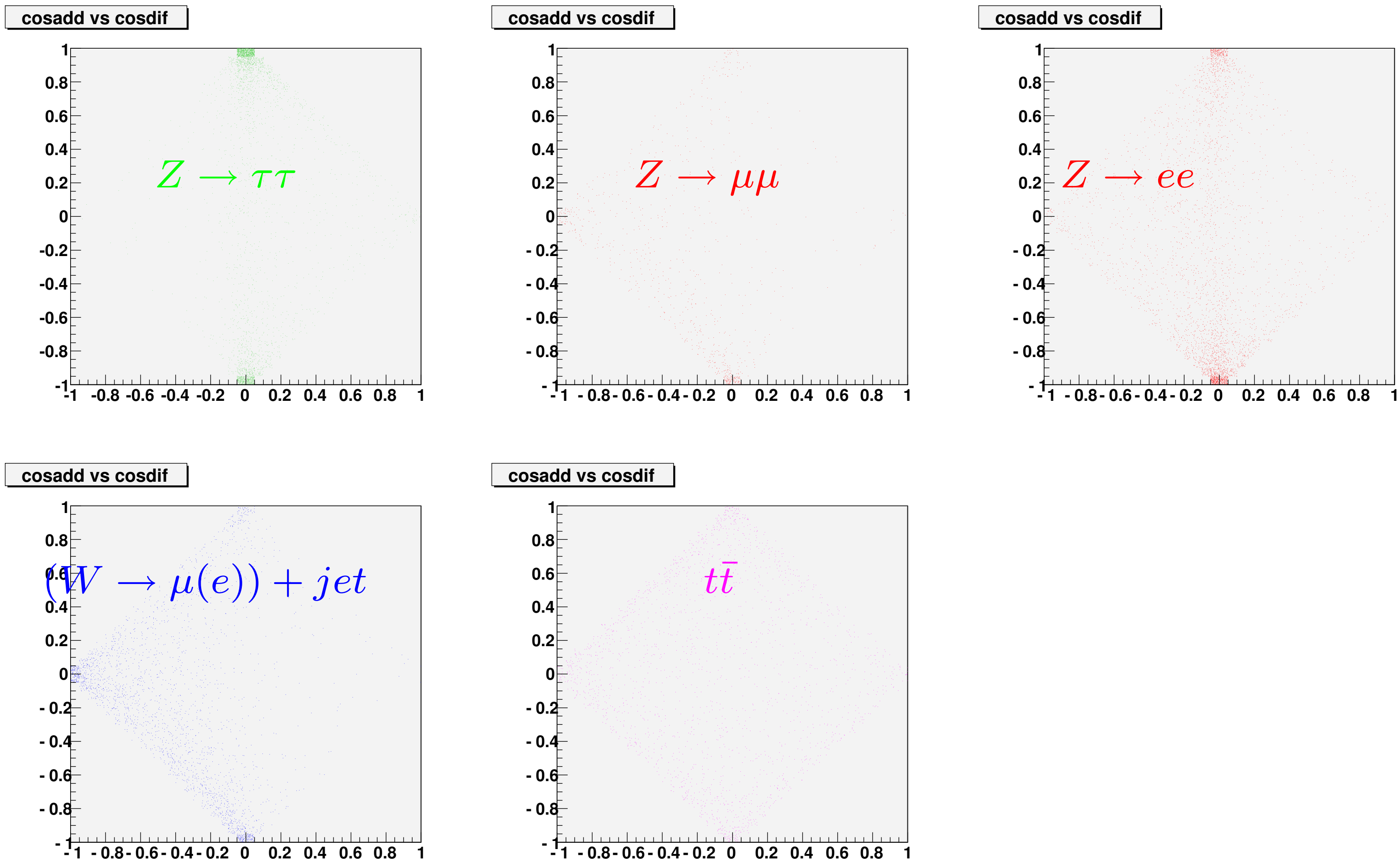
$\frac{1}{2}[(p_x^l \cdot \not{E}_{T\,x} + p_y^l \cdot \not{E}_{T\,y})/p_T^l - (p_x^\tau \cdot \not{E}_{T\,x} + p_y^\tau \cdot \not{E}_{T\,y})/p_T^\tau]/\not{E}_T$

cosadd=0 : l ,τ back-to-back (in x,y plane)

cosdif=0 : l ,τ lined up (in x,y plane)

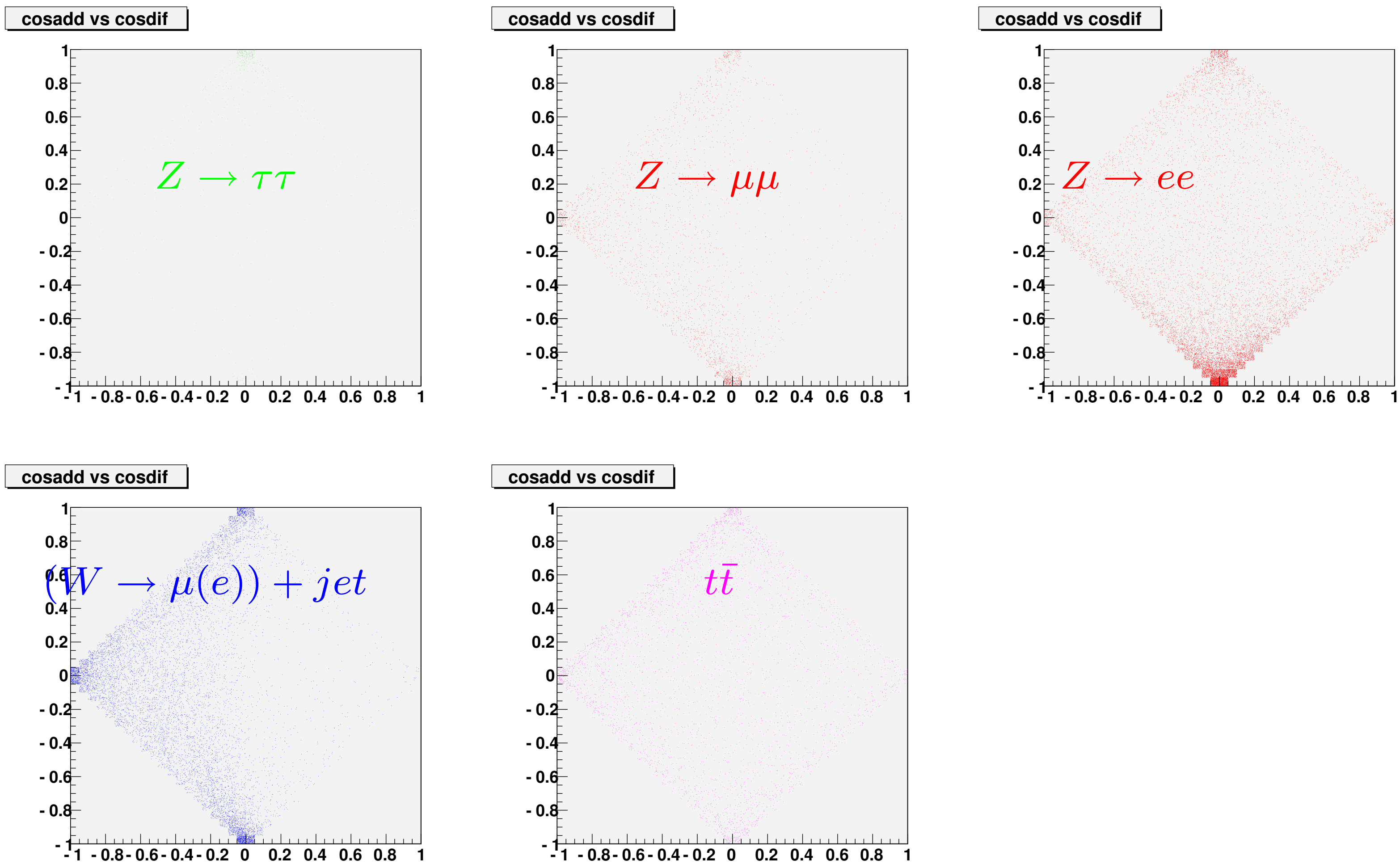
Pick OS (opposite sign) l, τ

$\mu + \tau$ cosadd vs cosdif, $NN > 0.7$



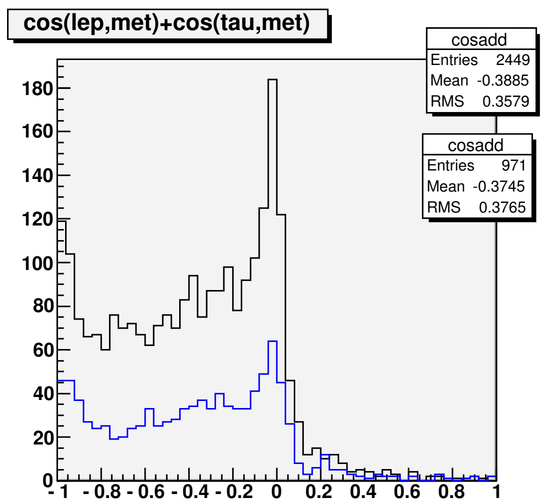
$(W \to \mu(e))$ has $W \to \tau(\to \mu(e))$, fakes from $Z \to ee$ mostly e's

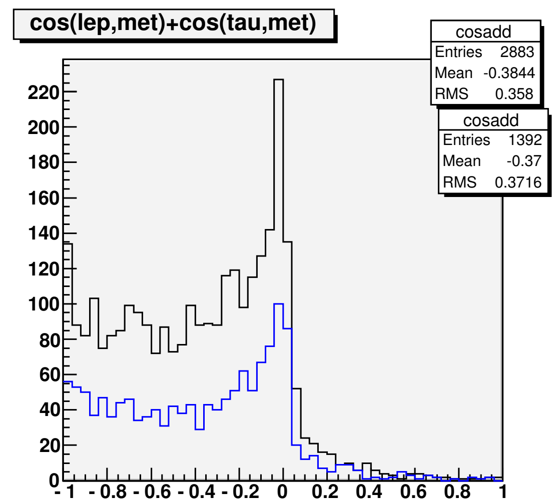
$\mu + \tau$ cosadd vs cosdif, $NN < 0.3$

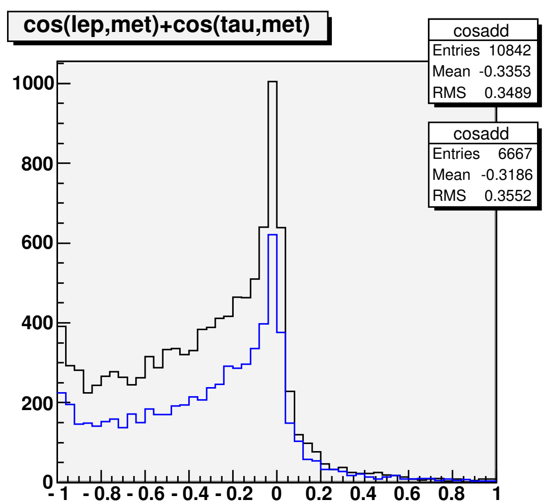


fakes from $Z \to ee$ mostly $jets$

cosadd $W(\rightarrow \mu) + jets$ OS SS





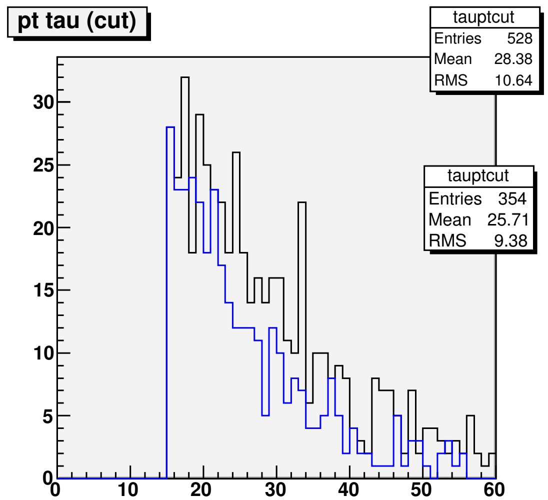


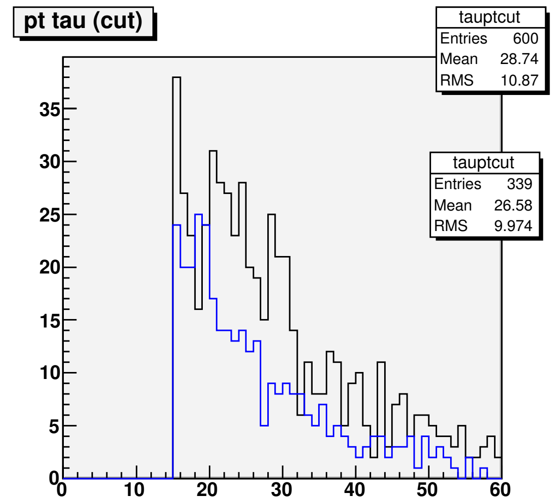
$NN > 0.7$ OS/SS=2.5

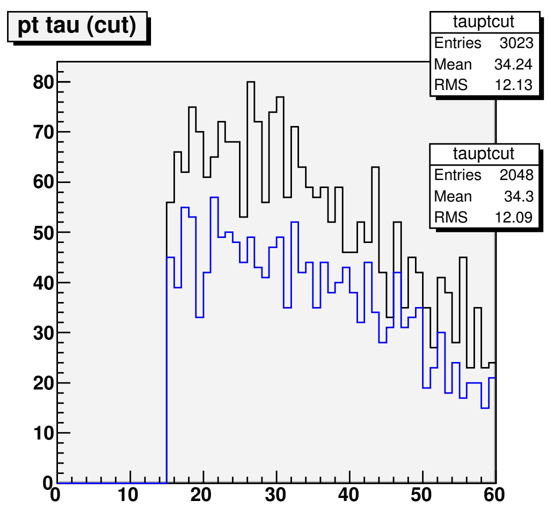
$0.3 > NN > 0.7$ OS/SS=2.07

$NN < 0.3$ OS/SS=1.62

p_T^τ $W(\rightarrow \mu) + jets$ OS SS (cosadd> -0.2)





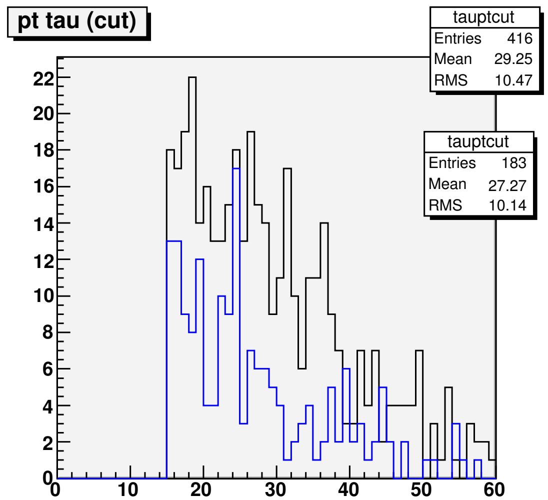


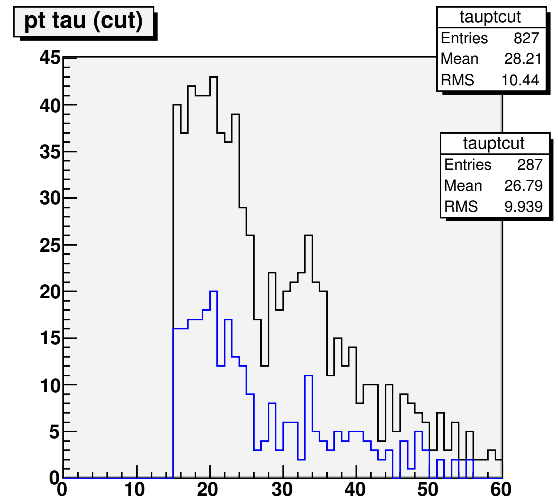
$NN > 0.7$ OS/SS=1.5

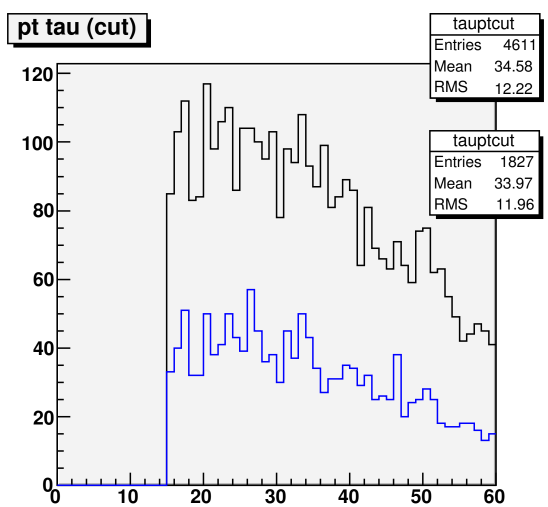
$0.3 > NN > 0.7$ OS/SS=1.8

$NN < 0.3$ OS/SS=1.5

p_T^τ $W(\rightarrow e) + jets$ OS SS (cosadd> −0.2)







$NN > 0.7$ OS/SS=2.3

$0.3 > NN > 0.7$ OS/SS=2.9

$NN < 0.3$ OS/SS=2.5

"Fake Data" and "Predictions"

- Divide all MC data into 3 regions: $NN > 0.7$, $0.3 < NN < 0.7$, $NN < 0.3$
- Construct fake OS data histograms by adding with appropriate weights: $Z \to \tau\tau$, $Z \to \mu\mu|ee$ $W \to \mu|e + jet$, $t\bar{t}$
- "Prediction":
  - Same channels but replace $W \to \mu|e + jets$ OS with $W \to \mu|e + jets$ SS
  - Minuit fit to fake data varying weights in each region (3 weights/channel)
- Fitted histograms:
  - cosadd (only NN cut)
  - after cosadd> -0.2: cosdif
  - add cosdif> -0.8: p_T^l, M_T^l, p_T^τ, M_T^τ, p_T^{jet} inc, $cos(jet, \not{E}_T)$, likelihood
  - add $M_T^{\mu|e} > 45$: $M(\mu|e, \tau)$, $M(\mu|e, \tau, \not{E}_T)$

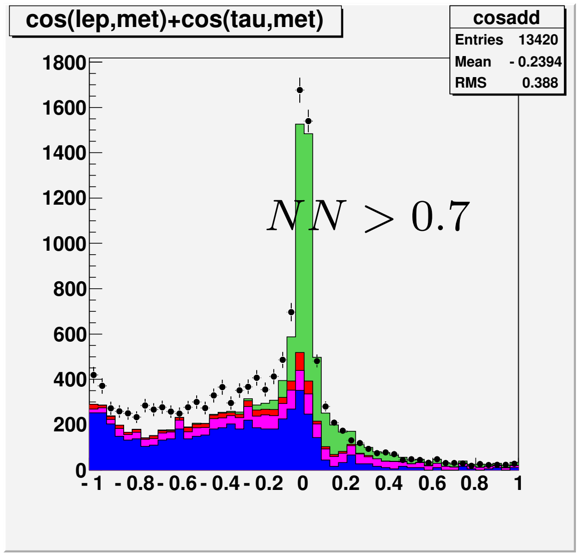
cosadd distributions

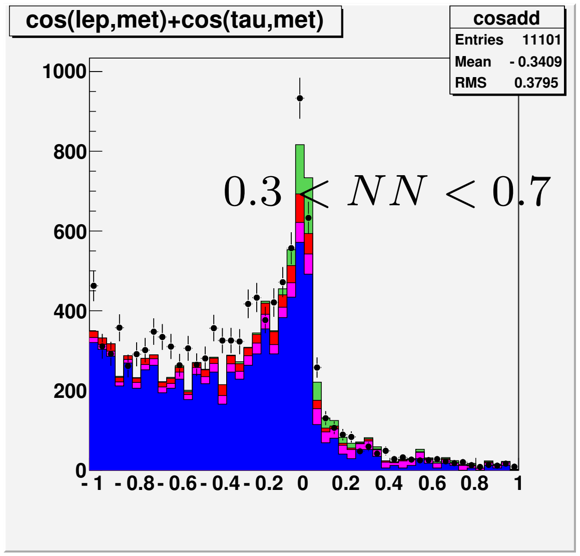
$Z \rightarrow \tau_\mu \tau_h$

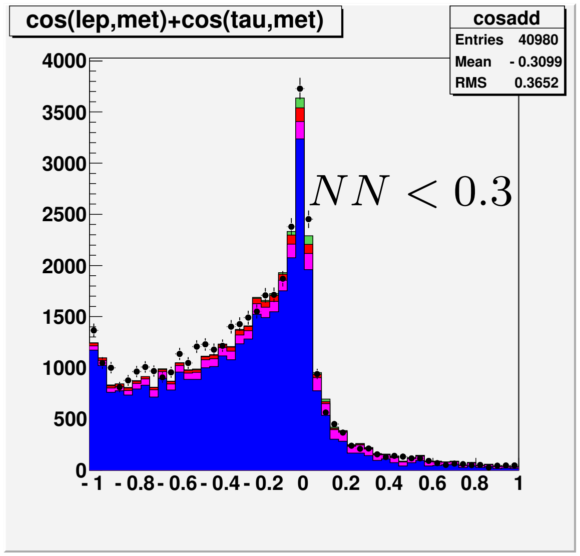
$Z \rightarrow \mu\mu$

$(W \rightarrow mu) + jet$ (SS)

$t\bar{t}$







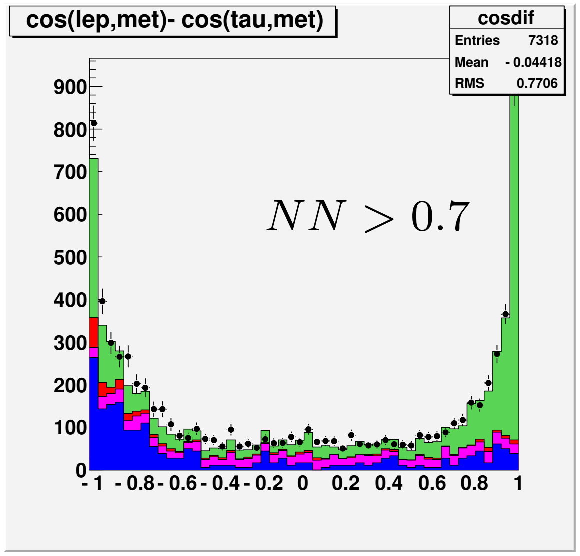
cosdif distributions (cosadd> -0.2)

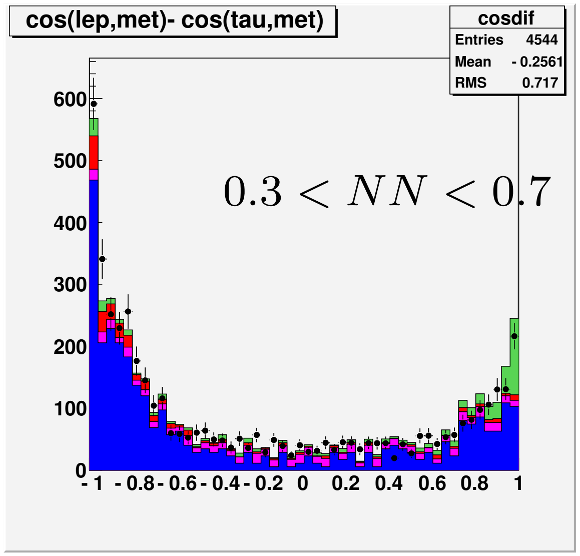
$Z \rightarrow \tau_\mu \tau_h$

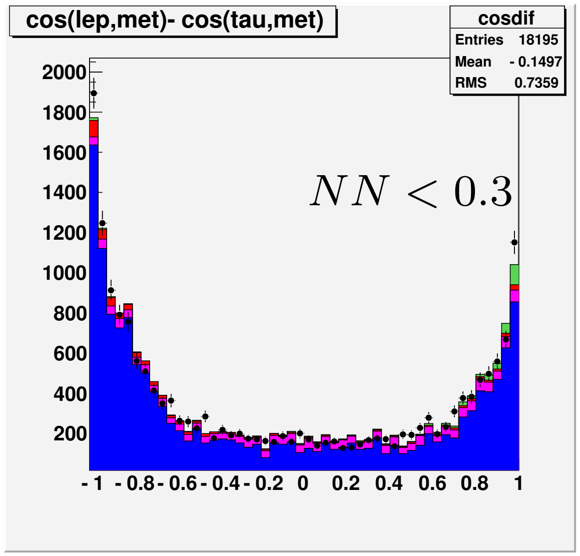
$Z \rightarrow \mu\mu$

$(W \rightarrow \mu) + jet$ (SS)

$t\bar{t}$







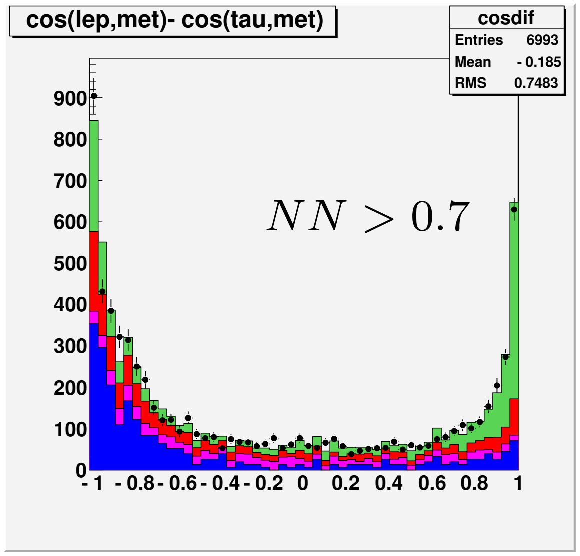
cosdif distributions (cosadd> -0.2)

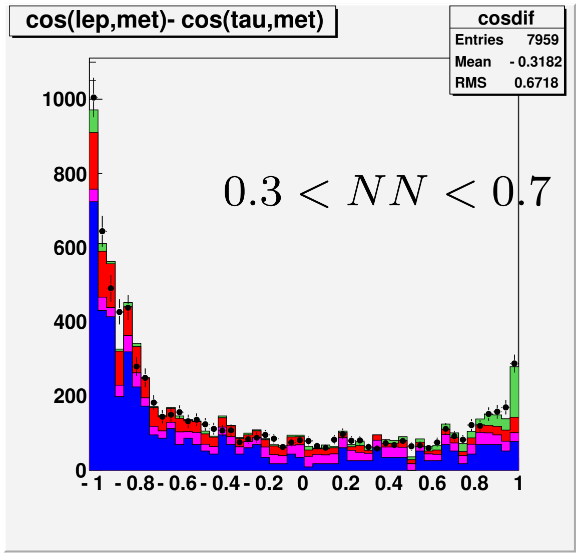
$Z \to \tau_e \tau_h$

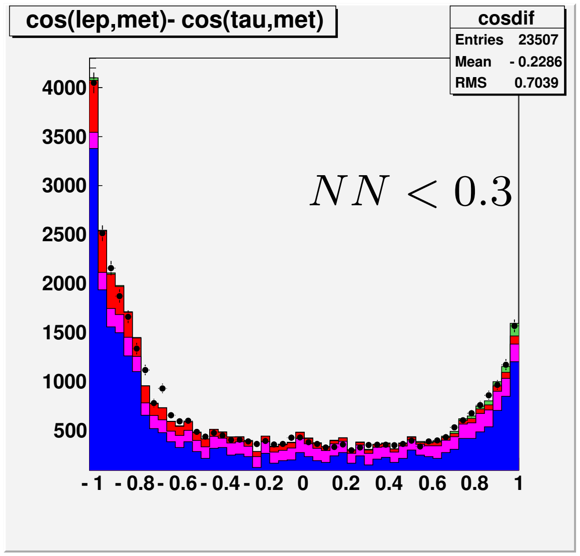
$Z \to ee$

$(W \to e) + jet$ (SS)

$t\bar{t}$







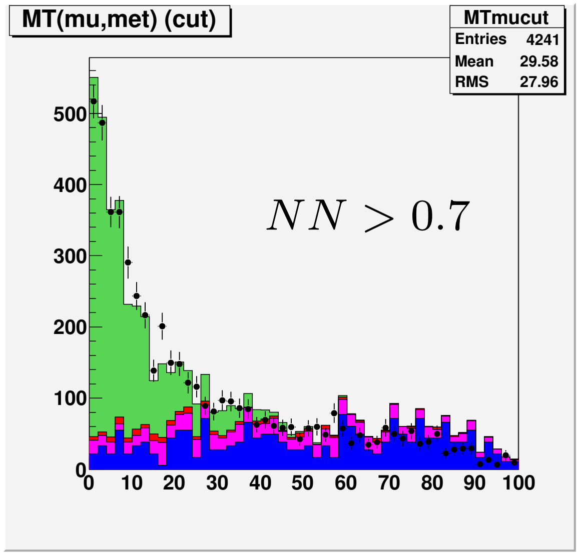
M_T^μ distributions (cosadd> -0.2, cosdif> -0.8)

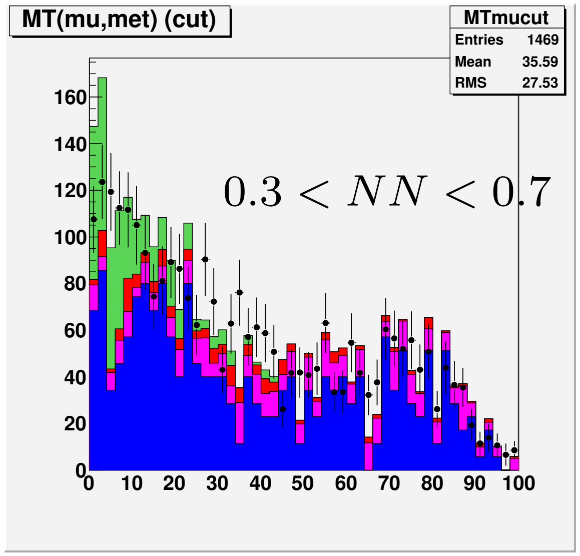
$Z \to \tau\tau$

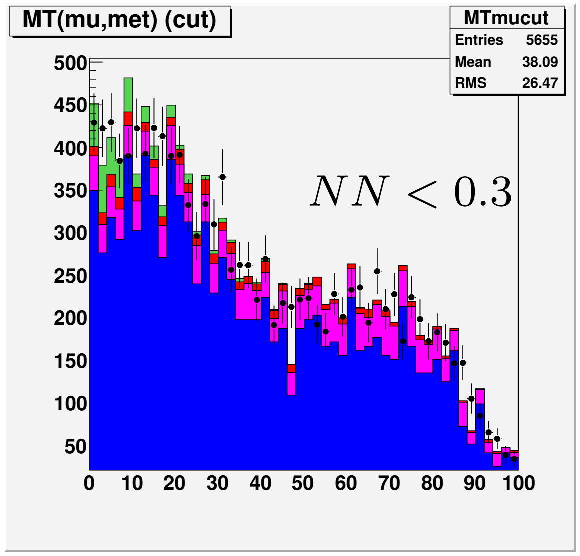
$Z \to \mu\mu$

$W \to \mu\nu + jet$ (SS)

$t\bar{t}$







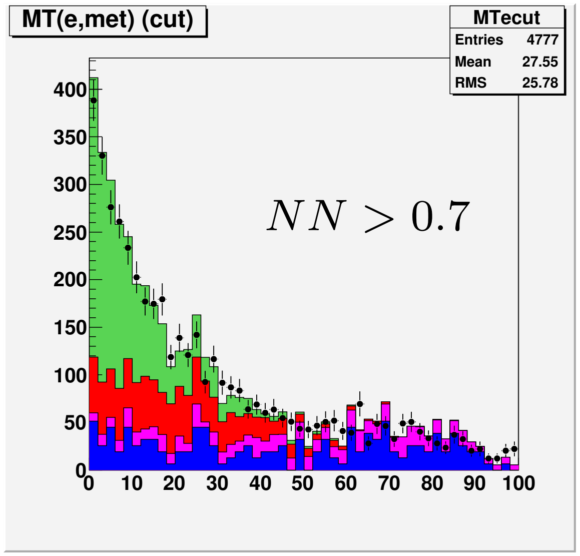
M_T^e distributions (cosadd> -0.2, cosdif> -0.8)

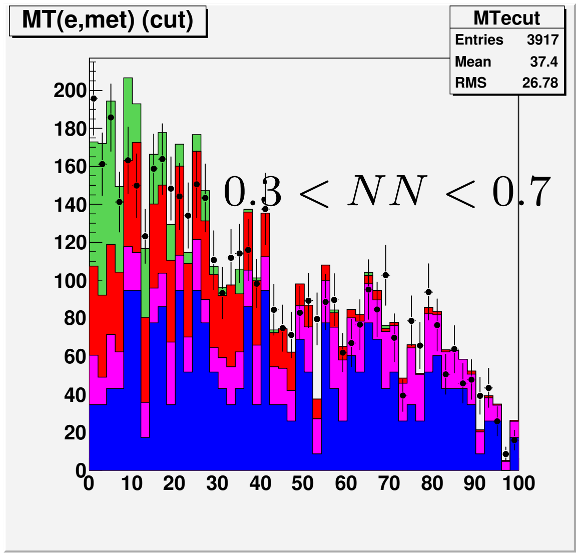
$Z \to \tau\tau$

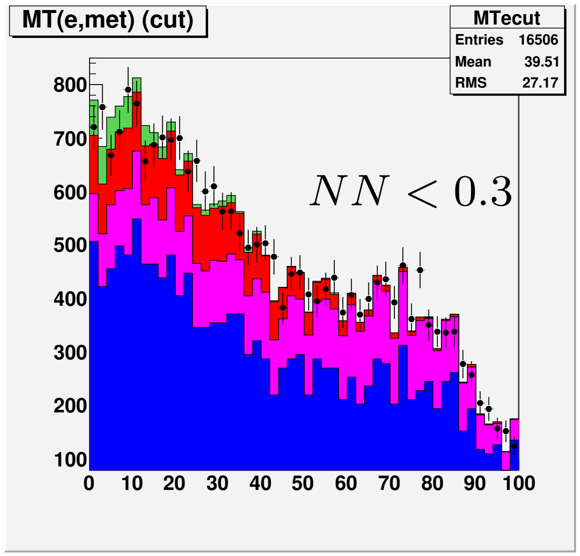
$Z \to ee$

$(W \to e) + jet$ (SS)

$t\bar{t}$







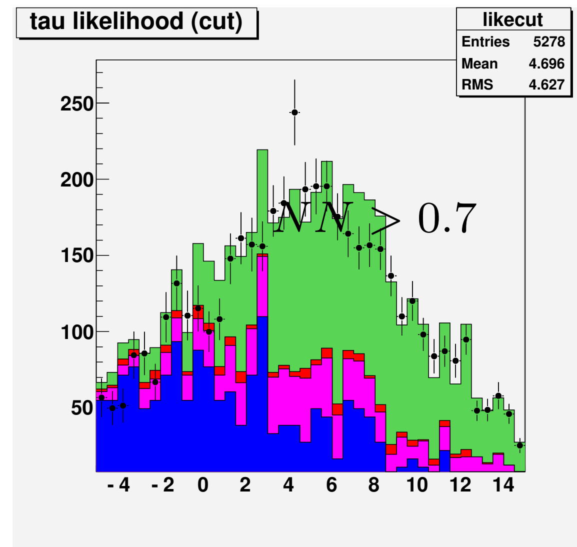
LL distributions (cosadd> -0.2, cosdif> -0.8)

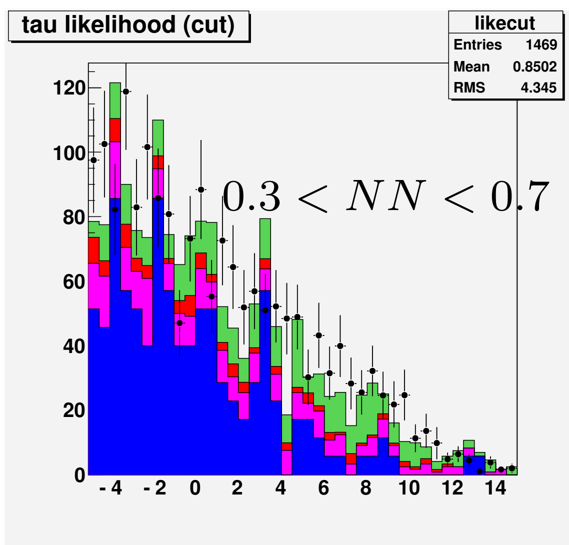
$Z \to \tau\tau$

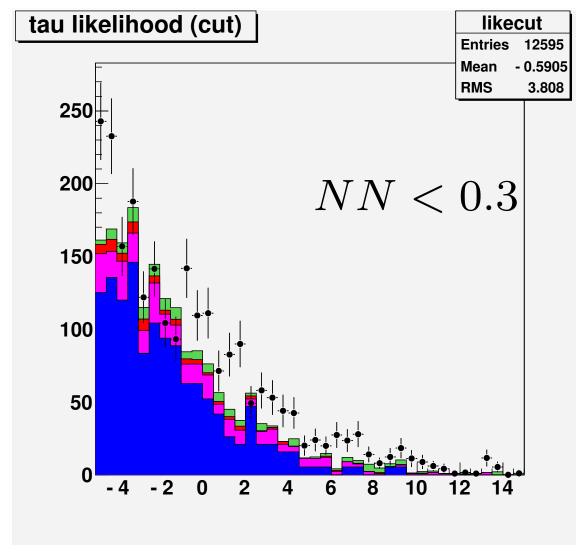
$Z \to \mu\mu$

$(W \to \mu) + jet$ (SS)

$t\bar{t}$







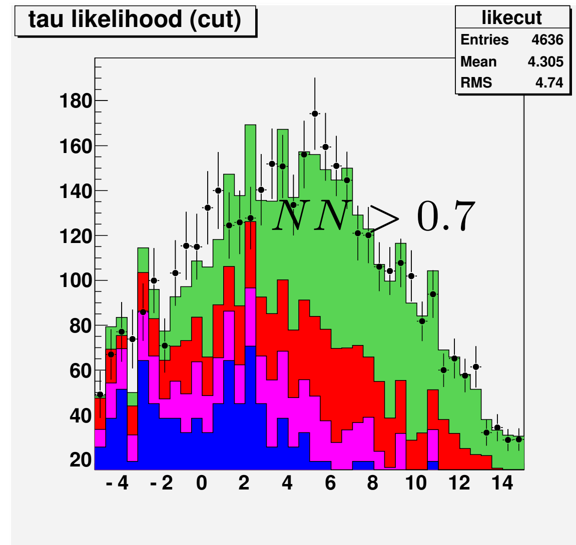
LL distributions (cosadd> -0.2, cosdif> -0.8)

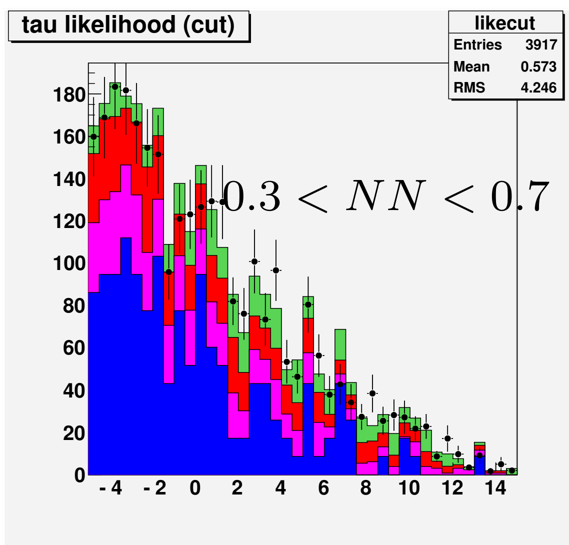
$Z \to \tau\tau$

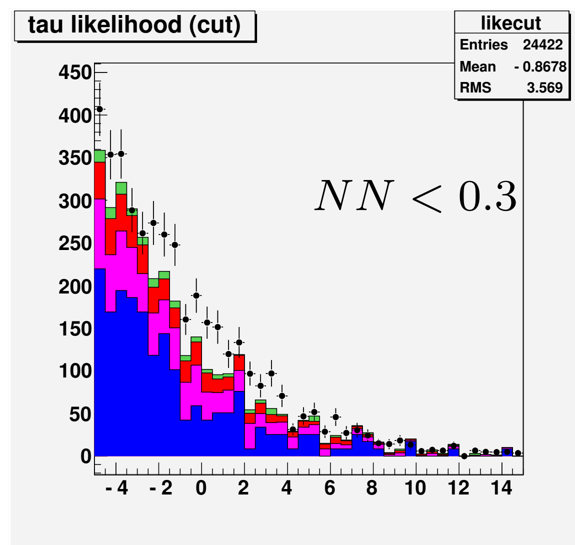
$Z \to ee$

$(W \to e) + jet$ (SS)

$t\bar{t}$







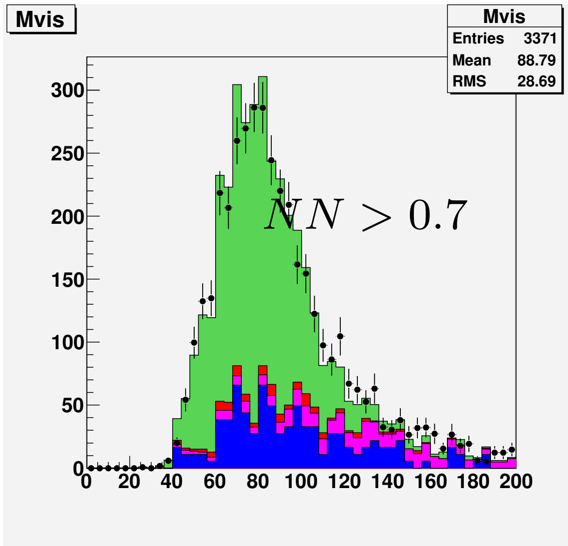
M_{vis} distributions (cosadd> -0.2, cosdif> -0.8 ,$M_T^{\mu} < 45$)

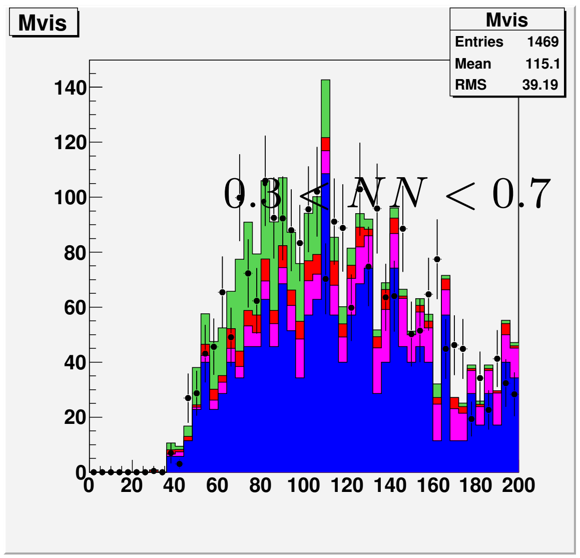
$Z \to \tau\tau$

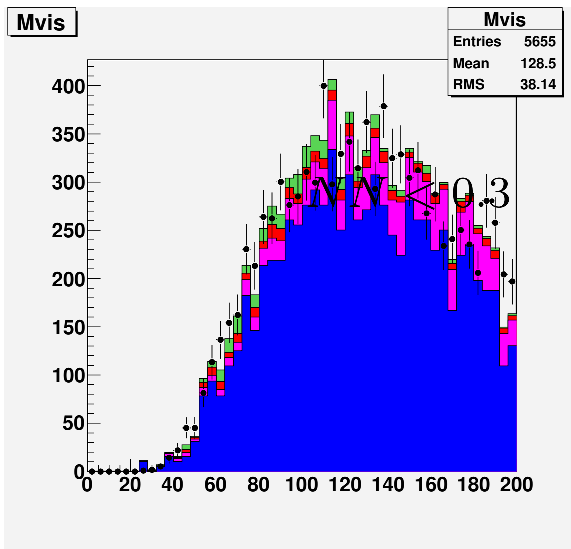
$Z \to \mu\mu$

$(W \to \mu) + jet$ (SS)

$t\bar{t}$







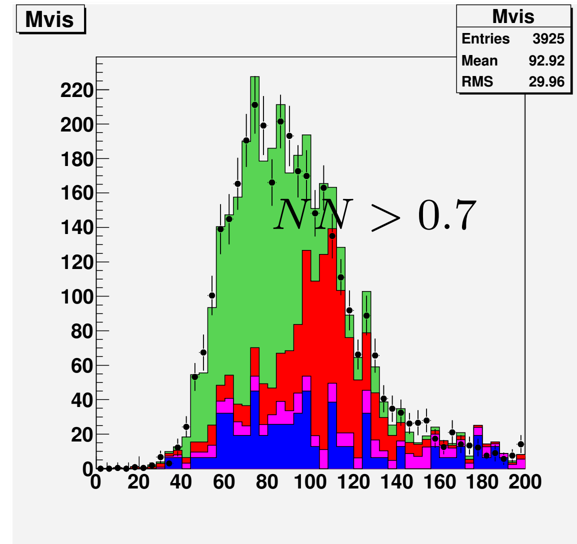
M_{vis} distributions (cosadd> -0.2, cosdif> -0.8 ,$M_T^{\mu} < 45$)

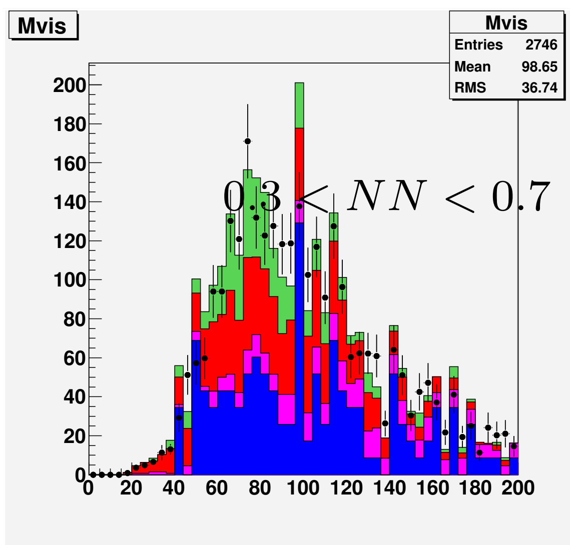
$Z \rightarrow \tau\tau$

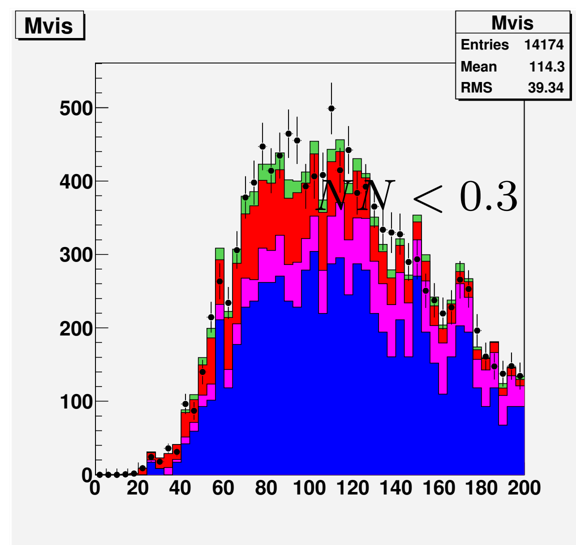
$Z \rightarrow ee$

$(W \rightarrow e) + jet$ (SS)

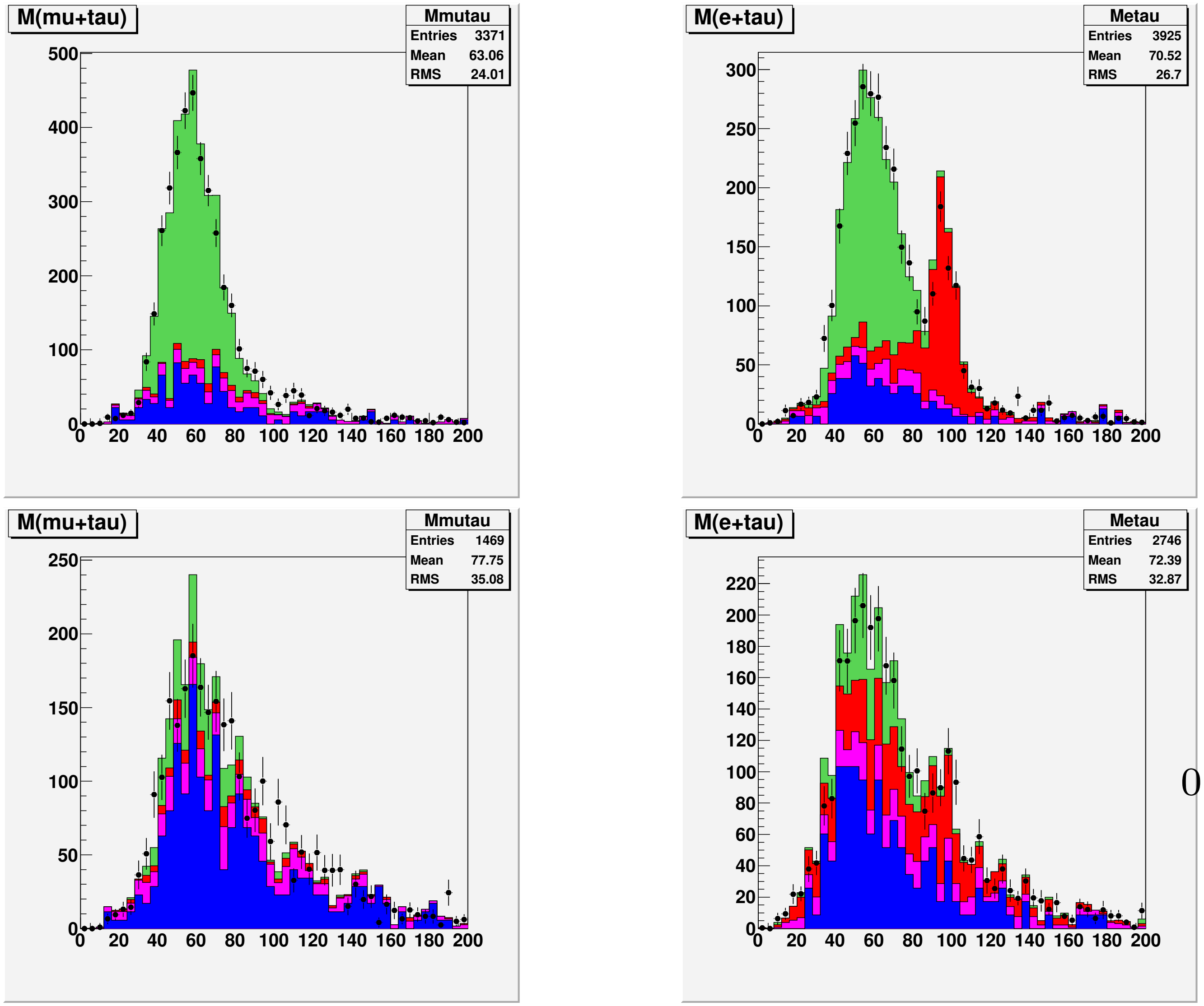
$t\bar{t}$







$M(\mu, \tau)$ $M(e, \tau)$



$NN > 0.7$

$0.3 < NN < 0.7$

$\mu + \tau$ event selection for $t\bar{t}$

Add following requirements:

- tight τ: Ntracks=1, $NN > 0.9$
- at least 2 jets $p_T > 20$ GeV

	OS/SS	
	$W + jets$	$t\bar{t}$
$NN > 0.9$	1.5 ± 0.3	6.2 ± 0.3
$0.3 > NN > 0.7$	1.7 ± 0.2	1.9 ± 0.1
$NN < 0.3$	1.5 ± 0.15	1.5 ± 0.05

Define $H_T \equiv \sum p_T^{jets} + \sum p_T^{l} + \not{E}_T$

$\mu + \tau$ Mvis and HT, $NN > 0.9$

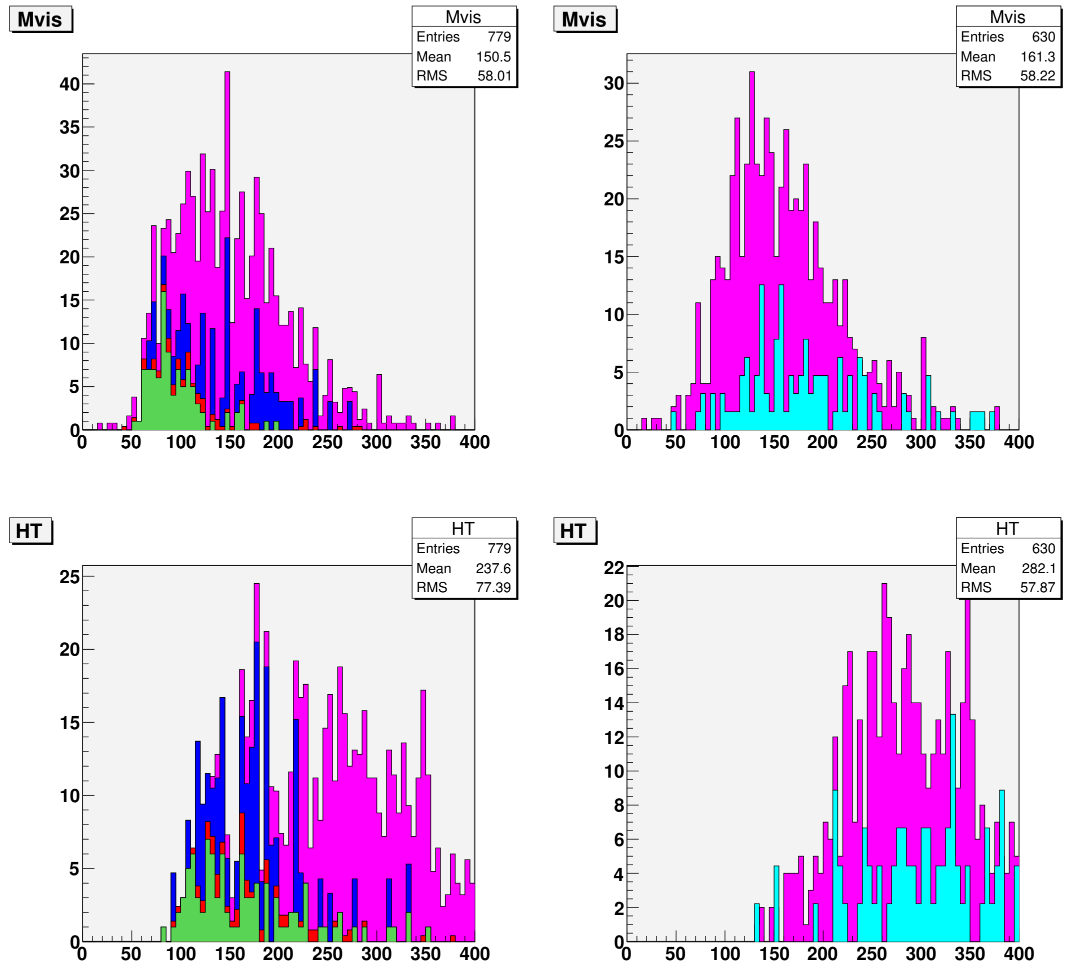
$Z \rightarrow \tau\tau$

$Z \rightarrow \mu\mu$

$W + jets$

$t\bar{t}$(no τ)

Main bckg to $t\bar{t}$ is $t\bar{t}$



CONCLUSIONS

- OS/SS for $W + jets$ can be as large as 2.5. A function of NN and p_T^τ (probably correlated). Larger for $W(\rightarrow e) + jets$ (elikelihood$_\tau$ cut?).
- Cuts in cosadd and codif plane effective for reducing bckg to $Z \rightarrow \tau\tau$. Optimization will be different for $\mu + \tau$ and $e + \tau$ channels.
- $Z \rightarrow \tau_e \tau_h$ channel has significant $Z \rightarrow ee$ after e removal and elikelihood$_\tau$ cut
- elikelihood$_\tau$ cut increases ratio $W + jets/Z \rightarrow \tau\tau$
- LL> 4.0 removes a significant number of τ's accepted by $NN > 0.7$ with little improvement in S/B. Keeps some additional τ's from region $0.3 < NN < 0.7$ (with some S/B deterioration).
- Main bckg to τ from $t\bar{t}$ are jets from $t\bar{t}$